COUNTY OF LOS ANGELES
CHIEF ADMINISTRATIVE OFFICE

713 HALL OF ADMINISTRATION LOS ANGELES CALIFORNIA 90012
974-1101

RICHARD B. DIXON
CHIEF ADMINISTRATIVE OFFICER

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To Xavier Swamikannu	From Marshall Langberg
Dept. Regional Water Quality Control Board	Co. LA County CAO
Fax # (213) 266-7600	Phone # (213) 893-2479
	Fax # (213) 626-7836

November 19, 1992

To: Each Supervisor

From: Richard B. Dixon
Chief Administrative Officer

Subject: **FORMATION OF BALLONA CREEK CLEANUP TASK FORCE**

This memo reports on the formation and initial discussions of the Ballona Creek Cleanup Task Force.

On September 22, 1992, on motion of Supervisor Deane Dana, as amended by Supervisor Edmund D. Edelman, your Board instructed my office "to coordinate formation of a Ballona Creek Cleanup Task Force to investigate the causes of recurring pollution and develop recommendations to eliminate these causes, including possible establishment of a hotline giving the public quick access to reports." As discussed below, we have formed a Task Force as outlined in the motion composed of specified County departments, affected state and local jurisdictions and public interest organizations. The Task Force held an organizational meeting on October 28,1992 and formed two working groups: Emergency Response and Best Management Practices. In addition, a number of preliminary issues for investigation were identified. The Task Force will meet again as a whole, and within working groups, and will report to your Board with their findings and recommendations within 90 days.

Other governmental units have indicated they are also focusing on Ballona Creek. State Senator Charles Calderon's Senate Committee on Toxics and Public Safety Management recently held a hearing on the contamination of Southern California beaches, and Los Angeles City Council Member Ruth Galanter introduced a motion dealing with the same subject. The Ballona Creek Cleanup Task Force members believe that their efforts also address the problems of beach pollution identified by Senator Calderon and Council Member Galanter.

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JURISDICTIONS

The Ballona Creek Watershed is approximately 127 square miles in area and encompasses the jurisdictional boundaries of Beverly Hills, West Hollywood, Culver City, and portions of Los Angeles, Inglewood, Santa Monica, and unincorporated County territory. No one jurisdiction is in charge as each jurisdiction oversees parts of the Ballona Creek drainage basin. Few formal mechanisms outlining roles and responsibilities exist, however, informal relationships exist among the many jurisdictions with responsibility for monitoring and reporting on water quality within the basin to form the basis for an emergency response program. In addition, there are programs in place or in the advanced planning stages that have the potential to reduce significantly the causes of recurring pollution.

TASK FORCE WORKING GROUPS

The Task Force is composed of the County Departments of Health Services, Public Works, Beaches and Harbors, and the Sanitation District. Other jurisdictions and organizations on the Task Force include the Cities of Los Angeles, Beverly Hills, Culver City, Inglewood, Santa Monica, West Hollywood and Heal the Bay, Santa Monica Bay Restoration Project, and the Regional Water Quality Control Board. A roster of those attending the first Task Force meeting is attached.

At the Task Force's organizational meeting on October 28, 1992, members created two working groups:

1. Emergency Response Working Group to review existing Emergency Response Programs, and a

2. Best Management Practices Working Group to set priorities among various Best Management Practices and expedite their implementation.

Emergency Response Working Group

The Emergency Response Working Group will be chaired by the County Department of Health Services with substantial participation by the City of Los Angeles' Bureau of Sanitation Environmental Monitoring Division. The City of Los Angeles has been an active participant in Task Force activities. A list of Working Group members is attached.

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This group will review the Emergency Response Program for Beach Closures as incorporated in the County Department of Health Services's Beach Regulatory and Monitoring Protocol. Task Force members were unanimous in their view that Beach Protocol procedures represent state-of-the-art public policy in ocean water bacteriological monitoring and corrective actions when standards are not met. The Emergency Response working group will recommend policies to reduce or eliminate jurisdictional problems which may sometimes slow the ability of governmental agencies to respond quickly to discharges into Ballona Creek.

The Emergency Response Group will also examine the applicability of the emergency response program of the Los Angeles County Fire Department's Hazardous Materials Unit to the ability of other emergency teams to reduce or eliminate jurisdictional barriers. Other subjects to be discussed include establishment of a high level team of officials, to include substantial participation by the City of Los Angeles and the County, to provide additional coordination for emergency response teams. In the event of a discharge, city officials would have immediate access to DHS experts in monitoring and Department of Public Works specialists with knowledge of the storm drain system.

The group will also consider an 800 Hotline Information Number to be made part of the Department of Beaches and Harbors surf line number to advise the public of beach closures. In addition, the Department of Public Works is developing a separate 800 number in conjunction with the County District Attorney's Office to allow citizens to report illegal discharging activities into flood control facilities.

Best Management Practices Working Group

This working group will be headed by the County Department of Public Works. The Department has responsibility as Principal Permittee under a National Pollutant Discharge Elimination System Municipal Stormwater Permit to submit a plan to the California Regional Quality Water Control Board to establish Best Management Practices (BMP). A BMP is a stormwater quality management practice that can significantly enhance stormwater/urban runoff water quality. An Early Action BMP, for example, may be directed at either improving the frequency of existing storm drain catch basin cleaning or the stricter enforcement of existing regulations.

The group, which includes the City of Los Angeles' Bureau of Sanitation Storm Water Management Division, will develop recommendations to establish priorities among BMPs

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and to expedite their implementation, once these practices have been approved by the Regional Water Quality Control Board, in an attempt to identify and eliminate pollution sources. A list of this working group's participants is attached.

The Ballona Creek Cleanup Task Force working groups on Emergency Response and Best Management Practices will be meeting over the next few weeks before reporting their recommendations to the Task Force as a whole. The Task Force will report to your Board within 90 days.

RBD:GK
ML:ne

Attachments

c: County Counsel
Executive Officer, Board of Supervisors

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BALLONA CREEK CLEANUP TASK FORCE

Angus Alexander
Senior Lifeguard
Los Angeles County Lifeguard Association

William Buol
Civil Engineer
City of Santa Monica

Larry Charness
Chief
Planning Division
Department of Beaches and Harbors
Los Angeles County

John Dorsey
Assistant Division Manager
Environmental Monitoring
Bureau of Sanitation
City of Los Angeles

Sam Furuta
Assistant Director
Bureau of Sanitation
City of Los Angeles

Robert Horvath
Assistant Department Engineer
Los Angeles County Sanitation District

Mark Gold
Staff Scientist
Heal the Bay

Jerry Greene
Associate Civil Engineer
City of Santa Monica

Mike Hawk
Associate Civil Engineer
City of Culver City

Richard Kebabjian
Chief, Recreational Health
Department of Health Services
Los Angeles County

Richard Kennon
Associate Civil Engineer
City of Inglewood

Rod Kubomoto
Section Head, Water Quality Management
Department of Public Works
Los Angeles County

Ralph Lopez
Deputy Director
Environmental Health
Department of Health Services
Los Angeles County

Michael Lyons
Head, Surveillance Unit
Regional Water Quality Control Board

Jose Ochoa
Hazardous Materials Specialist
Forester and Fire Warden

Ed Otsuka
Utilities Superintendent
City of Beverly Hills

Jack Petralia
Bureau Director
Environmental Protection
Department of Health Services
Los Angeles County

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Phil Richardson
Division Head
Storm Water Management
Bureau of Engineering
City of Los Angeles

Sharon Schiffman
City Engineer
City of West Hollywood

Xavier Swamikannu
Water Resources Control Engineer
Regional Water Quality Control Board

Guang Yu Wang
Environmental Specialist
Santa Monica Bay Restoration Project

[illegible]
11/18/92

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0004728

BALLONA CREEK TASK FORCE
EMERGENCY RESPONSE WORKING GROUP

CHAIR: Ralph Lopez
Deputy Director
Environmental Health
Department of Health Services
Los Angeles County

MEMBERS:

Angus Alexander
Senior Lifeguard
Los Angeles County Lifeguard Association

John Dorsey
Assistant Division Manager
Environmental Monitoring
Bureau of Sanitation
City of Los Angeles

.m Furuta
Assistant Director
Bureau of Sanitation
City of Los Angeles

Mark Gold
Staff Scientist
Heal the Bay

Clarence Henson
Intergovernmental Relations
Chief Administrative Office
Los Angeles County

Richard Kebabjian
Chief, Recreational Health
Department of Health Services
Los Angeles County

Rod Kubomoto
Section Head, Water Quality Management
Department of Public Works
L Angeles County

Michael Lyons
Head, Surveillance Unit
Regional Water Quality Control Board

Jose Ochoa
Hazardous Materials Specialist
Forester and Fire Warden

Jack Petralia
Bureau Director
Environmental Protection
Department of Health Services
Los Angeles County

BALLONA CREEK TASK FORCE
BEST MANAGEMENT PRACTICES WORKING GROUP

CHAIR: Rod Kubomoto
Section Head, Water Quality Management
Department of Public Works
Los Angeles County

MEMBERS:

Angus Alexander
Senior Lifeguard
Los Angeles County Lifeguard Association

John Dorsey
Assistant Division Manager
Environmental Monitoring
Bureau of Sanitation
City of Los Angeles

Mark Gold
Staff Scientist
Heal the Bay

Phil Richardson
Division Head
Storm Water Management
Bureau of Engineering
City of Los Angeles

Xavier Swamikannu
Water Resources Control Engineer
Regional Water Quality Control Board

Guang Yu Wang
Environmental Specialist
Santa Monica Bay Restoration Project

ne\g\mtgrp.2
11/9/92

VOL 11 0004229

November 13, 1992

To: RPG, RAH, DCG, JML, WDJ, XS
From: LMJ

RE: BALLONA CREEK CLEANUP TASK FORCE - STORM DRAIN COMMITTEE MEETING

A Storm Drain Committee Meeting was held on November 10, 1992 (participant listing attached). The committee wanted to establish Storm Drain Emergency Response guidelines. Sam Furuta (LA City Sanitation) indicated that during the September incident investigation (refer to JML's 10/30 memo) if there had been no jurisdictional restrictions, then his crew would have opened up the manholes and continued to investigate the problem. He believed that if there had been an MOU, then his crew would have been allowed to find the problem and cleanup would have been done by the appropriate party.

Ralph Lopez, LA Co. DHS, will look into the legal aspects of establishing an MOU. In the Ballona Creek drainage, five cities and one county have jurisdiction. If the Task Force were to expand its analysis to the Santa Monica Bay drainage, at least 19 cities would be involved. If the focus expanded to LA Co. (except the desert area), then there would be 85 cities. Initially Lopez wanted to establish generic guidelines and have the Storm Drain Emergency Response be applicable to all stormdrains, not just those associated with Ballona Creek. However, in light of the number of cities involved, the Task Force will focus on the Ballona Creek drainage to get a better handle on establishing appropriate guidelines. These guidelines can later be expanded to larger drainage areas.

A question was brought up whether this process might be better accomplished through the NPDES stormwater permit, maybe through the implementation plan. Lopez will investigate the legal issues regarding the identification of the cities and the language that can be used in reference to the NPDES permit. Two other issues (financial, operational) were discussed in reference to the establishment of guidelines.

The financial issue revolves around the identification of the responsible party (RP) that would pay for the cleanup costs of spills. Apparently, there are some local and state laws in place, or that will be in place, that would allow recovery of costs from an RP, if identified. If an RP is not identified, then an agreement should be established so that the agency that has jurisdiction in the area of the spill would pay for cleanup, even if that agency is not directly involved with the cleanup. Jack Petralia (LA Co. DHS) and Jose Ochoa (LA Co. FD) will be looking into this issue.

The third issue, operational, involves the identification of the key players and the emergency numbers involved, the establishment

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or refinement of emergency spill response (including what constitutes the minimum response team necessary), and the establishment of preventive measures. Petralia and Rod Kubomoto (LA Co. DPW) will obtain and organize this information. It was acknowledged that the role of the smaller cities involved would need to be determined. It might be easier if LA City and LA Co. were allowed to respond to spills regardless of jurisdiction. That way the smaller cities might not have to establish their own emergency response team.

There was discussion on preventive measures and incorporating them into the BMPs that each agency has or will have developed under the NPDES permit. Some of the committee felt that these measures should be included in the Storm Drain Emergency Response guidelines. The concern is that some cities might not be willing to use the BMPs without the approval from the Regional Board. Under the permit system, this may take some time.

One specific measure that was brought up was chlorination, when and when not to use it. This goes back to the DFG and DHS apparently incompatible goals: wildlife vs. public health. Furuta brought up the issue that under the NPDES permit LA City is supposed to chlorinate sewage spills when Lopez indicated that Ballona Creek was getting chlorinated. There seemed to be some confusion about this issue. I indicated that the permit likely did not have a condition that chlorine be put directly into the creek and that the Jackson facility has a system involving chlorine contact time before discharge. I said that this is a separate situation from the one where one dumps chlorine into a storm drain or river after a spill has occurred. Mark Gold (Heal the Bay) indicated that a chlorine chase would more likely cause harm than good and not provide the health protection for which it was intended. Basically, if chlorination is to be discussed under preventive measures, then the agencies would need to be educated as to when chlorine can be used for disinfection and why it serves no purpose under other conditions.

In the end, the committee will re-examine what is being done now in terms of emergency response and will determine the appropriate responses and guidelines necessary to address spills. Lopez anticipates that another committee meeting will be held the week of November 30th.

I've added a summary of this memo to JML's Ballona Creek summary report for the December EO report.

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11/10/-

Storm Drain Committee

Name	Agency	Phone
Ralph Lopez	L.A. Co DPW	213-881-4000
Jack Petralia	L.A. Co DHS	213-881-4011
Jose Ochoa	L.A.C. F.D. (NWCP)	213-890-4061
John Dorsey	CLA San/EMD	
Sam Furuta	CLA-Sanitation	(213) 485-5112
Lauma Jurkevics	CRWQCB-L.A.	(213) 266-7609
Rod Kubomoto	L.A.C.D.P.W.	(818) 458-3537
Clarence Henson	L.A.C./LAD	1(213) 893-2164
Angus Alexander	LA Co Lifeguard	Message 310 769-6109 W. 310 305-95
Mark Gold	Heal the Bay	(310) 394-4552

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0004322

R0033200

October 30, 1992

TO: RPG, RAH, DCG, WDJ, XS

FROM: JML

RE: BALLONA CREEK CLEANUP TASK FORCE

Approximately 20 people attended the first meeting of the task force on October 28, 1992 (see attached list). The task force was established in response to a motion adopted by the LA County Board of Supervisors (proposed by Supervisor Dana) and in anticipation of a similar motion being proposed by Councilwoman Ruth Galanter.

We decided to establish one working group, headed by Ralph Lopez (LA County Health Department), to evaluate the current emergency response when high bacteriological counts are found in Ballona Creek. The general consensus of the group is that beach closure and warning protocols are fairly well established (but there is a need for a public access number for information on beach closures). The major area needing improvement is the response to identify sources of the contamination. Under the present loosely defined response system, any agency (eg., City of LA, LA County, etc.) investigating the storm drain system to look for sources of contamination passes on the problem when reaching the limit of its jurisdiction. This is inefficient and often results in confusion, delays, or even complete stoppage of the investigation. The goal of this working group is to establish a system for crossing jurisdictional boundaries, identify response teams and define the actions required to investigate the problem, and consider possible cost recovery mechanisms. I volunteered to be part of this group.

A second working group, headed by Rod Kubomoto LA County Department of Public Works), will evaluate how the NPDES Stormwater Permit can be used to address these problems. The general consensus of the group is that eventually the permit should lead to better Best Management Practices or other solutions which may keep toxic materials and bacteriological contamination out of the stormdrains, but this will be a long process. In the short-term, the group will focus on what can be done to control trash and litter and keep it from reaching the beaches (eg. street sweeping, catch basin maintenance). I volunteered Xavier for this group.

Both committees intend to meet soon and hope to produce recommendations within 90 days.

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OCTOBER 28, 1992

NAME	AFFILIATION	PHONE NO.
JOHN DORSEY	City of L.A., Environmental Monitoring Division	(310) 648-5272
Mark Gold	Heal the Bay	(310) 394-4582
Richard Kellman	CITY OF INGLEWOOD	(310) 412-5333
ANGUS ALEXANDER	LACO LIFEGUARD ASSOC.	(310) 769-6109
Guangyu Wang	SMBRP	(213) 266-7568
Gary Greene	City of Santa Monica	(310) 458-8926
William Buol	" " "	(310) 458-8721
Mike Hawk	Culver City	(310) 202 5791
ED OTSUKA	BEVERLY HILLS	(310) 285-2495
Corey Cheng	CAO-LA. Cty	974-1305
Bob Horvath	LACSD	310-699-7411
Michael Lyons	LA Regional Water Quality Control Board	213 266-7616
Sam Furuta	CLA-Sanitation	(213) 485-5112
Ralph Lopez	- Dept of Hlth Service	(213) 881-4000
MARSHALL LANGBERG	CAO	213 893-2479
Jack Petralia	DHS	213-881-4011
RICHARD KEBABTIAN	DHS	213 881-4160
Jose Olave	L.A.C.F.D.(HWCP)	213-890-4045
Phil Richardson	City of LA/Engr.	213-362-6346
[illegible]	LACFW	[illegible]

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R0033202

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
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THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O.BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

JG 6948

VOL 11 — 000435

October 6, 1992

IN REPLY PLEASE REFER TO FILE WM-3

X5

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)
QUARTERLY PROGRESS REPORT (1992 3 Q) 5 #9

The following report is submitted in compliance with the above-captioned Permit, which was issued on June 18, 1990. This report provides a summary on the status of specific Permit tasks performed during the first quarter (July 1, 1992 through September 30, 1992) of the third year of the Permit which began on July 1, 1990.

Phase I (Santa Monica Bay Drainage Basin)

During this period, the Principal Permittee continued to organize and chair the monthly Co-Permittee meetings to coordinate Permit compliance. The terms of the Permit Implementation Agreement (Task 3.3) were finalized. A copy of the Agreement was provided to all Co-Permittees on July 15, 1992, for formal adoption. We have, to date, received signed Agreements from 15 of the 21 Co-Permittees. One additional Co-Permittees (16 total) have indicated that their City Council has approved the Agreement and will be forwarding us a signed copy.

The Permittees are still waiting for formal approval from your agency of our Early Action Best Management Practices (BMPs) Plan (Task 2.1.8); Stormwater/Urban Runoff Monitoring Program (Task 2.1.9); and Additional BMPs Plan (Tasks 3.1, 3.1.2, 3.1,3, and 3.1.4). Upon receiving approval from your agency, implementation of these programs will commence.

Enclosed with this status report is an updated version of the Location of Industry by SIC Code map (Task 2.1.3). This version incorporates the information provided to us by the City of Los Angeles. An updated tabulation listing the breakdown of industries by drainage area is also included.

The Los Angeles County Department of Public Works (LACDPW) has recently initiated a field inspection of the Pico-Kenter drainage system and Ballona Creek for illegal connections and/or illicit discharges.

Phase II (Upper Los Angeles River and Upper San Gabriel River Drainage Basins)

During this period, the Principal Permittee conducted three monthly Co-Permittee meetings to coordinate Permit compliance.

Included in this submittal is a copy of the deadlines set by the Principal Permittee for the first-year submittals required by the Permit. The various deadline dates were established to facilitate the completion of first-year tasks and the compilation of information to be forwarded to your agency.

Other Activities

During our routine storm drain maintenance inspections, the LACDPW field staff encountered an unusually high level of dry-weather discharge into Arcadia Wash from the Santa Anita Park (Racetrack). An analysis of the discharge showed very high bacteria counts indicating fecal contamination from human and/or animal sources. We are working with the Racetrack to resolve the problem. We will keep your agency updated on the status of this matter.

If you have any questions, please contact Rod Kubomoto at (818) 458-3537.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

FK:mp
WM-3/FYR4

Enc.

cc: Co-Permittees

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MINUTES OF THE BOARD OF SUPERVISORS
COUNTY OF LOS ANGELES, STATE OF CALIFORNIA

Larry J. Monteith, Executive Officer
Clerk of the Board of Supervisors
383 Hall of Administration
Los Angeles, California 90012

VOL 11

Chief Administrative Officer

At its meeting held September 22, 1992, the Board took the following action:

8

Supervisor Dana made the following statement:

"On Friday, September 4, 1992, we had yet another example of the continuing environmental concerns in dealing with the ocean waters in Santa Monica Bay, its multiple causes of unhealthful debris, polluted waters and other flotsam that find their way into Ballona Creek and then onto our beaches and ocean waters. Late Friday afternoon a spill of unknown origins forced the closures from the Imperial entrance at Dockweiler Beach to 23rd Street north of the Venice Pier. This is only the latest example. During 1991, these polluting materials forced closure of surrounding beach areas 14 times. Thus far, in 1992 the beaches have had to be closed on six occasions.

"The causes for the contamination are not limited to a single source or location, as the area ultimately draining into Ballona Creek ranges many miles inland. Clearly, too, responsibility for possible solutions is not limited to a single agency or government. Yet a solution is essential if we are to protect the public's health, especially along the beach and ocean area. While identifying those 'hidden' culprits who dump materials into street and storm drains will be difficult, targeting violators throwing refuse into the creek as a cost-saving measure could be possible.

"Achieving workable solutions, therefore, dictates a multi-level examination of the causes of the pollution and development of corrective steps."

(Continued on Page 2)

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R0033205

Syn. 8 (Continued)

Therefore, on motion of Supervisor Dana, seconded by Supervisor Hahn, unanimously carried, the Board took the following actions:

1. Instructed the Chief Administrative Officer to coordinate formation of a Ballona Creek Cleanup Task Force to investigate the causes of recurring pollution and develop recommendations to eliminate these causes, including possible establishment of a hot line giving the public quick access to reports;

2. Instructed that the Task Force include representatives from all County Departments involved with Ballona Creek, including the Departments of Public Works' Flood Control Section, Beaches and Harbors, Health Services and the Westside Sanitation Districts; and

3. Further instructed that the Task Force should also involve participation by the City of Los Angeles and other cities within the Ballona drainage basin.

Later in the meeting, on motion of Supervisor Edelman, seconded by Supervisor Dana, unanimously carried, the Board reconsidered the foregoing motion.

Supervisor Edelman offered an amendment to Supervisor Dana's motion to include on the Task Force, representatives from Heal the Bay, Santa Monica Bay Restoration Projects and the Regional Water Quality Control Board.

Supervisor Dana accepted Supervisor Edelman's amendment. On motion of Supervisor Edelman, seconded by Supervisor Dana, unanimously carried, Supervisor Dana's motion, as amended, was adopted.

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Copies distributed:
Each Supervisor
County Counsel
Director of Beaches and Harbors
Director of Health Services
Director of Public Works
Chief Engineer and General Manager,
Sanitation Districts

VOL 11 0004398

R0033206

** *BREAKFAST WORKSHOP FOR LOCAL GOVERNMENTAL OFFICIALS* **

FOCUS ON URBAN RUNOFF
IMPACT OF STORMWATER REGULATION ON LOCAL AUTHORITIES

Wednesday, July 8, 1992

Reuben's Restaurant
4211 Admiralty Way, Marina Del Rey

Held by: Los Angeles County Department of Public Works (LAC-DPW)

Sponsors: Santa Monica Bay Restoration Project (SMBRP)
Los Angeles Regional Water Quality Control Board (LARWQCB)

AGENDA

7:30 - 7:45 **Registration**

(Breakfast will be served at 7:45)

8:00 - 8:15 **Introduction and Welcome**

The Honorable Supervisors Deane Dana and Ed Edelman
Jim Noyes, Deputy Director, LAC-DPW

8:15 - 8:45 **Understanding Urban Runoff**

Catherine Tyrrell, Director, SMBRP

Urban runoff has been identified as contributing disproportionately to degradation of waterbodies in the Santa Monica Bay Watershed. This session will provide background information on the urban runoff problem, answer such questions as why pollution from urban runoff is a concern, what pollutants are found in urban runoff, and where those pollutants come from.

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8:45 - 9:15 **Understanding the NPDES Permit**

Dr. Robert Ghirelli, Executive Officer, LARWQCB

Recognizing the need to react quickly and responsibly to the urban runoff problem, in early 1990, key members of the SMBRP formed a working group to devise a strategy for the development of a stormwater management program. As a result, the Regional Water Quality Control Board issued a NPDES permit for municipal stormwater discharges to the County of Los Angeles Department of Public Works (as the principal permittee), with cities and other agencies as co-permittees.

In this session, Dr. Ghirelli will explain why the State issued the permit, the innovative strategy and phasing approach outlined by the permit, the timeline, and the compliance requirements of the permit.

9:15 - 9:30 **Questions and Discussion**

9:30 - 9:45 **Break**

9:45 - 10:45 **Panel - Perspectives on Progress**

Moderated by Neil Miller, Public Services Director,
City of Manhattan Beach

The success of the pollution control programs under the NPDES permit will depend on timely compliance of all co-permittees with permit requirements. The first year co-permittee tasks are considered relatively easy to accomplish. Down the road, co-permittees will face more difficult tasks. On this panel, involved parties will discuss their perspectives on how challenging these tasks will be to local municipalities, the likelihood of success, and the social and legal consequences of non-compliance.

- o Federal perspective - Bill Pierce, Chief Water Permit Branch U.S. EPA, Region IX
- o Environmental group perspective - Cliff Gladstein, President Heal the Bay
- o Co-permittees' perspective - Jim Noyes, LAC-DPW

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10:45 - 11:30 **Panel - Looking to the Future**

Moderated by Catherine Tyrrell, Director, SMBRP

The future looks bright... but only if we know how to accomplish and fund our tasks. And it makes sense for municipalities in the watershed to work together to create a program that will be adaptable to the characteristics of this region. On this panel, experts will share their knowledge and experience with the audience on four important issues frequently raised by co-permittees:

o Linkages between land use planning, watershed management & urban runoff pollution control	Craig Perkins Environmental Services Manager City of Santa Monica
o Looking for BMPs? Find out where to get them	Doug Harrison Chairman State Stormwater Task Force
o Can we afford to implement the permit? - Financing local programs	Phil Richardson Division Engineer Stormwater Management Division City of Los Angeles

11:30 - 12:00 **Open Discussion and Wrap-up**

Jim Noyes, Deputy Director, LAC- DPW

12:00 **Adjournment**

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COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

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THOMAS A. TIDEMANSON, Director

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P.O. BOX 1460
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July 1, 1992

IN REPLY PLEASE REFER TO FILE WM-3

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)
SECOND YEAR REPORT (1992 2Q) 15 #8

The following report is submitted in compliance with the provisions of NPDES Permit No. CA0061654. It provides a status report on the performance of Permit mandated tasks during the period July 1, 1991 to June 30, 1992.

Permit Tasks	Status
2.1.3	The remaining activity under this task, the identification of Standard Industrial Code (SIC) categories of facilities in drainage areas, has been completed. Information is being provided for all of the Santa Monica Bay Drainage Basin with the exception of that portion contained within the City of Los Angeles. The required information for the City of Los Angeles was not available at the time of this submittal. An updated version of this submittal which incorporates the City of Los Angeles data will be forwarded to you upon completion. Enclosed is a map showing industries by SIC category within drainage areas, plus a tabular database (Enclosure A) listing each drainage area, each SIC category found in that drainage area, and the total number of locations under each category.
3.1.1	The proposed workplan for the stormwater/urban runoff monitoring program was submitted to you for your approval on March 26, 1992. Approval of the workplan has not yet been received. Implementation of the workplan will begin subsequent to your approval.
3.1.2 3.1.3 3.1.4	Enclosed for your review and approval are the three proposed plans as required by these three Permit tasks (Enclosure B). Plans are included herein for all Permittees except Ventura County which became a Co-Permittee on February 24, 1992. Ventura County has been informed that they need to independently schedule public review of their plans prior to submittal to you.

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R0033210

As required, the proposed plans were circulated for public review from May 29 through June 17, 1992. Comments received and our response to the comments are included with the enclosure.

3.2 The Early Action Best Management Practices (BMP) plan was submitted to you for approval on January 22, 1992. Though approval of the plan has not yet been received, two Co-Permittees, the Cities of Los Angeles and Torrance, have elected to submit a progress report on the implementation of various BMPs (Enclosure E). The remaining Permittees will begin reporting on the implementation of Early Action BMPs subsequent to your approval.

3.3 Information concerning existing legal authorities was submitted as part of our existing BMP compilation during year one. In addition, a Stormwater Permit Implementation Agreement has been developed among the Phase I Permittees. This agreement clarifies the individual and collective responsibilities of each Permittee under the Permit. The agreement addresses the following major areas: (1) defining and characterizing the drainage areas of the storm drain system; (2) determining existing BMPs that enhance the quality of storm runoff; (3) developing Additional BMPs; and (4) insuring that adequate legal authority exists to regulate illegal discharges and illicit disposal practices affecting the drainage system and the ability to prosecute violators.

The agreement has been circulated to all Phase I Co-Permittees for final processing and adoption. A copy of the agreement is enclosed for your information (Enclosure C).

Phase II of the Permit, which involves the Upper Los Angeles River and Upper San Gabriel River Drainage Basins, begins July 1, 1992. Information meetings for Phase II cities were held on February 12, and May 27, 1992. To date, 33 of the 36 new cities in this Phase have submitted their Letters of Intent (see Enclosure D).

If you have any questions, please contact Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:mp
SYR

Enc.

cc: Phase I Permittees

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Heal the Bay.

1640 FIFTH STREET, SUITE 112
SANTA MONICA, CA 90401
310-394-4552 ; (fax) 310-395-6878

June 17, 1992

Mr. Jim Noyes
Los Angeles County Department of Public Works
Waste Management Division
Stormwater Discharge Program
P.O. Box 1460
Alhambra, CA 91802-1460

Dear Mr. Noyes

Heal the Bay respectfully submits the following comments on the proposed additional Best Management Practices (BMPS) required under NPDES permit no. CA0061654. Heal the Bay is a local environmental group with over 11,000 members dedicated to restoring, protecting, and preserving the Santa Monica Bay for people and marine life.

It is difficult to give detailed comments on Los Angeles County Department of Public Works (LACDPW) compilation of proposed additional BMPs required under Sections 3.1.2, 3.1.3, and 3.1.4 of the storm water NPDES permit for the region. One of the major reasons for this difficulty is the failure of the Regional Water Quality Control Board (RWQCB) to respond to the co-permittees on the adequacy of their Early Action BMPs submittal. Without knowledge of which BMPs are considered acceptable by the RWQCB for compliance with permit requirements, it is impossible to determine if the proposed additional BMPs achieve the goals of the discharge permit. The RWQCB must comment immediately on the proposed early action BMPS and provide direction to the cities under the permit before the co-permittees develop and implement programs that fail to achieve the desired impacts of pollutant load reductions and beneficial use protection. In addition, storm water pollution reports completed under the auspices of the Santa Monica Bay Restoration Project will prove to be invaluable references for co-permittees to develop and refine their storm water management and monitoring programs. Unfortunately, these reports were not available by the second year due date for permit compliance.

With the aforementioned comments in mind, the following are general comments on the proposed additional BMPs.

The need for more extensive program descriptions - Between the submittal of the early action and additional BMPs to the RWQCB, one should be able to assess the full extent of the BMPs used by a specific co-permittee. Unfortunately, many of the cities may have vastly underestimated their programs. For example, the City of Los Angeles decided not to include any of the BMPs that they are completing under the federal consent decree requirements. Santa Monica and Malibu did not adequately explain their storm drain ordinances in either the early action or additional BMP documents.

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Both documents contain numerous construction and flow reduction BMPs for new development. In addition, the Santa Monica ordinance contains numerous BMPs to reduce the pollutant load in runoff.

Another example of the lack of detailed programs are the BMP submissions by cities on the Palos Verdes peninsula. At first glance, the BMPs appear woefully inadequate, but perhaps there are justifiable reasons for the lack of new BMPs. The land uses on Palos Verdes are almost exclusively residential so there would be few BMPs for non-residential land. In addition, most of the cities' storm water drains into ESHAs or canyons that need to be protected because of high natural resource values. None of these resource protection requirements are mentioned in any of the documents. Obviously, co-permittees should submit far more comprehensive documents to the RWQCB. It is better to include too much detail on your BMP programs than too little. As it stands now, it is extremely difficult to accurately assess the storm water management programs for the cities.

Permit task 3.1.2 - The cities of Torrance and Los Angeles did an excellent job of submitting comprehensive storm water management programs and the city of Santa Monica also has a strong storm water management program. Co-permittees should model their programs on these three cities.

The additional BMPs submitted by most of the co-permittees were just lists of BMPS. Cities (and the County) need to take a more integrated approach to developing BMP based storm water management programs. Among the larger needs are land use based BMP programs. A BMP that is effective for an industrial land use may be ineffective for residential land uses. Also, programs need to include pollutant specific BMPs. BMPs that are effective at removing total suspended solids and/or oil and grease are imperative for successful programs.

None of the cities included transportation based land use BMPs. Considering that transportation practices in the County are probably the largest source of heavy metals and petroleum hydrocarbons to the storm drain system, BMPs that reduce the number of vehicles on the road, reduce vehicle trips and miles, and increase the use of public transportation are extremely important in reducing storm drain pollution.

A major oversight of the cities was their general failure to include BMPs on funding mechanisms for their storm water programs. In these economic times, a consistent source of funding for storm water programs is a necessity, not a luxury. Only the city of Los Angeles has a program that is not susceptible to the fluctuations in municipal and state general funds. All cities and the County should undertake comprehensive investigations to find the best, most reliable funding mechanism for their respective storm water management programs. Without adequate funding, the programs have little to no chance of succeeding in substantially reducing pollutant loads and protecting beneficial uses.

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Permit task 3.1.3 - Los Angeles, Manhattan Beach, Torrance and the County submitted excellent plans to detect and eliminate illegal discharges and illicit disposal practices. However, the majority of programs failed to address some major issues in this field. Most programs just addressed responding to reported illegal spills and discharges rather than including measures to detect illegal activities. The programs must include field inspections to truly be a deterrent against illegal dumping. Another major issue that should be included in all cities' programs are BMPs to abate the animal waste problem.

Many of the cities included BMPs that were irrelevant for this task. These BMPs more appropriately fit under permit task 3.1.2.

The lack of comprehensive programs for many cities begs the question of, "Are any of the cities planning to contract out to the County for services to detect and eliminate illegal discharges and illicit connections?" This would be an excellent idea for many cities because of the County's larger staff and extensive experience in this field.

Permit task 3.1.4 - The cities of Torrance and Los Angeles did an excellent job of submitting construction BMPs and the city of Santa Monica also will have a strong construction BMP program by the end of the summer. Malibu has a strong program, but they failed to detail it in the permit task. A general comment is that many cities included "promote awareness of pollution problems caused by construction" as their sole BMP for the 3.1.4 requirements. Promoting awareness is commendable, but it is not nearly enough to abate the environmental problems caused by poorly regulated development.

Many cities refer to existing construction regulations without explaining the requirements in the building codes or ordinances. It would be extremely helpful to include the contract provisions, plan check requirements, inspection requirements, and permit requirements for construction as they pertain to erosion, sedimentation and runoff controls. Without this information, it is difficult to determine if the cities' programs are adequate and, if not, where those inadequacies lie.

Heal the Bay was glad to see that so many cities in the Santa Monica Bay watershed are seriously considering the implementation of catch basin stencil programs. We are looking forward to working with the cities on these programs in the near future. If you would like to discuss the comments or other aspects of the storm water program, please feel free to call.

Thank you for the opportunity to comment and attend the monthly permit workshops.

Sincerely,

VOL 11 0004446

Mark Gold

Mark Gold
Staff Scientist

cc: Frank Kuo
Xavier Swammikannu

P.S. - We strongly urge you to oppose the proposed amendments to the General Industrial Permit. A permit program without monitoring programs will prove to be yet another bureaucratic exercise with little public benefit.

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OFFICE NO. 4

INSPECTOR: XS

FACILITIES INSPECTION REPORT

SWRCB 001 (REV. 5-91)

PCA System Task No. ___

4B190107099 (WDS NUMBER)	LOS ANGELES COUNTY DPW (NAME OF AGENCY OR PARTY RESPONSIBLE FOR DISCHARGE)	~~MINUCIPAL~~ MUNICIPAL STORM SEWER SYSTEM (NAME OF FACILITY)
CA0061654 (NPDES NUMBER)	900 S. FREMONT AVE. (AGENCY STREET)	(FACILITY STREET)
92 06 B1 (YY) (MM) (TYPE)	ALHAMBRA ,CA 91803 (AGENCY CITY AND STATE)	,CA (FACILITY CITY AND STATE)
SCHEDULED INSPECTION DATA	~~JOHN MITCHELL~~ GARY HILDEBRAND (AGENCY CONTACT PERSON)	~~JOHN MITCHELL~~ GARY HILDEBRAND (ONSITE FACILITY CONTACT PERSON)
92 · 04 · 23 (YYMMDD) ACTUAL INSPECTION DATE	818 / 458 - ~~3537~~ 5948 (AGENCY PHONE NO)	818 / 458 - ~~3537~~ 5948 (FACILITY PHONE NO.)

___ Inspection agency (State = S, State / EPA Joint = J)

N Is this a type "A1" or "B1" Compliance Inspection of an NPDES facility as required by the section 106 grant workplan? (Y/N) If so, send a copy of this report to EPA

INSPECTION TYPE (Check One)

A1 ___ "A" type compliance -- Comprehensive inspection in which samples are taken. (EPA Type S)

B1 ✓ "B" type compliance -- A routine nonsampling inspection. (EPA type C)

02 ___ Noncompliance follow-up -- Inspection made to verify correction of a previously identified violation.

03 ___ Enforcement follow-up -- Inspection made to verify that conditions of an enforcement action are being met.

04 ___ Complaint -- Inspection made in response to a complaint.

05 ___ Pre-requirement -- Inspection made to gather info. relative to preparing, modifying, or rescinding requirements.

06 ___ Miscellaneous -- Any inspection type not mentioned above.

If this is an EPA inspection not mentioned above, please note type. (e.g.--biomonitoring, performance audit, diagnostic, etc.)

___ (Type)

N Were VIOLATIONS noted during this inspection? (Yes/No/Pending Sample Results)

Y Was this a Quality Assurance-Based Inspection? (Y/N)

N Were bioassay samples taken? (N = No) If YES, then S = Static or F = Flowthrough.

INSPECTION SUMMARY (REQUIRED) (100 character limit)

DISCUSSED PROGRAM AND PACE OF COMPLIANCE PROGRESS SATISFACTORY

INSPECTOR'S DATA.

INITIALS XS SIGNATURE [signature] DATE 04/23/92

For Internal Use: Reviewed by: (1)___ (2)___ (3)___ Reg. WDS Coordinator

WDS Data Entry Date: ___ · ___ · ___ Regional Board File Number: ___

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FACILITIES INSPECTION REPORT

SWRCB 001 (REV. 5-91)
(Page 2)

VIOLATION (IF APPLICABLE)

VIOLATION TYPE? (A-G) _____ (See pages IK05 0 and IK05 1 of the Micro Waste Discharger System Users Manual)

DATE OF VIOLATION (YYMMDD) ____ - ____ - ____ DATE OF VIOLATION DETERMINATION (YYMMDD) ____ - ____ - ____

DESCRIPTION (200 Character Limit) _____

EPA SUGGESTED INSPECTION CHECKLIST

(S = Satisfactory, M = Marginal, U = Unsatisfactory, N = Not Evaluated)

S Permit	N Flow Measurement	N Pretreatment	S Operations & Maintenance
S Records/Reports	N Laboratories	S Compliance Schedules	N Sludge Disposal
S Facility Site Review	N Eff./Receiving Waters	S Self-Monitoring	N Other

_____ (1-5) Overall Facility Operation Evaluation (5 = Very reliable, 3 = Satisfactory, 1 = Unreliable)

ADDITIONAL COMMENTS, SPECIAL INSTRUCTIONS, ITEMS FOR FOLLOWUP ON FUTURE INSPECTIONS, NOTES, ETC. (Attach additional pages, if necessary)

HISTORICAL INFORMATION:

MOST RECENT ORDERS

ORDER NO.	DATE ADOPTED	TYPE
0-079	900618	NPD

MOST RECENT INSPECTIONS

DATE	INSP. TYPE	VIOLATIONS?
910613	B1	N

MOST RECENT VIOLATIONS

VIOL. TYPE	DATE

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COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

6948
XS

IN REPLY PLEASE REFER TO FILE WM-3

May 14, 1992

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

92 MAY 19 PM 2:

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)
QUARTERLY PROGRESS REPORT (1992 1Q) R #7

The following report is submitted in compliance with the above-captioned Permit, which was issued on June 18, 1990. This report provides a summary on the status of specific Permit tasks performed during the third quarter (January 1 through March 31, 1992) of the second year of the Permit, which began on July 1, 1991.

During this period, Ventura County submitted a Letter of Intent, dated February 24, 1992, to become a Phase I Co-Permittee for the portion of the County tributary to Santa Monica Bay. We are working with Ventura County to develop a time frame for compliance with Permit requirements.

On March 26, 1992, we submitted, for your approval, our work plan for the proposed stormwater/urban runoff monitoring program. With this submittal, all First-Year Tasks specified by the Permit have been completed by all Permittees, with the exception of the following: a) Early Action BMP plans have not been submitted by the following cities: Malibu, Calabasas, Beverly Hills, and Inglewood and b) identification of industries within drainage areas by SIC code category. We have performed an initial analysis of industries by SIC code category for each drainage area. However, there are a number of discrepancies in the information that require resolution. We estimate completion of this work by July 1, 1992.

A committee of Co-Permittees has been established to facilitate the development of the Additional BMP Plans required by Tasks 3.1.2, 3.1.3, and 3.1.4 of the Permit. In addition, Permittees have begun drafting preliminary Additional BMP plans for their own jurisdictions.

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In anticipation of the implementation of Phase II on July 1, 1992, an information meeting for Phase II cities was held on February 12, 1992, with a subsequent meeting scheduled for May 27, 1992. Phase II involves 36 cities in the Upper Los Angeles River and Upper San Gabriel River Drainage Basins. Phase II cities have been briefed on Permit requirements and are being provided with technical support and direction to assist them in implementation of their Permit requirements.

We have begun to receive Letters of Intent from Phase II cities. Copies of the Letters of Intent will be forwarded to you with our next quarterly report.

We are closely working with Phase I Co-Permittees towards finalization of the Stormwater Permit Implementation Agreement. We are targeting approval of the Agreement by July 1992.

If you have any questions, please contact Rod Kubomoto at (818) 458-3537.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:mp
FYR3

cc: Phase I Co-Permittees

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STATE OF CALIFORNIA PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500

January 31, 1992

Ms. Pamela Emerson
California Coastal Commission
245 W. Broadway, Suite 380
Long Beach, CA 90801

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS APPLICATION FOR STORMDRAIN CONSTRUCTION IN COASTAL ZONE

This Regional Board issued a stormwater/urban runoff NPDES permit to the County of Los Angeles and co-permittees in June 1990. The objective of their permit is the development of a comprehensive management program to control pollution in urban runoff. During the early phase of the program (first two years), the permittees are required only to document existing information on water quality and flow, land uses, practices to control pollutants in runoff from construction sites, practices addressing illegal/illicit discharges, and waste management practices; to implement early-action BMPs; and to develop and implement a stormwater/urban runoff monitoring program.

Evaluation of the effectiveness of different types of management practices for controlling pollutants, including structural ones, will be in the later phase of the program. In addition, a national CZMA and Clean Water Act task force is working on a guidance document for nonpoint source pollution control mechanisms to be published some time this summer.

However, new flood control construction projects are underway or planned. At this point, this Regional Board recommends that the County should consider future structural improvements on stormdrains currently in the planning and construction phase. Once innovative structural BMPs have been identified and tested for large-scale application, they may be incorporated into existing flood control structures.

If you have any questions, please call me at (213) 266-7594.

WINNIE DESLATE-JESENA
Senior Water Resource Control Engineer

cc: Gary Hildebrand, LACPW
Catherine Tyrrell, SMBRP

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STATE OF CALIFORNIA PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500

AGENDA

STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

353rd Regular Meeting
Monday, January 27, 1992 - 9:30 A.M.

STATE OFFICE BUILDING
107 SOUTH BROADWAY, ROOM 1138
LOS ANGELES, CALIFORNIA

INTRODUCTION

1. Roll Call.

2. Introduction of New Board Members.

3. Election of Officers

4. Approval of Minutes of the Regular Meeting held on December 2, 1991.

UNCONTESTED ITEMS

5. Uncontested Items Calendar. *(Items marked with an asterisk are expected to be routine and noncontroversial. The Board will be asked to approve these items at one time without discussion. If any interested party, Board Member, or staff person requests that an item be removed from the calendar, it will be taken up in the regular agenda order.)*

PUBLIC FORUM

6. Public Forum. *(Any member of the public may address the Board regarding any matter within the Board's jurisdiction. This need not be related to any item on the agenda.)*

7. Board Member Communications. *(The Board Members may discuss communications, correspondence, or other items of general interest relating to matters within the Board's jurisdiction. There will be no voting or formal action taken.)*

WASTE DISCHARGE REQUIREMENTS

8. Consideration of NPDES Permits - New and Renewal. *(The Board will be asked, during a public hearing, to adopt the proposed permits for the following facilities.)*

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Agenda
January 27, 1992

NEW

*8.1 Arco Products Co., Compton {E. Solomon} CA0062286

*8.2 Grand Rent-A-Car Corporation, Los Angeles {J. Huang} CA0062669

RENEWAL

*8.3 Rockwell International Corporation, (Santa Susana Field Laboratory) {H. Kang} CA0001309

*8.4 Lubricating Specialties Company, Pico Rivera {R. Jesena} CA0059013

9. Consideration of Non-NPDES Requirements. *(The Board will be asked to adopt the proposed requirements for the following facilities.)*

NEW

*9.1 J.M. Smucker Company, Oxnard {G. Kwey} 91-52

*9.2 Port of Los Angeles, Berths 177-179 Dredging {J.M. Lyons} 91-69

*9.3 Port of Los Angeles, Fire Station No. 112, Berths 84-86 Dredging {J.M. Lyons} 91-71

*9.4 Thrifty Oil Company, Former Thrifty Service Station #269, Long Beach {J. Huang} 91-67

ENFORCEMENT

10. Consideration of Administrative Civil Liability Complaint No. 91-113 For Violation of Terms of Revised Cleanup and Abatement Order No. 90-38 Requiring J.C. Incorporated Liquid Waste Disposal and Mr. Jack Barry Zwahlen to Cleanup and Abate the Effects of Chemicals Including Organic Compounds Discharged to Soil and Ground Water. {Keith Elliott} *(The Board will be asked, during a public hearing, whether to adopt Directive for Administrative Civil Liability Complaint No. 91-113.)*

11. Consideration of a Resolution Requesting the Attorney General to Take Appropriate Actions for Discharges of Petroleum Products Into the Santa Clara River by Mobil Oil Corporation. {J. Michael Lyons} *(The Board will be asked to adopt the proposed resolution.)*

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Agenda
January 27, 1992

STATE REVOLVING FUND

*12. Consideration of Proposed Amendment to the Previously Adopted 1992 State Revolving Fund Loan Program Priority List for Fiscal Years 1991-92 through 1995-96. {John Lewis} *(The Board will be asked to adopt the tentative Resolution amending the approved Priority List.)*

WATER QUALITY ASSESSMENT

*13 Consideration of Adoption of the 1991 Water Quality Assessment Report. {Debbie Smith} *(The Board will be asked to adopt the Regional Water Quality Assessment Report.)*

MUNICIPAL STORMWATER PERMIT

14. Progress Report on the Los Angeles County Stormwater/Urban Runoff Program for the Santa Monica Bay Drainage Basin (NPDES Permit No. CA0061654). {X. Swamikannu} *(This item is for information only. There will be no voting or formal action taken by the Board.)*

RESOLUTIONS OF APPRECIATION

*15. Resolution of Appreciation for Henry M. Morgan. *(The Board will be asked to adopt the tentative Resolution.)*

*16. Resolution of Appreciation for Eugene C. Ramstedt. *(The Board will be asked to adopt the tentative Resolution.)*

INFORMATION ITEM

17. Report by South El Monte Property Owners Association Regarding Site Investigation and Cleanup Activities. {H. Yacoub} *(This item is for information only. There will be no voting or formal action taken by the Board.)*

18. Executive Officer's Report. *(This item is for information only. There will be no voting or formal action taken by the Board.)*

CLOSED SESSION

19. Closed Session. *(Please note that Item 19 is not open to the public.)*

.1 United States, State of California, et al. v. City of Los Angeles, U.S. District Court, Central District of California, Case Number CV77-3047-HP, Amended Consent Decree. *(The Board will meet in closed session to discuss this matter. Authority: Government Code Section 11126(q)).*

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At any time during the regular session, the Board may adjourn to a closed session to consider litigation, personnel matters, or to deliberate on a decision to be reached based upon evidence introduced in the hearing. Discussion of litigation is within the attorney-client privilege and may be held in closed session. Authority: Government Code Section 11126(a)(d)(q).

ADJOURNMENT

20. Adjournment to Regular Meeting of March 9, 1992, at 9:30 a.m. in Los Angeles.

***

A copy of the Agenda is available for examination by the public at the office of the Board during regular working hours. Please call Dolores Paquet, Executive Assistant to the Board, at (213) 266-7514 for general information about the Agenda. Questions about specific items on the Agenda should be directed to the staff person whose name is listed with the item.

****

Material presented to the Board as part of testimony that is to be made part of the record must be left with the Board. This includes photographs, slides, charts, diagrams, etc.

*****

All Board files pertaining to the items on this Agenda are hereby made a part of the record submitted to the Regional Board by staff for its consideration prior to action on the related items.

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MUNICIPAL STORMWATER DISCHARGE PERMIT FOR LOS ANGELES COUNTY

SECOND YEAR REQUIREMENTS

3.1.1 MONITORING PROGRAM BASED ON APPROVED WORKPLAN OF YEAR 1

3.1.2 PLAN WITH SCHEDULE OF IMPLEMENTATION FOR ADDITIONAL BMPs

3.1.3 PLAN WITH SCHEDULE OF IMPLEMENTATION OF PROCEDURES TO DETECT AND ELIMINATE ILLEGAL DISCHARGE/DISPOSAL PRACTICES

3.2 EVIDENCE OF IMPLEMENTATION OF EARLY ACTION BMPs APPROVED IN YEAR 1

3.3 EVIDENCE OF ACQUISITION OF NECESSARY LEGAL AUTHORITY TO ENFORCE STORMWATER PROGRAM

R0033225

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, LOS ANGELES REGION
Los Angeles, California
January 27, 1992
353rd Regular Meeting

ITEM: 14

SUBJECT: STORMWATER PERMIT FOR THE LOS ANGELES COUNTY - FIRST YEAR COMPLIANCE WORKSHOP

DISCUSSION: On June 18, 1990, the California Regional Water Quality Control Board (Regional Board) adopted waste discharge requirements for municipal stormwater and urban runoff discharges in Los Angeles County with the Los Angeles County Department of Public Works (County) as the principal permittee. The County of Los Angeles is divided into five drainage basins which are phased into the municipal stormwater program starting with the Santa Monica Bay Drainage Basin on July 1, 1990.

The stormwater permit required the Santa Monica Bay Drainage Basin municipalities/permittees to undertake ten tasks during the first compliance year, July 1, 1990, to June 30, 1991. These tasks included compilation of existing information on waste management programs, characterization of the basin for stormwater quality management, development of a stormwater/urban runoff monitoring plan, and documentation of existing (or plans to obtain) comprehensive legal authority to implement a stormwater program.

On July 15, 1991, the Los Angeles County Department of Public Works and co-permittees submitted their first-year annual compliance report. This report was updated with a supplemental report on November 4, 1991. Board staff's review of the submitted reports shows that not all of the first year requirements were complied with by any permittee; and that the extent of compliance among permittees varied. The attached report details staff's evaluation of the County and co-permittee's performance during the first year of the program.

INFORMATION ONLY: This is an information item only. There will be no voting or formal action taken by the Board.

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

STAFF REPORT
ON THE
MUNICIPAL STORMWATER PERMIT FOR LOS ANGELES COUNTY

REVIEW OF FIRST YEAR'S COMPLIANCE
(July 1, 1990 - June 30, 1991)

BACKGROUND

On June 18, 1990, this Regional Board adopted Order No. 90-079 (NPDES No. CA0061654) regulating stormwater and urban runoff discharges from separate stormwater sewers throughout Los Angeles County. The permit was the result of a cooperative effort among representatives of regulatory agencies and the regulated communities. It is aimed toward the development of an aggressive and comprehensive municipal stormwater program. The Los Angeles County Department of Public Works (County) was designated as the principal permittee with the municipalities and entities discharging in the permitted area as co-permittees. The County is to coordinate compliance of co-permittees with the requirements of the permit.

The permitted area is divided into five drainage basins which are phased into the municipal stormwater program over three years starting with the Santa Monica Bay Drainage Basin. The Santa Monica Bay Drainage Basin municipalities/permittees were required to begin compliance with the provisions of the permit beginning July 1, 1990.

SANTA MONICA BAY DRAINAGE BASIN CO-PERMITTEES

At the time the stormwater permit was adopted, seventeen cities were identified as co-permittees: Agoura Hills, Beverly Hills, Culver City, El Segundo, Hermosa Beach, Inglewood, Los Angeles, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Santa Monica, Torrance, West Hollywood, and Westlake Village.

The permit provides that additional entities will be designated co-permittees to the stormwater program once it is identified that their discharges constitute part of the Los Angeles County municipal stormwater drainage system. (Otherwise, the municipality/entity must apply for a separate permit from the Regional Board).

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After adoption of the stormwater permit, Caltrans and the newly incorporated cities of Calabasas and Malibu joined the County as co-permittees. The Regional Board has determined that stormwater discharges from portions of the City of Thousand Oaks and unincorporated areas of Ventura County are part of the Los Angeles stormwater drainage system within the Santa Monica Bay Drainage Basin. The County of Ventura has not yet decided whether to become a co-permittee to the Los Angeles system or to file for a separate municipal stormwater permit for all unincorporated areas of Ventura County. However, it has participated and partly completed the tasks required during the first year of the permit.

The City of Thousand Oaks elected to file for a separate municipal stormwater discharge permit. The Regional Board has directed the City to submit Part 1 of the application for the areas discharging into the Santa Monica Bay Drainage Basin on or before March 30, 1992. The City has agreed to cooperate with the County to ensure that all necessary information is provided in a timely manner. However, the City has not yet submitted the required information nor conducted the required tasks.

FIRST YEAR COMPLIANCE WITH PERMIT REQUIREMENTS

On July 15, 1991, the County submitted the first year report of compliance with requirements of the municipal stormwater permit. A supplemental report was submitted on November 4, 1991.

The following represents Board staff's evaluation of the first year performance of the County and co-permittees:

Task 2.1.1 Water quality data and flow data from 1980 to present; Identification of drainage areas

Los Angeles County, Ventura County, Caltrans and the cities of Manhattan Beach and Santa Monica have provided water quality/flow data. The City of Los Angeles has been collecting water quality and flow data but has not yet submitted this information. All other permittees reported no available data.

Outer watershed boundaries for storm drains and water courses that discharge to Santa Monica Bay have been identified and mapped. However, further subdivision into 200+ drainage areas for characterization is incomplete. Drainage areas ("runoff areas") identified by Caltrans for the highway system have not been incorporated in the basin characterization map.

Task 2.1.2 Wet weather 90th percentile values for TSS and Oil & grease

The permit required submittal of 90th percentile values for total suspended solids (TSS) and oil and grease computed from all wet

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weather data collected by permittees for the basin from 1980 through 1990. The County reported 90th percentile values of 2,362 mg/l for TSS and 8.6 mg/l for oil and grease based only on the County's data. Values of these constituents should be calculated incorporating wet weather data from the City of Los Angeles and Caltrans.

Task 2.1.3 Supplementary information for contaminant sources identification

This task has not been completed by any permittee. Mapping of pollutant sources within drainage areas as related to industries, land uses, waste disposal facilities, etc. is still on-going and is being conducted in conjunction with Task 2.1.1.

Task 2.1.4 Monthly precipitation data from 1980 through 1990 and estimate of impervious areas within drainage areas

Precipitation data was submitted by the counties of Los Angeles and Ventura, and the cities of Beverly Hills, Los Angeles, Palos Verdes Estates, Redondo Beach, Santa Monica, and Westlake Village. The City of Torrance has been collecting precipitation data as part of the National Weather Service Network but has not submitted the data. All other permittees reported no gauging stations under their jurisdiction.

No permittee has submitted estimates of impervious areas. This task is being conducted in conjunction with Tasks 2.1.1 and 2.1.3.

Task 2.1.5 Documentation of existing procedures to identify and eliminate illegal discharge/disposal practices

The County and the cities of Los Angeles and Santa Monica have mature programs to address illegal practices through their industrial waste programs. The cities of Palos Verdes Estates, Redondo Beach, Rolling Hills Estates, West Hollywood, and Westlake Village reported no existing procedures to address illegal discharge/disposal practices. Other permittees have various referral procedures to other local, county, and/or state agencies. The effectiveness of the referral procedures is greatly dependent on actions of the agencies to whom the illegal practice was referred.

In developing a basin-wide program to address this aspect of the stormwater program, the permittees should consider a documentation component that includes identity of violators, nature of violations, referrals, number of inspections, number of citations, correction follow-ups, referrals made and to whom, etc.

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Task 2.1.6 Documentation of existing procedures and improvement plans to control runoff from construction sites

All permittees submitted procedures they have in place. Most of the procedures addressing runoff from construction sites are incorporated in construction activity prohibitions, land development codes, and/or informal prohibitions given during site inspections. The City of Inglewood has no documented procedure to address construction site runoff.

Generally, existing procedures to control runoff from construction sites are inadequate. There is a need for standardization of procedures and codes used by permittees to review construction plans. However, no plans were submitted to improve existing procedures. Documentation procedures similar to those recommended for Task 2.1.5 should be included in the improvement plans.

The federal stormwater regulations require a State issued NPDES permit for stormwater discharges associated with construction activity on five or more acres after October 1, 1992. The State Water Resources Control Board and the Regional Boards are developing a statewide general permit for this category of stormwater discharge. Construction site runoff control improvement plans that the permittees will develop must integrate and augment the State's construction activity permitting program.

Task 2.1.7 Documentation of existing management practices to control pollutants

The permittees presented a wide range of on-going management practices, which may be broadly grouped under sanitary system controls, waste management practices, road and storm drain maintenance activities, and public education/information programs. The nature of controls used varies from permittee to permittee.

The list provided by the permittees could serve as a basis in selecting early Best Management Practices (BMPs) for implementation under the stormwater quality management program.

Task 2.1.8 Plan with schedule of implementation of early action BMPs

Drafts of early action BMP plans and schedules of implementation of these plans have been submitted to the Board. These plans and schedules are to receive public comment prior to submittal to the Executive Officer for approval as required in the permit. Board staff will review the plans and schedules after public comment/input are incorporated. These plans must also include procedures and documentation to evaluate the effectiveness of early action BMP programs.

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Task 2.1.9 Workplan for the development of a stormwater/urban runoff monitoring program

This workplan has not yet been submitted to the Regional Board. Public input during the development of this plan is also required prior to submittal.

Task 2.1.10 Documentation of possession of and/or plans to obtain the necessary legal authority to operate a stormwater quality management program

The permittees have complied with this requirement. A Stormwater Permit Implementation Agreement delineating permittee responsibilities is being developed by permittees.

SUMMARY

The municipal stormwater permit required permittees located within the Santa Monica Bay Drainage Basin to complete ten tasks during the first year. These tasks required compilation of existing information on waste management programs, characterization of the basin for stormwater quality management, development of stormwater/urban runoff monitoring plans, and documentation of existing and/or plans to obtain comprehensive legal authority to manage stormwater programs.

The supplemental report submitted on November 4, 1991, on the first year's requirements provided documentation that permittees had been brought to almost the same level of compliance, although not all required tasks were completed by any permittee. The average compliance achieved by permittees was about 70% of first year requirements.

CONCLUSION

At this point in time it is clear that the permittees got off to a slow start during the first year and must now play "catch up". Permittees must not only complete all second year requirements on time, but must also finish the remaining first year tasks as soon as possible.

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COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

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ALHAMBRA, CALIFORNIA 91803-1331
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IN REPLY PLEASE REFER TO FILE WM-3

92 JAN 23 AM 11:33
LOS ANGELES REGION

January 22, 1992

Dr. Robert P. Ghirelli
California Regional Water Quality
Control Board - Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

STORMWATER DISCHARGE PERMIT - NPDES PERMIT NO. CA0061654-CI6948
EARLY ACTION BEST MANAGEMENT PRACTICES (BMP) PLAN

On behalf of the Permittees, we are submitting the Early Action BMP Plan required by Section 2.1.8 of our Permit for review and approval by your agency. This document was circulated for public input between November 25, 1991 and December 23, 1991. (Copies of the Proof of Publications are enclosed). We received only one response from the "Heal the Bay" organization. A copy of their comments is attached.

The major concerns of Heal the Bay are that the Early Action BMPs are not optimized to the maximum extent practicable and that they are similar to the Existing BMPs as identified in our First Year report. Also included was a list of BMPs compiled by Heal the Bay for our consideration.

In response, the Early Action BMPs identified by each Co-Permittee represent those Existing BMPs that each Co-Permittee has optimized to a level that it feels appropriate based on the consideration of a number of factors including fiscal constraints. New BMPs shall be addressed in the development of the Additional BMP plans during Year II of the Permit. The BMPs identified by Heal the Bay will be considered at that time.

The Early Action BMP plan does not include Early Action BMPs for five cities (Beverly Hills, Calabasas, El Segundo, Inglewood, and Malibu). These cities did not provide the information prior to the public review period. These cities have been informed that they need to independently schedule, public review of their Early Action BMP plans prior to our submittal of them to you for approval. It is our understanding that this submittal fulfills the requirement as specified in Section 2.1.8 of our Permit.

If further information is needed, please feel free to contact Gary Hildebrand of my staff at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

FK:mp/SDP3

Enc.

cc: Co-Permittees

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Heal the Bay.

1640 FIFTH STREET, SUITE 112
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WMD

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

December 18, 1991

John Mitchell
Los Angeles County Department of Public Works
Waste Management Division
Stormwater Discharge Program
P.O. Box 1460
Alhambra, CA 91802-1460

Dear Mr. Mitchell,

After reviewing the "Proposed Early Action Best Management Practices" compiled by the Los Angeles County Department of Public Works for NPDES permit number CA0061654, Heal the Bay feels that the document is on the right track towards permit compliance. However, we are concerned at the lack of initiative on the part of some of the "Co-Permittees". Although BMPs were submitted by the "Co-Permittees," the programs were simplistic. None of the early action BMPs in the document are presented as "optimized to the maximum extent practicable" as required in the NPDES permit, section 2.1.8. It seems as if the BMPs listed are basically no different than the existing BMP list required under section 2.1.7.

It is unclear what is adequate for full permit compliance for the early action BMP requirements for the permittee and the co-permittees. Heal the Bay strongly believes that an early action BMP is not just the status quo, but also how the existing BMPs can be improved immediately to reduce urban runoff pollution.

Heal the Bay believes that in order to make this permit successful in reducing the largest source of pollution to Los Angeles area beaches, a greater effort by the Co-Permittees in conjunction with the Principal-Permittee is needed. The County needs to take a stronger role in providing leadership to the co-permittees on improving existing BMPs to the maximum extent practicable.

Enclosed is a draft copy of an extensive compilation of Best Management Practices for stormwater/urban runoff control. We hope theses are useful for your year two requirements under the permit.

For any assistance or questions, please contact Mark Gold at the above address and/or telephone numbers.

Sincerely,

Carlos Urrunaga
Scientific Intern

Roger Gorke
Research Scientist

Mark Gold
Staff Scientist

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HEAL THE BAY'S
Best Management Practices
For Stormwater/Urban Runoff Control

I. For RESIDENTIAL AREAS:

Keeping all objects containing grease, oil, or other contaminants well covered or indoors. Also placing a drip pan underneath such objects would help prevent the flow of contaminants into the runoff. The water collected from the drip pan should later be disposed of properly to insure the safety of the environment.(5)

The application of pesticides, herbicides, and rodenticides must be when there is no precipitation forecast for the area. This would insure that there is no spreading of these chemicals out of the area for which they were intended.(4)

Using biological controls or less toxic chemicals to control insects and weeds could be just as effective to control pests while not being detrimental to the health of pets and roaming animals.

The use of fertilizers, pesticides, herbicides, and rodenticides should follow the respective company's instructions and not be over-used. When these chemicals are over-used and get into the runoff due to rain or overwatering, it flows into the stormdrains and onto the beach where people swim.(1)

Properly clean and dispose of pet wastes to insure that no viral infections are spread through the stormdrain system to end up in the Santa Monica Bay.(1)

The use of water for irrigation purposes should be in moderation. No irrigation water will be allowed to leave the property boundaries because it is a carrier for oil, grease, chemicals, and other toxics.

Rain gutters shall be oriented towards permeable surfaces rather than driveways or hardtop so that the runoff will penetrate the ground instead of flowing into a stormdrain.

Residents need to inspect vehicles more often to reduce leakage of oil, antifreeze, hydraulic fluid, etc.(1)

Using drip irrigation systems and soak hoses in lieu of sprinklers lowers the amount of water lost to evaporation and lowers the likelihood that water will leave the premises on a scale which occurs with sprinklers.

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Rain water can be collected in barrels or cans. The stored water can be used later for irrigation and also helps to lower the peak runoff.

Landscaping should be contoured to minimize the amount of stormwater leaving the property. The use of berms, french drains, green strip filters, gravel beds, swales, etc. are options.

Driveways should be made of porous materials such as rock or gravel to allow water to percolate into the ground.

Using concrete instead of asphalt would drastically reduce the input of hydrocarbons into urban runoff.

II. For COMMERCIAL and INDUSTRIAL AREAS:

Keeping all objects containing grease, oil, or other contaminants either indoors or well covered outside. This could be accomplished by placing anchored plastic sheeting which would be temporary or constructing a covered area protected by wind and rain.

The storage area is to be graded to divert spills away from buildings or surrounded by a tall curb. If a curb is used, a drain should be installed for the draining of accumulations of rainwater or spills.(5)

Installing a drainage system and placing a "drip pan" underneath objects containing grease, oil, or other contaminants would help prevent the flow of pollutants into the runoff. The water collected from the drip pan should later be disposed of properly to insure the safety of the environment.(5)

Proper collection and disposal of waste products, prevention of oil leaks, and proper maintenance of equipment would reduce or prevent the pollution of runoff.(1)

Signs should be posted on stormdrain catchbasins indicating that they are not to receive any waste products.(5)

Waste products and/or hazardous wastes must not be opened, handled, or stored in a manner which may cause a rupture or leak which would contaminate runoff. These containers must be examined for leakage at a regular interval.(5)

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The owner should have a written "Emergency Spill Cleanup Plan" and employees shall be trained in its execution.(5)

The business owner/manager/operator should retain, on-site, appropriate materials for rapid cleanup of spills.(5)

Industrial areas should reserve space for detention basins. These separate sediments from runoff and saves the sediment for later removal and lower the peak runoff rate.

Detention basins such as dry-settling basins which can be either above or below ground, hold runoff so that suspended solids or particulates settle out.

Oil/water separators should be used in parking lots or in areas where hydrocarbons and other pollutants could accumulate. This would prevent the flow of oil into the stormdrain system. There are three types of separators: API, SCS, and CPI.

Directing runoff away from pollutant laden areas such as parking lots instead of through them would also prevent storm runoff from becoming polluted.

Machines to be repaired or maintained on site should be placed on a pad of absorbent material to contain leaks, spills, or small discharges.(5)

The washing of all vehicles and equipment should be done only at a commercial washing business or at an area in which no polluted runoff may flow into storm drains or into sensitive areas.(5)

Using concrete instead of asphalt would drastically reduce the input of hydrocarbons into urban runoff.

Use natural drainage, detention ponds, or infiltration pits so that runoff may collect and seep into the ground at a rate which would reduce or prevent downhill erosion.

Use retention structures for storing runoff on rooftops or in subsurface areas and releasing at predetermined times or rates. This will minimize the peak rate of runoff discharge into stormdrains.(5)

Landscaping should be contoured to minimize the amount of stormwater leaving the

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property. The use of swales, berms, green strip filters, gravel beds, french drains, etc. are options.

The use of porous materials for or near walkways would increase the amount of water seeping into the ground and not flowing collecting toxics.

Maximize the percentage of permeable surfaces on the property. Suggestions include more landscaping and porous pavement parking lots. This would allow more percolation of runoff into the ground.

Parking lots should be swept or vacuumed at appropriate intervals to remove debris which may otherwise travel into the stormdrain system and find its way onto the beach.

Hydrocarbon spots should be removed on a regular basis to avoid runoff from becoming contaminated.

Absorbants, cleaning compounds, and oil/grease traps should be used for controlling oil and grease in those areas where they tend to accumulate.

III. For CONSTRUCTION AREAS:

Scheduling construction to minimize runoff and erosion due to rain.(4)

At the entrance of a construction site there must be an area of crushed stone or gravel to reduce or eliminate the tracking of mud or sediments off of the construction site. Any tracking of sediments off of the site must be shovelled or swept to prevent it from entering the stormdrain system.(7)

A project site should have the capacity to convey, or store the peak runoff from a storm and release it at a slow rate to minimize the peak discharge into stormdrains.

Use natural drainage, detention ponds, sediment ponds, or infiltration pits to allow runoff to collect and seep into the ground at a rate which would reduce or prevent downhill erosion.

A temporary sediment barrier consisting of a filter fabric stretched across and attached

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to supporting posts and entrenched. These barriers intercept and detain small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site and to decrease the velocity of sheet flows and low to moderate level channel flows.(2)

Preserve existing vegetation to reduce erosion.(2)

Establish vegetative cover on all disturbed sites where construction activity has been interrupted for an extended period of time.(3)

Clearing should be done in such a way so as to allow only the areas actively being worked on to be cleared to avoid erosion problems.

Mulching or matting of bare soil using oat straw, hay or other materials such as wood chips, bark, sawdust, or other. Mulches can be used before, during, or after seeding to protect existing vegetation and/or reseeding and/or replanting exposed surfaces.(2)

Mulch may be netted down to prevent its loss to wind or water.(2)

Seeding of bare soil or disturbed areas should be done to stabilize the soil to prevent erosion.

Plastic covering could be used as a temporary measure to prevent erosion of an otherwise unprotected area. This however, produces 100% runoff which may cause serious erosion problems and/or flooding at the base of slopes unless runoff is intercepted and safely conveyed.

Jute netting exposed soil surfaces could help prevent or slow erosion rates.(4)

Dikes, filter berms or ditches could hold runoff and drain them at reduced rates.

Using downdrains to carry runoff from the top of a slope to the bottom could help decrease or prevent erosion.(4)

Chutes and flumes could be used to aid the transport of runoff downslope without causing erosion. This could be accomplished by using plastic sheeting or any other impervious materials which would lay between the flowing water and the ground.(4)

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Sand bag or straw bale barriers with a sand or gravel filter outlet directs, and allows the runoff to flow at a slower rate and also filters out large-sized sediments.(4)

Proper collection and disposal of waste products, prevention of oil leaks, and proper maintenance of equipment would reduce or prevent the pollution of runoff.(1)

A brush barrier could be used as a temporary sediment barrier at the perimeter of a disturbed area from the residue materials available from cleaning and grubbing the site. When properly netted down, it intercepts and retains sediment from limited disturbed areas.(2)

Machines to be repaired or maintained on site should be placed on a pad of absorbent material to contain leaks, spills, or small discharges.(5)

The washing of all vehicles and equipment should be done only at a commercial washing business or at an area in which no polluted runoff may flow into storm drains or into sensitive areas.(5)

Keeping all objects containing grease, oil, or other contaminants well covered or indoors. Also placing a "drip pan" underneath such objects would help prevent the flow of contaminants into the runoff. The water collected from the drip pan should later be disposed of properly to insure the safety of the environment.(5)

Flowing water must be directed or contained so as not to become contaminated.

Excavated basement soil should be located a reasonable distance behind the curb, such as in the backyard or side yard area. This will increase the distance eroded soil must travel to reach the storm drain (which will be avoided using the proper methods described in this list). Soil piles should be covered until the soil is either used or removed. Piles should not be situated so as to allow sediments to run into the street or adjoining property(ies).

Rough grading the construction site will eliminate large soil mounds which are highly erodible and prepares the site for temporary cover which will further reduce erosion potential.(2)

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Remove excess soil from the site as soon as possible after backfilling. This will eliminate any sediment loss from surplus fill.(2)

If a lot has a soil bank higher than the curb, a trench or berm should be installed moving the bank several feet behind the curb. This will reduce the occurrence of gully and rill erosion while providing a storage and settling area for stormwater.(2)

IV. For RURAL AREAS:

Provide permanent seeding or planting on disturbed areas to prevent soil erosion by wind or water, and to improve wildlife habitat and site aesthetics.(2)

Development along or near streams should be limited or prohibited to provide protection from erosion and sedimentation.(2)

Vegetative buffer zones can be used to protect natural swales and incorporated into the natural landscaping of an area.(2)

Restrict the clearing and grading of all areas that will later function as post development buffer zones.(3)

When grading slopes steeper than 3:1, and greater than 5 vertical feet, require surface roughening, either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation. This grading aids in the establishment of vegetative cover, reduces runoff velocity, and increases infiltration.(2)

Gradient terraces reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a nonerosive velocity. These should be used only on already denuded land having or potentially having a water erosion problem.(2)

A ridge of compacted soil or a swale with vegetative lining located at the top or base of a sloping disturbed area intercepts storm runoff from drainage areas above unprotected slopes and direct it to a stabilized outlet.(2)

Small dams constructed across a swale or drainage ditch reduces the velocity of concentrated flows, reducing erosion of the swale or ditch, and to slow water velocity to allow retention of sediments.(2)

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A brush barrier could be used as a temporary sediment barrier at the perimeter of a disturbed area from the residue materials available from cleaning and grubbing the site. When properly netted down, it intercepts and retains sediment from limited disturbed areas.(2)

Using structurally lined aprons or other acceptable energy dissipating devices placed at the outlets of pipes or paved channel sections could prevent scour at stormwater outlets and minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.(2)

The use of riprap should be used to slow the velocity of concentrated runoff or to stabilize slopes with seepage problems or non-cohesive soils.(2)

Stabilizing streambanks through vegetative means would protect streambanks against erosion.(2)

Bioengineering methods of streambank stabilization should be required in order to provide protection of critical sections of streambank where ordinary vegetative means of protection are not feasible or offer insufficient protection.(2)

Mulching or matting of bare soil using oat straw, hay or other materials such as wood chips, bark, sawdust, or other. Mulches can be used before, during, or after seeding to protect existing vegetation and/or reseeding and/or replanting exposed surfaces.(2)

Mulch may be netted down to prevent its loss to wind or water.(2)

Machines to be repaired or maintained on site should be placed on a pad of absorbent material to contain leaks, spills, or small discharges.(5)

Using natural drainage, detention ponds, retention structures, and/or infiltration pits so that runoff may collect and seep into the ground at a rate which would prevent downhill erosion.

A sediment trap could be used to intercept runoff from a drainage area and hold it or slowly release it with sediments held in the trap for later removal.

Jute netting exposed soil surfaces so as to prevent or slow erosion rates.(4)

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Dikes, filter berms or ditches store runoff and drain them at reduced rates.

Chutes and flumes could be used or constructed to aid the transport of runoff downslope from one elevation to another without causing erosion. This could be accomplished by using plastic sheeting or any other impervious materials which would lay between the flowing water and the ground.(4)

Sand bag or straw bale barriers with a sand or gravel filter outlet, directs, and allows the runoff to flow out at a slower rate and also filters out large-sized sediments.(4)

Using downdrains to carry runoff from the top of a slope to the bottom could help decrease or prevent erosion.(4)

IV.(a) Educational Measures:

Educate farmers, ranchers, and other managers of agricultural and/or open-space lands re: the need for and practical methods for erosion control and sediment control.(1)

Educate managers and users of park lands and open-space lands re: the need to restrict off-trail activities. Establish and enforce practical, site specific regulations to control off-trail activities.(1)

V. City actions for the public:

Design a program for reporting illegal littering or dumping with an easy to memorize telephone number.(1)

Develop and implement cleanup days and curbside collection of organic matter to be used by the city or county as compost.(1)

Provide, collect, and maintain more litter receptacles in strategic public places and during public events.(1)

Label stormdrain catchbasins warning of the harmful effects to both the environment and public health.(1)

Develop and implement programs which permit citizens the use of city yards to properly

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dispose of oil, antifreeze, pesticides, herbicides, paints, solvents, degreasers, and other chemicals.(1)

VI. Possible programs to be instituted by the City:

Transfer of development rights could be an effective way to prevent the development of undeveloped areas.

Determine the effectiveness of increasing the frequency of cleaning out stormdrain inlets, catchbasins, and drainage channels in areas where sediments and/or debris tend to accumulate. Develop and implement improved programs where appropriate.(1)

Determine the effectiveness of using street flushers to reduce pollutants in runoff.(1)

Build, maintain, and assess the performance and potential impacts of several relatively small infiltration basins at selected locations in urbanized areas throughout the watershed.(1)

Improve pavement repair and maintenance on streets and parking areas.(1)

Develop and implement field programs to detect and prevent the dumping or discharging of pollutants into stormdrains or drainage channels. More hydrocarbon sensors could be used
for the purpose of detecting hydrocarbons.(1)

Develop and implement a field program to detect and control illicit connections to sanitary sewers or septic systems.(1)

Develop and implement a field program to detect and control sanitary sewer or septic system leaks.(1)

Develop and implement effective erosion and sediment control regulations and requirements for corresponding construction inspection programs. These should apply to both public-sector and private-sector construction programs.(1)

Research, implement, and enforce regulations to require site drainage designs and systems which minimize the total volume of runoff and the peak rate of runoff from new

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construction, where local conditions permit.(1)

Research, strengthen, and enforce regulations which require oil and grease controls in areas which are significant sources (e.g., gas stations, automotive shops, wrecking yards, machine shops, commercial/industrial facilities, parking areas and food service establishments).(1)

Require new commercial, industrial, institutional, and major multi-family residential building complexes to have drainage facilities that incorporate on-site retention and/or infiltration - to assure that neither the total volume of runoff nor the peak rate of runoff exceed pre-project conditions.(1)

Require new public and private sector developments to make significant use of permeable surfaces in new landscaping, recreation areas, walkways, and parking areas to maximize infiltration (e.g., bark, gravel, other groundcover, brick, cobblestones, porous pavement). Use planted areas and/or grassy swales, where appropriate, to maximize retention and infiltration.(1)

Coordinate with the Regional Water Quality Control Board to be sure that potential water quality impacts are adequately considered at the time National Pollution Discharge Elimination System (NPDES) permits are issued for any discharges to storm drains or drainage channels. Include monitoring of all pertinent constituents as a permit stipulation.(1)

Adopt policies which require all California Environmental Quality Act (CEQA) compliance documents and site drainage designs to explicitly address the following: erosion potential, proposed erosion and sediment control plans, proposed inspection programs, related environmental impacts, and enforceable mitigation measures to minimize environmental impacts.(1)

Develop and implement regulations which require landowners and/or tenants to provide covers (e.g., roofs, tarps) to keep rain off of areas which contain contaminants (e.g., chemical storage areas, waste storage areas, contaminated industrial areas); and to keep runoff from draining through areas which contain contaminants.(1)

Develop and implement intensified street sweeping programs in strategic locations (e.g., central business districts, shopping malls, major parking lots, industrial areas) and/or at strategic times (e.g., following extended periods of dry weather).(1)

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Build, maintain, and assess the performance of several relatively small detention basins at selected locations in urbanize areas throughout the watershed.(1)

Determine the effectiveness of constructed wetlands to treat runoff.

Coordinate with efforts (by others) to intensify the implementation of existing regulations which call for improved designs of new tanks (e.g., double walls, monitoring facilities); an aggressive self-monitoring program to be conducted by landowners and tenants; and a strategically focused spot-check program to search for, identify, test, and control leaking storage tanks.(1)

Require contractors to post bonds to cover potential damages from erosion and/or sediment deposition.(1)

Develop and implement practical programs for revegetating and otherwise restoring eroding areas (e.g., areas damaged by fires, overgrazing, landslides, and offroad vehicle use, etc).(1)

Develop and implement improved erosion and sediment control policies in the environmental elements of all General Plans.(1)

Develop and implement a program to search for, test, remove, and properly dispose of sediment deposits in drainage channels and/or stormwater storage/retention basins or stormdrains which may contain relatively high concentrations of pollutants.(1)

Determine the effectiveness of building, maintaining, and testing relatively large detention basins at several locations in the lower reaches of the watershed.(1)

Develop and implement an aggressive field program to search for, detect, and correct situations where rainfall and/or runoff presently contact potential contaminants.(1)

Develop and implement a program which provides a means of recording the observations of field inspection and maintenance personnel, so this information can be used to help locate the source(s) of pollutants.(1)

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VII. Educate the general public regarding:

the impacts of household chemicals, oil, antifreeze, solvents, paints, pesticides, and other potentially hazardous chemicals being dumped onto the street or into storm drains.(1)

the environmental impacts which result from leaks and spills from gasoline, fuel oil, and chemical tanks (above and below ground).(1)

the non-point source pollution impacts that result from littering and improper waste disposal practices.(1)

the need to minimize both the total volume of runoff and the peak rate of runoff from a given area. Explain that it lowers erosion rates and pollutant loading.(1)

the need to intensify vehicle inspection and maintain efforts to reduce leakage of oil, antifreeze, hydraulic fluid, etc.(1)

the need to keep rainfall and runoff from contacting potential contaminants.(1)

the general public regarding decreasing automobile use by increasing ride sharing and carpooling, or by using alternative public transportation or human-powered transportation.(1)

VIII. Educating professionals:

Educate architects, engineers, contractors, and public works personnel about the need for methods to control erosion, sediments, groundwater disposal, and site waste disposal.(1)

Provide generic plans and specifications, and demonstrate results which will encourage architects, engineers, and building departments to implement systems which temporarily retain rainfall peaks on rooftops and/or in retention facilities to minimize the peak rate of discharge to the storm drain system.(1)

List of Best Management Practices compiled by Carlos Urrenaga.

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***References:**

(1) Santa Clara Valley Nonpoint Source Study Volume II: NPS Control Program Final Report, Woodward-Clyde Consultants, Oakland, CA, December 14, 1989.

(2) Stormwater Management Manual for the Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, June 1991, Publication #90-73.

(3) Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, US Environmental Protection Agency, Office of Water, May 1991.

(4) Nonpoint Source Control Guidance Construction Activities, US Environmental Protection Agency, Office of Water Planning & Standards, Washington, DC, December 1976.

(5) Water Quality Best Management Practices Manual: For Commercial and Industrial Businesses, For the City of Seattle by Resource Planning Associates, Seattle, WA, June 30, 1989.

(6) Newport Bay Watershed: Construction Best Management Practices Plan For Sediment Control, Boyle Engineering Corporation, San Diego, November, 1981.

(7) Water Quality Management Plan for the Lake Tahoe Region Volume II, Handbook of Best Management Practices, Tahoe Regional Planning Agency, November 30, 1988.

* Any BMP with no reference was compiled from personal communications.

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0004800

R0033248

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

IN REPLY PLEASE
REFER TO FILE

WM-3

January 22, 1992

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

92 JAN 23 AM 11:3
CALIFORNIA REGIONAL WATER
QUALITY CONTROL BOARD
LOS ANGELES REGION

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)
QUARTERLY PROGRESS REPORT (1991 Q4) #6

The following report is submitted in compliance with the above-captioned Permit, which was issued on June 18, 1990. This report provides a summary on the status of specific Permit tasks/requirements performed during the second quarter (October 1 through December 31, 1991) of the second year of the Permit, which began on July 1, 1991.

Permit Tasks

The following information reflects the current status of the remaining First Year tasks to be completed:

Task No.

2.1.1 Subdivision of the Santa Monica Bay Drainage Basin (SMBDB) into drainage areas is complete. Enclosed are two maps showing the drainage areas. The drainage areas were developed utilizing information received from all Co-Permittees.

Water quality data has been provided by the City of Los Angeles and is included herein.

2.1.2 The 90th percentile value for the water quality perameters, 1) total suspended solids, and 2) oil and grease, for the period 1980 to the present have been provided by the City of Los Angeles and are included herein.

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2.1.3 Identification of the existing land use and description of soils, waste disposal facilities and RCRA sites for each drainage area is complete. Please see Attachment I for this information.

The identification of facilities in drainage areas by Standard Industrial Code (SIC) categories has not yet been completed. Performance of this work requires use of our Geographical Information System (GIS). The drainage area boundaries have been digitized and entered into the system. We are presently working on having the tabular listing of facilities by SIC category properly coded and entered into the GIS.

As a participant in the Statewide Stormwater Quality Task Force, we have become aware of the questionable value of the SIC Classification and its use for water quality concerns. The numbers are arbitrarily assigned by a variety of organizations for various purposes and not necessarily with direct involvement of the identified industries concerned. The usefulness of this information may be marginal. We are, therefore, requesting a re-evaluation of this task.

2.1.8 The Early Action BMP plan has completed the public review and comment process and is being submitted to your office for your approval. One comment was received and is included with the plan along with our response.

2.1.9 The site selection process for monitoring sites included in our work plan has taken somewhat longer than anticipated to complete. The work plan will be submitted for public review and comment by early February 1992. We, therefore, foresee submitting the plan to you by mid-March 1992.

2.1.10 A third draft of the Stormwater Permit Implementation Agreement is being prepared and will be distributed to the Co-Permittees. This document addresses 1) each Permittee's responsibilities in implementing the Permit requirements 2) the need for adequate legal authority to regulate illegal discharges and illicit disposal practices to drainage facilities, and 3) to prosecute violators.

Year II Tasks 3.1.2, 3.1.3, and 3.1.4 require the development of: a) additional BMPs; b) procedures to detect and eliminate illegal discharges and illicit disposal practices; and c) measures to control pollutants in surface runoff from construction sites. Committees of Co-Permittees are being established to address the development of these plans.

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If you have any questions, please contact Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:mp
FYR2

Enc.

cc: All Co-Permittees

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0004083

R0033251

STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500

VOL 11 — 0004844

January 15, 1992

Thomas A. Tidemanson, Director
Department of Public Works
County of Los Angeles
900 S. Fremont Avenue
Alhambra, CA 91803-1331

MUNICIPAL STORMWATER PERMIT FOR LOS ANGELES COUNTY (NPDES No. CA0061654) - FIRST YEAR COMPLIANCE REVIEW AND NOTICE OF WORKSHOP

On June 18, 1990, the California Regional Water Quality Control Board (Regional Board) adopted waste discharge requirements for municipal stormwater/urban runoff discharges in Los Angeles County with the Los Angeles County Department of Public Works (County) as the principal permittee. The permitted area is divided into five drainage basins which are phased into the municipal stormwater program starting with the Santa Monica Bay Drainage Basin on July 1, 1990.

The stormwater permit required the Santa Monica Bay Drainage Basin municipalities/permittees to undertake ten tasks during the first compliance year, July 1, 1990 to June 30, 1991. These tasks included compilation of existing information on waste management programs, characterization of the basin for stormwater quality management, development of a stormwater/urban runoff monitoring plan, and documentation of existing or plans to obtain comprehensive legal authority to implement a stormwater program.

On July 15, 1991, the Los Angeles County Department of Public Works and co-permittees submitted their first year annual compliance report. The extent of compliance among permittees varied significantly. A supplemental report was submitted on November 4, 1991. The supplemental report documented that permittees' compliance had been brought to about the same level. However, not all of the first year requirements were complied with by any permittee. See attached staff report.

At its January 27, 1992, meeting in accordance with the stormwater permit stipulation (Finding No. 20), the Regional Board will hold an informational workshop to solicit comments and inform the public of the progress of the municipal stormwater program for Los Angeles County. The meeting will be held at Room 1127, 107 South Broadway, Los Angeles and will begin at 9:30 a.m. All permittees and interested entities/parties are invited to participate in the workshop.

If you have any questions, please call me at (213) 266-7510, or have your staff call David Gildersleeve at (213) 266-7520 or Xavier Swamikannu at (213) 266-7592.

Robert P. Ghirelli

ROBERT P. GHIRELLI, D.Env.
Executive Officer

cc: Jorge Leon, Office of Chief Counsel, State Water Resources Control Board
Paul Helliker, Assistant Secretary, California Environmental Protection Agency
Archie Matthews, Section Chief, Division of Water Quality, State Water Resources Control Board
Bill Pierce, Chief, Permits and Compliance Branch, Environmental Protection Agency, Region IX
Jim Noyes, Waste Management Division, County of Los Angeles, Department of Public Works
John Mitchell, Waste Management Division, County of Los Angeles, Department of Public Works
Phil Richardson, Stormwater Division, Bureau of Engineering, City of Los Angeles
Co-permittees
Interested parties

Enclosures

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

STAFF REPORT
ON THE
MUNICIPAL STORMWATER PERMIT FOR LOS ANGELES COUNTY

REVIEW OF FIRST YEAR'S COMPLIANCE
(July 1, 1990 - June 30, 1991)

BACKGROUND

On June 18, 1990, this Regional Board adopted Order No. 90-079 (NPDES No. CA0061654) regulating stormwater and urban runoff discharges from separate stormwater sewers throughout Los Angeles County. The permit was the result of a cooperative effort among representatives of regulatory agencies and the regulated communities. It is aimed toward the development of an aggressive and comprehensive municipal stormwater program. The Los Angeles County Department of Public Works (County) was designated as the principal permittee with the municipalities and entities discharging in the permitted area as co-permittees. The County is to coordinate compliance of co-permittees with the requirements of the permit.

The permitted area is divided into five drainage basins which are phased into the municipal stormwater program over three years starting with the Santa Monica Bay Drainage Basin. The Santa Monica Bay Drainage Basin municipalities/permittees were required to begin compliance with the provisions of the permit beginning July 1, 1990.

SANTA MONICA BAY DRAINAGE BASIN CO-PERMITTEES

At the time the stormwater permit was adopted, seventeen cities were identified as co-permittees: Agoura Hills, Beverly Hills, Culver City, El Segundo, Hermosa Beach, Inglewood, Los Angeles, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Santa Monica, Torrance, West Hollywood, and Westlake Village.

The permit provides that additional entities will be designated co-permittees to the stormwater program once it is identified that their discharges constitute part of the Los Angeles County municipal stormwater drainage system. (Otherwise, the municipality/entity must apply for a separate permit from the Regional Board).

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After adoption of the stormwater permit, Caltrans and the newly incorporated cities of Calabasas and Malibu joined the County as co-permittees. The Regional Board has determined that stormwater discharges from portions of the City of Thousand Oaks and unincorporated areas of Ventura County are part of the Los Angeles stormwater drainage system within the Santa Monica Bay Drainage Basin. The County of Ventura has not yet decided whether to become a co-permittee to the Los Angeles system or to file for a separate municipal stormwater permit for all unincorporated areas of Ventura County. However, it has participated and partly completed the tasks required during the first year of the permit.

The City of Thousand Oaks elected to file for a separate municipal stormwater discharge permit. The Regional Board has directed the City to submit Part 1 of the application for the areas discharging into the Santa Monica Bay Drainage Basin on or before March 30, 1992. The City has agreed to cooperate with the County to ensure that all necessary information is provided in a timely manner. However, the City has not yet submitted the required information nor conducted the required tasks.

FIRST YEAR COMPLIANCE WITH PERMIT REQUIREMENTS

On July 15, 1991, the County submitted the first year report of compliance with requirements of the municipal stormwater permit. A supplemental report was submitted on November 4, 1991.

The following represents Board staff's evaluation of the first year performance of the County and co-permittees:

Task 2.1.1 Water quality data and flow data from 1980 to present; Identification of drainage areas

Los Angeles County, Ventura County, Caltrans and the cities of Manhattan Beach and Santa Monica have provided water quality/flow data. The City of Los Angeles has been collecting water quality and flow data but has not yet submitted this information. All other permittees reported no available data.

Outer watershed boundaries for storm drains and water courses that discharge to Santa Monica Bay have been identified and mapped. However, further subdivision into 200+ drainage areas for characterization is incomplete. Drainage areas ("runoff areas") identified by Caltrans for the highway system have not been incorporated in the basin characterization map.

Task 2.1.2 Wet weather 90thpercentile values for TSS and Oil & grease

The permit required submittal of 90thpercentile values for total suspended solids (TSS) and oil and grease computed from all wet

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weather data collected by permittees for the basin from 1980 through 1990. The County reported 90th percentile values of 2,362 mg/l for TSS and 8.6 mg/l for oil and grease based only on the County's data. Values of these constituents should be calculated incorporating wet weather data from the City of Los Angeles and Caltrans.

Task 2.1.3 Supplementary information for contaminant sources identification

This task has not been completed by any permittee. Mapping of pollutant sources within drainage areas as related to industries, land uses, waste disposal facilities, etc. is still on-going and is being conducted in conjunction with Task 2.1.1.

Task 2.1.4 Monthly precipitation data from 1980 through 1990 and estimate of impervious areas within drainage areas

Precipitation data was submitted by the counties of Los Angeles and Ventura, and the cities of Beverly Hills, Los Angeles, Palos Verdes Estates, Redondo Beach, Santa Monica, and Westlake Village. The City of Torrance has been collecting precipitation data as part of the National Weather Service Network but has not submitted the data. All other permittees reported no gauging stations under their jurisdiction.

No permittee has submitted estimates of impervious areas. This task is being conducted in conjunction with Tasks 2.1.1 and 2.1.3.

Task 2.1.5 Documentation of existing procedures to identify and eliminate illegal discharge/disposal practices

The County and the cities of Los Angeles and Santa Monica have mature programs to address illegal practices through their industrial waste programs. The cities of Palos Verdes Estates, Redondo Beach, Rolling Hills Estates, West Hollywood, and Westlake Village reported no existing procedures to address illegal discharge/disposal practices. Other permittees have various referral procedures to other local, county, and/or state agencies. The effectiveness of the referral procedures is greatly dependent on actions of the agencies to whom the illegal practice was referred.

In developing a basin-wide program to address this aspect of the stormwater program, the permittees should consider a documentation component that includes identity of violators, nature of violations, referrals, number of inspections, number of citations, correction follow-ups, referrals made and to whom, etc.

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Task 2.1.6 Documentation of existing procedures and improvement plans to control runoff from construction sites

All permittees submitted procedures they have in place. Most of the procedures addressing runoff from construction sites are incorporated in construction activity prohibitions, land development codes, and/or informal prohibitions given during site inspections. The City of Inglewood has no documented procedure to address construction site runoff.

Generally, existing procedures to control runoff from construction sites are inadequate. There is a need for standardization of procedures and codes used by permittees to review construction plans. However, no plans were submitted to improve existing procedures. Documentation procedures similar to those recommended for Task 2.1.5 should be included in the improvement plans.

The federal stormwater regulations require a State issued NPDES permit for stormwater discharges associated with construction activity on five or more acres after October 1, 1992. The State Water Resources Control Board and the Regional Boards are developing a statewide general permit for this category of stormwater discharge. Construction site runoff control improvement plans that the permittees will develop must integrate and augment the State's construction activity permitting program.

Task 2.1.7 Documentation of existing management practices to control pollutants

The permittees presented a wide range of on-going management practices, which may be broadly grouped under sanitary system controls, waste management practices, road and storm drain maintenance activities, and public education/information programs. The nature of controls used varies from permittee to permittee.

The list provided by the permittees could serve as a basis in selecting early Best Management Practices (BMPs) for implementation under the stormwater quality management program.

Task 2.1.8 Plan with schedule of implementation of early action BMPs

Drafts of early action BMP plans and schedules of implementation of these plans have been submitted to the Board. These plans and schedules are to receive public comment prior to submittal to the Executive Officer for approval as required in the permit. Board staff will review the plans and schedules after public comment/input are incorporated. These plans must also include procedures and documentation to evaluate the effectiveness of early action BMP programs.

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Task 2.1.9 Workplan for the development of a stormwater/urban runoff monitoring program

This workplan has not yet been submitted to the Regional Board. Public input during the development of this plan is also required prior to submittal.

Task 2.1.10 Documentation of possession of and/or plans to obtain the necessary legal authority to operate a stormwater quality management program

The permittees have complied with this requirement. A Stormwater Permit Implementation Agreement delineating permittee responsibilities is being developed by permittees.

SUMMARY

The municipal stormwater permit required permittees located within the Santa Monica Bay Drainage Basin to complete ten tasks during the first year. These tasks required compilation of existing information on waste management programs, characterization of the basin for stormwater quality management, development of stormwater/urban runoff monitoring plans, and documentation of existing and/or plans to obtain comprehensive legal authority to manage stormwater programs.

The supplemental report submitted on November 4, 1991, on the first year's requirements provided documentation that permittees had been brought to almost the same level of compliance, although not all required tasks were completed by any permittee. The average compliance achieved by permittees was about 70% of first year requirements.

CONCLUSION

At this point in time it is clear that the permittees got off to a slow start during the first year and must now play "catch up". Permittees must not only complete all second year requirements on time, but must also finish the remaining first year tasks as soon as possible.

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PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA,
County of Los Angeles,

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above-entitled matter. I am the principal clerk of the printer of the

Daily News

a newspaper of general circulation, printed and published 7 times weekly in the Cities of Los Angeles, Burbank & San Fernando, County of Los Angeles, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Los Angeles, State of California, under the date of May 26, 1983, Case Number Adjudication #C349217; that the notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit: .....

Nov 24

all in the year 19 91

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated at Woodland Hills, California, this 25th day of Nov, 19 91

Signature

This space is for the County Clerk's Filing Stamp

92 JAN 23 AM 11:33
QUALITY CONTROL BOARD
LOS ANGELES REGION

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Public Notices

(DAILY NEWS G 167477

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT NO. CA 0061654-C16948

Notice is hereby given that in compliance with NPDES Permit No. CA0061654-C16948, a copy of the "Early Action Best Management Practices (BMP) plan" is available for public review and comment at the Los Angeles County Department of Public Works, Waste Management Division, Stormwater Discharge Program Unit located at the Annex Building, 900 South Fremont Avenue, Alhambra, CA 91803-1331. Written comments will be accepted from November 25, 1991 through December 23, 1991. For additional information, please call (818) 458-4972.

The NPDES Permit requires the development of a plan, with implementation schedules, to improve existing Best Management Practices (BMPs) that have a positive impact on the quality of stormwater/urban runoff discharge into the storm drainage system. This document outlines the proposed improvements to the existing BMPs by the various Permittees. The Permittees are the County of Los Angeles, the State of California Department of Transportation (Caltrans), the Cities of Agoura Hills, Beverly Hills, Calabasas, Culver City, El Segundo, Hermosa Beach, Inglewood, Los Angeles, Malibu, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Santa Monica, Torrance, West Hollywood, Westlake Village. A copy of the document is available for public review at the city halls of the above-listed cities. (For Caltrans and the City of Los Angeles, please see locations listed below.)

A copy of the document is available for review at the following locations:

Las Virgenes Library
29130 West Roadside Drive
Agoura Hills

Hermosa Beach Library
550 Pier Avenue
Hermosa Beach

Malibu Library
23519 West Civic Center Way
Malibu

Point Dume Library
6955 Fernhill Drive
Malibu

Caltrans
120 S. Spring Street,
Room 210, Los Angeles

City of Los Angeles
Stormwater Management Division
600 S. Spring Street,
4th Floor, Los Angeles

Bureau of Engineering Office
San Pedro
Municipal Building
14410 Sylvan Street
Van Nuys

Manhattan Beach Library
1320 Highland Avenue
Manhattan Beach

Manhattan Heights
1560 Manhattan Beach Boulevard
Manhattan Beach

Marina Del Rey Library
4533 Admiralty Way
Marina Del Rey

West Hollywood Library
715 North San Vicente Boulevard
West Hollywood

Bureau of Engineering Office
West Los Angeles
Municipal Building
1645 Corinth Avenue,
Room 209
West Los Angeles

Bureau of Engineering Office
San Pedro
Municipal Building
638 S. Beacon Street
San Pedro

Publish November 24, 1991

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DN - 2510

R0033259

PROOF OF PUBLICATION

(2015.5 C.C.P.)

STATE OF CALIFORNIA

County of Los Angeles

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above-entitled matter. I am the principal clerk of the printer of the THE DAILY BREEZE

a newspaper of general circulation, printed and published DAILY

in the City of Torrance

County of Los Angeles, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Los Angeles, State of California, under the date of June 10, 1974

Case Number SWC7146

that the notice of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

Nov 24

all in the year 19 91

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated at Torrance

California, this 25 day of Nov 19 91

Ralph Morgan
Signature

Daily Breeze

5215 TORRANCE BLVD • TORRANCE, CALIFORNIA 90509
(213) 540-5511, 772-6281

Copley LOS ANGELES Newspapers

DB Case G167478

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT NO. CA0061654-C16948

Notice is hereby given that in compliance with NPDES Permit No. CA0061654-C16948, a copy of the "Early Action Best Management Practices (BMP) plan" is available for public review and comment at the Los Angeles County Department of Public Works, Waste Management Division, Stormwater Discharge Program Unit located at the Annex Building, 900 South Fremont Avenue, Alhambra, CA 91803-1331. Written comments will be accepted from November 25, 1991 through December 23, 1991. For additional information, please call (818) 458-6972.

The NPDES Permit requires the development of a plan, with implementation schedules, to improve existing Best Management Practices (BMPs) that have a positive impact on the quality of stormwater/urban runoff discharge into the storm drainage system. This document outlines the proposed improvements to the existing BMPs by the various Permittees. The Permittees are the County of Los Angeles, the State of California Department of Transportation (Caltrans), the Cities of Agoura Hills, Beverly Hills, Calabasas, Culver City, El Segundo, Hermosa Beach, Inglewood, Los Angeles, Malibu, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Santa Monica, Torrance, West Hollywood, Westlake Village. A copy of the document is available for public review at the city halls of the above-listed cities. (For Caltrans and the City of Los Angeles, please see locations listed below.)

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550 Pier Avenue
Hermosa Beach

Malibu Library
23519 West Civic Center Way
Malibu

Point Dume Library
6955 Fernhill Drive
Malibu

Caltrans
120 S. Spring Street Room 210
Los Angeles

City of Los Angeles
Stormwater Management Division
600 S. Spring Street, 4Th Floor
Los Angeles

Bureau of Engineering Office
San Pedro Municipal Building
14410 Sylvan Street
Van Nuys

Manhattan Beach Library
1320 Highland Avenue
Manhattan Beach

Manhattan Heights
1560 Manhattan Beach Boulevard
Manhattan Beach

Marina Del Rey Library
4533 Admiralty Way
Marina del Rey

West Hollywood Library
715 North San Vicente Boulevard
West Hollywood

Bureau of Engineering Office
West Los Angeles Municipal Building
1645 Corinth Avenue, Room 209
West Los Angeles

Bureau of Engineering Office
San Pedro Municipal Building
638 S. Beacon Street
San Pedro

Pub.: November 24, 1991.

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COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

JG 6948
XS

VOL 11 — 0004993

November 4, 1991

IN REPLY PLEASE REFER TO FILE WM-3

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)
QUARTERLY PROGRESS REPORT (1991 Q3) #5

The following report is submitted in compliance with the above-captioned Permit, which was issued on June 18, 1990. This report provides a summary on the status of specific Permit tasks/requirements performed during the first quarter (July 1 through September 30, 1991) of the second year of the Permit, which began on July 1, 1991.

During this period, two newly incorporated cities have become Co-Permittees, the Cities of Calabasas and Malibu. We have met with these cities to discuss implementation of the first year requirements. They will be reporting to us with their estimated completion dates for these tasks.

With the inclusion of the Cities of Calabasas and Malibu, only two municipalities within the Santa Monica Bay Drainage Basin have yet to apply for Co-Permittee Status - the City of Thousand Oaks and the County of Ventura. As mentioned to you in our previous report, their participation in this program is necessary to achieve Permit goals and objectives within their drainage areas.

During this reporting period, a number of Co-Permittees have continued to submit information concerning existing data, practices, and procedures. Please refer to Attachment I for a summary of these submittals. This additional information is included in Attachment II.

<u>Permit Tasks</u>

The following information reflects the current status of the remaining First Year tasks to be performed:

2.1.1 Subdivision of the SMBDB into smaller drainage areas continues. Our current estimate for completion of this task remains November 30, 1991. Copies of these maps should be submitted to you by December 16, 1991.

2.1.3 The existing land use, and description of soils, waste disposal facilities and RCRA sites for each drainage area is being developed in concert with Task 2.1.1. Therefore, this data should be submitted to you by December 16, 1991.

2.1.8 Based on the present state of development of the Early Action BMP plan, we anticipate that the plan will be made available for public input in mid-November, with final submittal to the Executive Officer during mid-January 1992.

2.1.9 As stated in our previous report, the workplan for the stormwater/urban runoff monitoring program should be completed for submittal to you by December 31, 1991.

2.1.10 A second draft of a Stormwater Permit Implementation Agreement has been prepared. This document will delineate the individual and collective responsibilities of all Permittees. This second draft has been distributed to the Co-Permittees for review and comment on October 17, 1991.

Lastly, we are awaiting your response regarding our First Year Report submitted on July 15, 1991.

If you have any questions, please contact Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:mp
FYR1

Enc.

cc: All Co-Permittees

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R0033263

SANTA MONICA BAY DRAINAGE BASIN

Data for Entries in Bold Face Included in this Report**

CO-PERMITTEE	*1. Existing Water Quality and Flow Data 1980 to Present		*2. 90th Percentile Values for (i) Oil & Grease (ii) Total Suspended Solids	*4. Existing Rainfall Data 1980 to Present	*5. Existing Illegal Discharge & Disposal Practices	*6. Existing Construction Site BMPs	*7. All Other Existing BMPs
	Flow	W.Q.					
LOS ANGELES COUNTY	X	X	X	X	X	X	X
AGOURA HILLS	**N**	**N**	**N**	**N**	X	X	X
BEVERLY HILLS	**N**	**N**	**N**	X	X	X	X
CULVER CITY	**N**	**N**	**N**	**N**	X	X	X
EL SEGUNDO	**N**	**N**	**N**	**N**	X	X	X
HERMOSA BEACH	**N**	**N**	**N**	**N**	X	X	X
INGLEWOOD	**N**	**N**	**N**	**N**	X	**N**	X
LOS ANGELES	**N**			X	X	X	X
MANHATTAN BEACH	**N**	X	**N**	**N**	X	X	X
PALOS VERDES ESTATES	**N**	**N**	**N**	X	**N**	X	X
RANCHO PALOS VERDES	**N**	**N**	**N**	**N**	X	X	X
REDONDO BEACH	**N**	**N**	**N**	X	**N**	X	X
ROLLING HILLS	**N**	**N**	**N**	**N**	X	X	X
ROLLING HILLS ESTATES	**N**	**N**	**N**	**N**	**N**	X	X
SANTA MONICA	**N**	X	**N**	X	X	X	X
TORRANCE	**N**	**N**	**N**	**N**	X	X	X
VENTURA COUNTY (1)	X	X	**N**	X	X	X	X
WEST HOLLYWOOD	**N**	**N**	**N**	**N**	**N**	**N**	X
WESTLAKE VILLAGE	**N**	**N**	**N**	X	**N**	X	X
CALTRANS	**N**	X	**N**	**N**	X	X	X

(1) Not a Co-Permittee X = Submitted N = No Data Available (The Co-Permittee has not historically gathered this data)

*Number Corresponds to Year 1 Permit Task **All other data submitted in our July 15, 1991 report.

SMBCHART October 31, 1991

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

July 15, 1991

IN REPLY PLEASE REFER TO FILE WM-3

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654
FIRST YEAR REPORT

The following report is submitted in compliance with the provisions of NPDES Permit No. CA0061654. It provides a status report for tasks and activities mandated under the Permit for accomplishment during the period July 1, 1990 to June 30, 1991, the first year of the Permit.

Permit Implementation

During this period, the Permit activities addressed the Santa Monica Bay Drainage Basin. The efforts of the County of Los Angeles and its Co-Permittees were directed at meeting Permit requirements as well as establishing the mechanisms necessary for attainment of the Permit's long-term goals.

Co-Permittee understanding and coordination regarding Permit mandates was developed through meetings and related activities. To date, the majority of original Permittees are actively involved in implementing Permit requirements. Additional entities have also elected to join the Permit. On March 25, 1991, the City of Palos Verdes Estates submitted its request for Co-Permittee status. Following our discussions with the California Department of Transportation, on April 10, 1991, Caltrans submitted a Letter of Intent to participate as a Co-Permittee.

Of the municipalities in existence on the date of Permit adoption (June 18, 1990), only the City of Thousand Oaks and the County of Ventura have yet to apply for Co-Permittee status. They are located in one of the most rapidly developing portions of the Santa Monica Bay Drainage Basin. Their participation, preferably under the current permit, is necessary to achieve Permit goals and objectives within their unique drainage areas. The ongoing efforts of your staff to resolve this situation are pivotal to the continued progress of the Permit.

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R0033264

Two new cities, the City of Calabasas and the City of Malibu, were incorporated during the past year. In June, 1991, both cities were sent letters inviting their participation as Co-Permittees. No response has been received, to date, from either city.

Finally, as we have discussed with your staff, no information or data has been submitted, to date, by the City of Hermosa Beach.

Permit Tasks

The following information reflects the current status of each of the ten Year 1 tasks. Enclosed, you will find a chart identifying tasks for which data is included in this report.

2.1.1 All existing water quality and flow data submitted by the Co-Permittees, including the County of Los Angeles is included herein (Attachments A and B). To date, we have mapped the outer watershed boundary for the storm drains and natural watercourses that discharge into Santa Monica Bay. Included herein are 17 maps showing this information (Attachment C). The subdivision of these larger watersheds into an estimated 200+ drainage areas continues. This work is being performed by the County utilizing information compiled by the County and the Co-Permittees. Our current estimate for completion of this task is November 30, 1991.

2.1.2 Of the information received, only Los Angeles County has wet weather samples which contain data on Total Suspended Solids and Oil & Grease. This information is included herein, together with calculated 90th percentile values (Attachment A).

2.1.3 Utilizing information received from the Co-Permittees, maps identifying the principal existing land use classifications in the Santa Monica Bay Drainage Basin have been prepared. These maps will be utilized in Task 2.1.1 to identify the existing land use for each drainage area. Maps of the various soil types within the SMBDB will be obtained from the Los Angeles County Department of Public Works Hydrology Manual. These maps will be used to identify the various soils within each drainage area. A map showing the location of dumps, landfills, and waste disposal sites within the SMBDB is being developed from information obtained from each Co-Permittee and from the County's Major Waste Systems Plan. RCRA facilities will also be included, based on the most current information available from the CRWQCB. Our current estimate for completion of this task is November 30, 1991.

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2.1.4 All existing precipitation data received from the Co-Permittees is included herein (Attachment B). The estimate of impervious surfaces in each drainage area is being performed in conjunction with Tasks 2.1.1 and 2.1.3.

2.1.5
2.1.6
2.1.7 All existing BMP information received from Co-Permittees is included herein (Attachment D). To date, we have not received existing BMP information from the following Co-Permittees: The Cities of Culver City, Hermosa Beach, and Rolling Hills.

2.1.8 We are currently developing an Early Action BMP Plan, with schedule of implementation. We estimate the Plan will be made available for public input by September 1, 1991. Following an analysis of public input, the final Plan and implementation schedule should be submitted to you by November 1, 1991.

2.1.9 The development of the workplan for the stormwater/urban runoff monitoring program is continuing. A preliminary list of constituents and parameters has been developed, along with sampling methodologies. We have scheduled meetings with various water quality sampling equipment manufacturers to identify what equipment exists that could handle the sampling needs for our monitoring program. This information will be incorporated into the monitoring site selection criteria that is currently being developed. We estimate that the workplan will be available for public input by October 1, 1991. Following an analysis of public input, the workplan should be submitted to you by December 31, 1991.

2.1.10 Major Permittee efforts have been directed at technical/BMP provisions of the Permit, however, initial development has also taken place regarding an MOU or similar document to delineate and document the individual and collective responsibilities of all Permittees. An initial draft has been prepared, reviewed by all Permittees, and is ready for further development.

Conclusions

During the negotiations which led to the creation and adoption of the Los Angeles County Stormwater Permit, it was realized that the first year of the Permit would involve much uncertainty. A large number of separate and distinct jurisdictions, each with their own continuing responsibilities and concerns, must now coordinate their efforts to effectively reach the goals established in the Permit. In recognition of this, representatives from the CRWQCB and prospective Permittees agreed that a two-year period between the start of Phase I activities and the implementation of Phase II was necessary to deal with the start-up uncertainties of such a major undertaking.

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The lessons learned and procedures developed during the implementation of Year 1 tasks will make the expansion of the Permit activities to the remainder of Los Angeles County -and a total of 80+ cities- much more effective.

While work on several Permit tasks has exceeded the time frames originally set by the Permit, we believe that the extra time applied to ground work organization will better support long-term success. At the same time, completion of the remaining tasks is within time frames for which we request your approval as substantially in conformance with the Permit, especially in light of the magnitude and complexity of the tasks.

The current state of storm system flow quality is the product of decades of metropolitan growth and the daily practices of residents and workers in the Los Angeles County area. By defining the current situation carefully and thoroughly designing and implementing programs to monitor, control, and improve the changing conditions, we expect our efforts to benefit the environment and the citizens of Los Angeles County in the most effective manner possible.

If you have any questions, please contact Mr. Brian Hooper at (818) 458-5118.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

Dave Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

BDH:cr/FYR3

Enc.

cc: All Co-Permittees

VOL 11 0004999

SANTA MONICA BAY DRAINAGE BASIN

Information from the Following First-Year Permit Tasks is Included in this Report

CO-PERMITTEE	1.*Existing Water Quality and Flow Data 1980 to Present (2.1.1)		2.*90th Percentile Values for (i) Oil & Grease (ii) Total Suspended Solids (2.1.2)	4.*Existing Rainfall Data 1980 to Present (2.1.4)	5.*Existing Illegal Discharge & Disposal Practices (2.1.5)	6.*Existing Construction Site BMPs (2.1.6)	7.*All Other Existing BMPs (2.1.7)
	Flow	W.Q.					
LOS ANGELES COUNTY	X	X	X	X	X	X	X
AGOURA HILLS	N	N	N	N	X	X	X
BEVERLY HILLS					X	X	X
CULVER CITY	N	N	N	N			
EL SEGUNDO					X	X	X
HERMOSA BEACH							
INGLEWOOD	N	N	N	N	X	N	X
LOS ANGELES				X	X	X	X
MANHATTAN BEACH		N	N		X	X	X
PALOS VERDES ESTATES				X	N	X	X
RANCHO PALOS VERDES	N	N	N	N	X	X	X
REDONDO BEACH	N	N	N	X	N	X	X
ROLLING HILLS	N	N	N	N			
ROLLING HILLS ESTATES	N	N	N	N	N	X	X
SANTA MONICA		X	N	X	X	X	X
TORRANCE	N	N	N	N	X	X	X
VENTURA COUNTY	X	X	N	X	X	X	X
WEST HOLLYWOOD	N	N	N	N	N	N	X
WESTLAKE VILLAGE	N	N	N	X	N	X	X
CALTRANS					X	X	

X = Submitted N= No Data Available INC = Incomplete *Number corresponds to Year 1 Permit Task

CR2 July 11, 1991

R0033268

VOL 11

STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL

FACILITIES INSPECTION REPORT

SWRCB 001 (NEW 6-87)

ADDITIONAL INFORMATION SHOULD BE ATTACHED TO C.

1. WDS NUMBER (Must be 11 digits) 4 8 1 9 0 1 0 7 0 0 9	2. NAME OF AGENCY RESPONSIBLE FOR DISCHARGE: LA COUNTY DEPT PUBLIC WORKS
3. DATE INSPECTION COMPLETED (Year Mo Day): 91 10 16 13	4. NAME OF FACILITY: MUNICIPAL STORM DRAIN SYSTEM

5. INSPECTION TYPE (Check One)

A1 ☐ "A" type compliance—Comprehensive inspection in which samples are taken.

B1 ☑ "B" type compliance—A routine nonsampling inspection.

C2 ☐ Noncompliance follow-up—Inspection made to verify correction of a previously identified violation.

C3 ☐ Enforcement follow-up—Inspection made to verify that conditions of an enforcement action are being met.

C4 ☐ Complaint—Inspection made in response to a complaint.

C5 ☐ Pre-requirement—Inspection made to gather information relative to preparing, modifying, or rescinding requirements.

C6 ☐ Miscellaneous—Any inspection not mentioned above.

NPDES

6. INSPECTION BY: ☑ State ☐ State/EPA Joint	7. IS EPA INSPECTION REQUIRED? ☐ Yes ☑ No
8. DID YOU TAKE A BIOASSAY SAMPLE? ☐ Yes ☑ No	9. IF A BIOASSAY SAMPLE WAS TAKEN, WAS IT: ☐ Static ☐ Flowthrough

10. INSPECTION COMMENTS SUMMARY—REQUIRED (100 Character Maximum)

DISCUSSED FIRST YEAR PROGRESS

11. WAS THERE A VIOLATION?

☐ Yes (Complete violation form.) ☑ No ☐ Pending (e.g., lab results)

12. INSPECTOR'S INITIALS → KSL

ADDITIONAL COMMENTS

John Mitchell, Water Quality Section
(818) 458-3537.
First Year Report due in July 91
Expect partial delay in first year schedule

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0005001

R0033269

STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500

June 13, 1991

John Mitchell
Waste Management Division
Department of Public Works
County of Los Angeles
P.O. Box 1460
900 S. Fremont Avenue
Alhambra, CA 91802-1460

COPIES OF NPDES PERMITS FOR DISCHARGES TO SANTA MONICA BAY

As per your request, attached are, (i) NPDES permits issued to date, and (ii) annual summary of discharge monitoring reports, or when unavailable, the 1991 first quarter monitoring report, for all permitted discharges to Santa Monica Bay.

This information is being submitted to you in order to facilitate your development of a program to identify illegal connections to the municipal storm drain system, and thus, meet requirements of the municipal stormwater discharge permit issued by the Regional Board to Los Angeles County (NPDES No. CA0061654).

In the future, copies of all NPDES permits issued for waste discharge to your storm drain system will be sent to you as they are adopted. Please retain these copies for your reference.

If you have any questions, please contact Xavier Swamikannu at (213) 266-7592.

DAVID C. GILDERSLEEVE
Chief, Regulatory Section

Attachments

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R0033270

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

May 8, 1991

IN REPLY PLEASE REFER TO FILE WM-3

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

91 MAY 10 PM 3:10

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI 6948)
QUARTERLY PROGRESS REPORT (1991 Q1) #3

The following report is submitted in compliance with the above-captioned Permit, which was issued on June 18, 1990. This report provides a summary on the status of specific Permit tasks/requirements performed during the third quarter (January 1, through March 31, 1991) of the first year of the Permit, which began on July 1, 1990.

Permit Tasks

2.1.1 We have received information from the Cities of Los Angeles, Manhattan Beach, Santa Monica, and Torrance regarding storm drains they own that discharge directly into the Santa Monica Bay. We will soon begin the process of subdividing the watershed into smaller drainage areas for each storm drain and natural watercourse discharging into the Santa Monica Bay.

2.1.2 We have received additional water quality data from the Cities of Beverly Hills, Manhattan Beach, Palos Verdes Estates, Redondo Beach, Santa Monica, Westlake Village, and the County of Ventura. This new data will be incorporated into the existing data.

2.1.3 We are about 85% complete in identifying existing land uses for the Santa Monica Bay Drainage Basin. This land use information will be used in Task 2.1.1 to guide the watershed subdivision process. A description of soils, waste disposal sites, and Resource Conservation and Recovery Act (RCRA) sites will be provided for each drainage area.

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We are awaiting receipt of information requested from your agency detailing all NPDES Permits which have been issued for the Santa Monica Bay Drainage Basin. This data will be used in the identification of legal and illegal connections to storm drain systems.

2.1.5, 2.1.6, and 2.1.7 — The County has completed its initial inventory of Existing Best Management Practices for the unincorporated areas of the County and for those storm drain systems owned and operated by the County that are contained within the jurisdiction of the other Permittees. To date, we have received information on existing BMPs from the Cities of Agoura Hills, Beverly Hills, Inglewood, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Torrance, Rolling Hills Estates, Rolling Hills, Santa Monica, West Hollywood, Westlake Village, and the County of Ventura.

2.1.8 — We are compiling a list of existing BMPs, categorized according to type. This will allow for easy comparison of existing BMPs between Co-Permittees. The list will be distributed to all Co-Permittees to assist them in the identification of all existing BMPs and in the preparation of their early action BMP plans.

2.1.9 — We are finalizing our proposed list of constituents and parameters to be monitored. We have begun research into the various types of automated sampling equipment available.

2.1.10 — To date, we have received comments from the Cities of Beverly Hills, Culver City, Los Angeles, Manhattan Beach, Torrance, Rolling Hills Estates, Santa Monica, and West Hollywood on our first draft of a stormwater permit implementation agreement. A second draft incorporating the comments received has not yet been prepared.

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If you have any questions, please contact Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

David Yamahara

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:ld/IIIYR

VOL 11 0005005

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

RPG 2/22 XS DCG 2/22

February 19, 1991

IN REPLY PLEASE REFER TO FILE WM-3

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI 6948)
QUARTERLY PROGRESS REPORT (1990 Qtr) #2

The following report is submitted in compliance with the above-captioned permit, which was issued on June 18, 1990. The report provides a summary on the status of specific permit tasks/requirements performed during the second quarter (October 1, through December 31, 1990) of the first year of the Permit, which began on July 1, 1990.

General

The computer system that will be used to receive, store, and manage the data being gathered by the various Permittees is now operational. The data base programs have been transmitted to all Permittees, allowing them to conduct information gathering activities in a common, easily integrated format.

A letter, dated July 25, 1990, was sent to your agency requesting a copy of all NPDES Permits issued in the Santa Monica Bay Drainage Basin. No information has yet been received. This information is needed to assist in the identification of legal and/or illegal connections to the storm drain system.

We are continuing to work with each Co-Permittee in the planning and implementation of their permit activities and the coordination of our joint efforts.

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R0033274

VOL 11 0005071

Permit Tasks

The following is the status of the 10 first-year permit requirements:

Task	Status
2.1.1	The available flow data for the Drainage Basin has been gathered. To date, we have identified the alignments and outer watershed boundaries for all County-owned storm drains and natural watercourses discharging into the Santa Monica Bay. We have not, as yet, received drain alignment and drainage area information from 16 of the Co-Permittees.
2.1.2	We are currently gathering the available existing water quality data for the Drainage Basin. The 90th percentile values should be determined by the end of February 1991.
2.1.3	We have received your letter dated January 10, 1991, approving our proposed list of SIC code categories of businesses we feel need to be identified. We are investigating possible sources for a list of businesses with these SIC codes. Land use information has been received from all Co-Permittees. We are in the process of identifying the land use within each major watershed. Once this has been completed, drainage areas, as defined in the Permit, will be identified within each major watershed. A description of soils, dumps, landfills, waste disposal sites, and Resource Conservation and Recovery Act (RCRA) sites will be provided for each drainage area when all such areas have been identified.
2.1.4	Precipitation data from rain gauge stations in the basin has been gathered. An estimate of impervious surfaces within each drainage area has not yet been performed.

2.1.5, 2.1.6, and 2.1.7	The County has completed its initial inventory of Existing Best Management Practices for the unincorporated areas of the County and for those storm drain systems owned and operated by the County that are contained within the jurisdiction of the other Permittees. To date, we have received information on existing BMP's from two Co-Permittees.
2.1.8	Work on an Early Action BMP plan, with schedule of implementation, will begin shortly. Initial efforts will be concentrated on existing BMP's performed by the County.
2.1.9	Work has begun on our work plan for the development of the stormwater/urban runoff monitoring program.
2.1.10	A draft version of a stormwater permit implementation agreement has been prepared and is being reviewed by the Permittees. Comments on the agreement were due by the end of January. As of February 14, 1991, we have received comments from approximately one-third of the Co-Permittees. A review and consideration of all comments received will follow together with any needed negotiations among the Permittees.

If you have any questions, please contact Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:ld/CI6948

VOL 11
0000508

File

STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500

VOL 11

0000509

January 10, 1991

John K. Mitchell
Water Quality Section
Waste Management Division
County of Los Angeles
Department of Public Works
900 So. Fremont Avenue
Alhambra, CA 91802-1460

STANDARD INDUSTRIAL CODE CATEGORIES FOR DRAINAGE AREA CHARACTERIZATION (NPDES PERMIT NO. CA0061654)

Your letter dated December 19, 1990, requested our review of your proposed Standard Industrial Code (SIC) categories for the identification of facilities in each drainage area. The list includes all SIC classes identified by the Environmental Protection Agency (EPA) as discharging storm water associated with "industrial activity", and additional categories considered by Los Angeles County as necessary to address stormwater and urban runoff quality concerns.

Your proposed list appears satisfactory for purposes of drainage area characterization. We recommend that SIC Category 5015 listed as 'Motor vehicle parts, used' be utilized exclusively for Auto-salvage yards (junkyards) because of the potential for contamination of storm water. We have no additional comments.

If you have any questions, please call Xavier Swamikannu at (213) 266-7592.

David C. Gildersleeve

DAVID C. GILDERSLEEVE
Chief, Regulatory Section

R0033277

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

VOL 11

00051 0

20 December 1990

James W. Baetge
Executive Director
State Water Resources Control Board
901 P Street
P. O. Box 100
Sacramento, Ca 95801

Dear Mr. Baetge:

EPA Region 9 has reviewed the revised FY-90 319(h) project workplan for the **Los Angeles County Urban Runoff Public Education Campaign.** Your staff in working with the staff of the Los Angeles Regional Board and LA County, have adequately responded to our comments (EPA letters dated July 30, 1990, and December 7, 1990). Accordingly, EPA approves the revised workplan and looks forward to commencement of the urban runoff public education campaign in Los Angeles County.

Please contact me if you have any questions regarding this action, or have your staff contact Jovita Pajarillo at 415/744-2011.

Sincerely,

Harry Seraydarian
Director
Water Management Division

cc: Stan Martinson
Tom Howard
Marguerite Crouse

Printed on Recycled Paper

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

XS

VOL 11

00051

December 19, 1990

IN REPLY PLEASE
REFER TO FILE:

Dr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654
STANDARD INDUSTRIAL CODE (SIC) CATEGORIES

Section 2.1.3 of the NPDES Permit issued to Los Angeles County requires the identification of SIC code categories of facilities in each drainage area. The final Federal Storm Water Regulations, issued in November of this year list by SIC code the classes of facilities that discharge stormwater associated with industrial activity. These are shown in Enclosure A. Enclosure B lists additional SIC codes that we feel need to be identified in order to properly address water quality concerns.

So as to comply with Section 2.1.3 of our permit, we are proposing to identify only those businesses in each drainage area that fall under the SIC codes shown in Enclosures A and B.

Please respond with any comments on our proposal by January 15, 1991. If no response is received by this date, we shall view this as acceptance of our proposal and will proceed accordingly.

If you have any questions concerning this matter, please contact Gary Hildebrand at (818) 458-5948.

Yours very truly,

T. A. TIDEMANSON
Director of Public Works

John K. Mitchell

John K. Mitchell
Water Quality Section
Waste Management Division

GWH:ld/SICODES

Enc.

Enclosure A

STANDARD INDUSTRIAL CLASSIFICATION CODE

MINING

Code	Short Title
10	**METAL MINING**
101	**Iron Ores**
1011	Iron ores
102	**Copper Ores**
1021	Copper ores
103	**Lead and Zinc Ores**
1031	Lead and zinc ores
104	**Gold and Silver Ores**
1041	Gold ores
1044	Silver ores
106	**Ferroalloy Ores, Except Vanadium**
1061	Ferroalloy ores, except vanadium
108	**Metal Mining Services**
1081	Metal mining services
109	**Miscellaneous Metal Ores**
1094	Uranium-radium-vanadium ores
1099	Metal ores, nec
12	**COAL MINING**
122	**Bituminous Coal and Lignite Mining**
1221	Bituminous coal and lignite-surface
1222	Bituminous coal-underground
123	**Anthracite Mining**
1231	Anthracite mining
124	**Coal Mining Services**
1241	Coal mining services
13	**OIL AND GAS EXTRACTION**
131	Crude Petroleum and Natural Gas
1311	Crude petroleum and natural gas
132	**Natural Gas Liquids**
1321	Natural gas liquids
138	**Oil and Gas Field Services**
1381	Drilling oil and gas wells
1382	Oil and gas exploration services
1389	Oil and gas field services, nec
14	**NONMETALLIC MINERALS, EXCEPT FUELS**
141	Dimension Stone
1411	Dimension stone
142	**Crushed and Broken Stone**
1422	Crushed and broken limestone
1423	Crushed and broken granite
1429	Crushed and broken stone, nec
144	**Sand and Gravel**
1442	Construction sand and gravel
1446	Industrial sand
145	**Clay, Ceramic, & Refractory Minerals**
1455	Kaolin and ball clay
1459	Clay and related minerals, nec
147	**Chemical and Fertilizer Minerals**
1474	Potash, soda, and borate minerals
1475	Phosphate rock
1479	Chemical and fertilizer mining, nec
148	**Nonmetallic Minerals Services**
1481	Nonmetallic minerals services
149	**Miscellaneous Nonmetallic Minerals**
1499	Miscellaneous nonmetallic minerals

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R0033280

CONSTRUCTION

Code	Short Title
15	**GENERAL BUILDING CONTRACTORS**
152	**Residential Building Construction**
1521	Single-family housing construction
1522	Residential construction, nec
153	**Operative Builders**
1531	Operative builders
154	**Nonresidential Building Construction**
1541	Industrial building and warehouses
1542	Nonresidential construction, nec
16	**HEAVY CONSTRUCTION, EX. BUILDING**
161	Highway and Street Construction
1611	Highway and street construction
162	**Heavy Construction, Except Highway**
1622	Bridge, tunnel, & elevated highway
1623	Water, sewer, and utility lines
1629	Heavy construction, nec
17	**SPECIAL TRADE CONTRACTORS**
171	**Plumbing, Heating, Air-Conditioning**
1711	Plumbing, heating, air-conditioning
172	**Painting and Paper Hanging**
1721	Painting and paper hanging
173	**Electrical Work**
1731	Electrical work
174	**Masonry, Stonework, and Plastering**
1741	Masonry and other stonework
1742	Plastering, drywall, and insulation
1743	Terrazzo, tile, marble, mosaic work
175	**Carpentry and Floor Work**
1751	Carpentry work
1752	Floor laying and floor work, nec
176	**Roofing, Siding, and Sheet Metal Work**
1761	Roofing, siding, and sheet metal work
177	**Concrete Work**
1771	Concrete work
178	**Water Well Drilling**
1781	Water well drilling
179	**Misc. Special Trade Contractors**
1791	Structural steel erection
1793	Glass and glazing work
1794	Excavation work
1795	Wrecking and demolition work
1796	Installing building equipment, nec
1799	Special trade contractors, nec

MANUFACTURING

Code	Short Title
20	**FOOD AND KINDRED PRODUCTS**
201	**Meat Products**
2011	Meat packing plants
2013	Sausages and other prepared meats
2015	Poultry slaughtering and processing
202	**Dairy Products**
2021	Creamery butter
2022	Cheese, natural, and processed
2023	Dry, condensed, evaporated products
2024	Ice cream and frozen desserts
2026	Fluid milk
203	**Preserved Fruits and Vegetables**
2032	Canned specialties
2033	Canned fruits and vegetables
2034	Dehydrated fruits, vegetables, soups
2035	Pickles, sauces, and salad dressings
2037	Frozen fruits and vegetables
2038	Frozen specialties, nec
204	**Grain Mill Products**
2041	Flour and other grain mill products
2043	Cereal breakfast foods
2044	Rice milling
2045	Prepared flour mixes and doughs
2046	Wet corn milling
2047	Dog and cat food
2048	Prepared feeds, nec
205	**Bakery Products**
2051	Bread, cake, and related products
2052	Cookies and crackers
2053	Frozen bakery products, except bread
206	**Sugar and Confectionery Products**
2061	Raw cane sugar

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Code	Short Title
2062	Cane sugar refining
2063	Beet sugar
2064	Candy & other confectionery products
2066	Chocolate and cocoa products
2067	Chewing gum
2068	Salted and roasted nuts and seeds
207	**Fats and Oils**
2074	Cottonseed oil mills
2075	Soybean oil mills
2076	Vegetable oil mills, nec
2077	Animal and marine fats and oils
2079	Edible fats and oils, nec
208	**Beverages**
2082	Malt Beverages
2083	Malt
2084	Wines, brandy, and brandy spirits
2085	Distilled and blended liquors
2086	Bottled and canned soft drinks
2087	Flavoring extracts and syrups, nec
209	**Misc. Food and Kindred Products**
2091	Canned and cured fish and seafoods
2092	Fresh or frozen prepared fish
2095	Roasted coffee
2096	Potato chips and similar snacks
2097	Manufactured ice
2098	Macaroni and spaghetti
2099	Food preparations, nec
21	**TOBACCO PRODUCTS**
211	**Cigarettes**
2111	Cigarettes
212	**Cigars**
2121	Cigars
213	**Chewing and Smoking Tobacco**
2131	Chewing and smoking tobacco
214	**Tobacco Stemming and Redrying**
2141	Tobacco stemming and redrying
22	**TEXTILE MILL PRODUCTS**
221	**Broadwoven Fabric Mills, Cotton**
2211	Broadwoven fabric mills, cotton
222	**Broadwoven Fabric Mills, Manmade**
2221	Broadwoven fabric mills, manmade
223	**Broadwoven Fabric Mills, Wool**
2231	Broadwoven fabric mills, wool
224	**Narrow Fabric Mills**
2241	Narrow fabric mills
225	**Knitting Mills**
2251	Women's hosiery, except socks

Code	Short Title
2252	Hosiery, nec
2253	Knit outerwear mills
2254	Knit underwear mills
2257	Weft knit fabric mills
2258	Lace & warp knit fabric mills
2259	Knitting mills, nec
226	**Textile Finishing, Except Wool**
2261	Finishing plants, cotton
2262	Finishing plants, manmade
2269	Finishing plants, nec
227	**Carpets and Rugs**
2273	Carpets and rugs
228	**Yarn and Thread Mills**
2281	Yarn spinning mills
2282	Throwing and winding mills
2284	Thread mills
229	**Miscellaneous Textile Goods**
2295	Coated fabrics, not rubberized
2296	Tire cord and fabrics
2297	Nonwoven fabrics
2298	Cordage and twine
2299	Textile goods, nec
23	**APPAREL AND OTHER TEXTILE PRODUCTS**
231	**Men's and Boys' Suits and Coats**
2311	Men's and boys' suits and coats
232	**Men's and Boys' Furnishings**
2321	Men's and boys' shirts
2322	Men's and boys' underwear & nightwear
2323	Men's and boys' neckwear
2325	Men's and boys' trousers and slacks
2326	Men's and boys' work clothing
2329	Men's and boys' clothing, nec
233	**Women's and Misses' Outerwear**
2331	Women's and misses' blouses & shirts
2335	Women's, juniors', & misses' dresses
2337	Women's and misses' suits and coats
2339	Women's and misses' outerwear, nec
234	**Women's and Children's Undergarments**
2341	Women's and children's underwear
2342	Bras, girdles, and allied garments

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Code	Short Title
235	**Hats, Caps, and Millinery**
2353	Hats, caps, and millinery
236	**Girls' and Children's Outerwear**
2361	Girls' & children's dresses, blouses
2369	Girls' and children's outerwear, nec
237	**Fur Goods**
2371	Fur goods
238	**Miscellaneous Apparel and Accessories**
2381	Fabric dress and work gloves
2384	Robes and dressing gowns
2385	Waterproof outerwear
2386	Leather and sheep-lined clothing
2387	Apparel belts
2389	Apparel and accessories, nec
239	**Misc. Fabricated Textile Products**
2391	Curtains and draperies
2392	Housefurnishings, nec
2393	Textile bags
2394	Canvas and related products
2395	Pleating and stitching
2396	Automotive and apparel trimmings
2397	Schiffli machine embroideries
2399	Fabricated textile products, nec
24	**LUMBER AND WOOD PRODUCTS**
241	**Logging**
2411	Logging
242	**Sawmills and Planing Mills**
2421	Sawmills and planing mills, general
2426	Hardwood dimension & flooring mills
2429	Special product sawmills, nec
243	**Millwork, Plywood, & Structural Members**
2431	Millwork
2434	Wood kitchen cabinets
2435	Hardwood veneer and plywood
2436	Softwood veneer and plywood
2439	Structural wood members, nec
244	**Wood Containers**
2441	Nailed wood boxes and shook
2448	Wood pallets and skids
2449	Wood containers, nec
245	**Wood Buildings and Mobile Homes**
2451	Mobile homes
2452	Prefabricated wood buildings
249	**Miscellaneous Wood Products**
2491	Wood preserving
2493	Reconstituted wood products
2499	Wood products, nec
25	**FURNITURE AND FIXTURES**
251	**Household Furniture**
2511	Wood household furniture
2512	Upholstered household furniture
2514	Metal household furniture
2515	Mattresses and bedsprings
2517	Wood TV and radio cabinets
2519	Household furniture, nec
252	**Office Furniture**
2521	Wood office furniture
2522	Office furniture, except wood
253	**Public Building & Related Furniture**
2531	Public building & related furniture
254	Partitions and Fixtures
2541	Wood partitions and fixtures
2542	Partitions and fixtures, except wood
259	**Miscellaneous Furniture & Fixtures**
2591	Drapery hardware & blinds & shades
2599	Furniture and fixtures, nec
26	**PAPER AND ALLIED PRODUCTS**
261	**Pulp Mills**
2611	Pulp mills
262	**Paper Mills**
2621	Paper mills
263	**Paperboard Mills**
2631	Paperboard mills
265	**Paperboard Containers and Boxes**
2652	Setup paperboard boxes
2653	Corrugated and solid fiber boxes
2655	Fiber cans, drums & similar products
2656	Sanitary food containers
2657	Folding paperboard boxes
267	**Misc. Converted Paper Products**
2671	Paper coated & laminated, packaging

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Code	Short Title
2672	Paper coated and laminated, nec
2673	Bags: plastics, laminated, & coated
2674	Bags: uncoated paper & multiwall
2675	Die-cut paper and board
2676	Sanitary paper products
2677	Envelopes
2678	Stationery products
2679	Converted paper products, nec
27	**PRINTING AND PUBLISHING**
271	**Newspapers**
2711	Newspapers
272	**Periodicals**
2721	Periodicals
273	**Books**
2731	Book publishing
2732	Book printing
274	**Miscellaneous Publishing**
2741	Miscellaneous publishing
275	**Commercial Printing**
2752	Commercial printing, lithographic
2754	Commercial printing, gravure
2759	Commercial printing, nec
276	**Manifold Business Forms**
2761	Manifold business forms
2771	**Greeting Cards**
2771	Greeting cards
278	**Blankbooks and Bookbinding**
2782	Blankbooks and looseleaf binders
2789	Bookbinding and related work
279	**Printing Trade Services**
2791	Typesetting
2796	Platemaking services
28	**CHEMICALS AND ALLIED PRODUCTS**
281	**Industrial Inorganic Chemicals**
2812	Alkalies and chlorine
2813	Industrial gases
2816	Inorganic pigments
2819	Industrial inorganic chemicals, nec
282	**Plastics Materials and Synthetics**
2821	Plastics materials and resins
2822	Synthetic rubber
2823	Cellulosic manmade fibers
2824	Organic fibers, noncellulosic
283	**Drugs**
2833	Medicinals and botanicals
2834	Pharmaceutical preparations
2835	Diagnostic substances
2836	Biological products exc. diagnostic
284	**Soap, Cleaners, and Toilet Goods**
2841	Soap and other detergents
2842	Polishes and sanitation goods
2843	Surface active agents
2844	Toilet preparations
285	**Paints and Allied Products**
2851	Paints and allied products
286	**Industrial Organic Chemicals**
2861	Gum and wood chemicals
2865	Cyclic crudes and intermediates
2869	Industrial organic chemicals, nec
287	**Agricultural Chemicals**
2873	Nitrogenous fertilizers
2874	Phosphatic fertilizers
2875	Fertilizers, mixing only
2879	Agricultural chemicals, nec
289	**Miscellaneous Chemical Products**
2891	Adhesives and sealants
2892	Explosives
2893	Printing ink
2895	Carbon black
2899	Chemical preparations, nec
29	**PETROLEUM AND COAL PRODUCTS**
291	**Petroleum Refining**
2911	Petroleum refining
295	**Asphalt Paving and Roofing Materials**
2951	Asphalt paving mixtures and blocks
2952	Asphalt felts and coatings
299	**Misc. Petroleum and Coal Products**
2992	Lubricating oils and greases
2999	Petroleum and coal products, nec
30	**RUBBER AND MISC. PLASTICS PRODUCTS**
301	**Tires and Inner Tubes**
3011	Tires and inner tubes
302	**Rubber and Plastics Footwear**
3021	Rubber and Plastics footwear
305	**Hose & Belting & Gaskets & Packing**
3052	Rubber, plastics hose & belting

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Code	Short Title
3053	Gaskets, packing, & sealing devices
306	**Fabricated Rubber Products, NEC**
3061	Mechanical rubber goods
3069	Fabricated rubber products, nec
308	**Misc. Plastics Products, NEC**
3081	Unsupported plastics film & sheet
3082	Unsupported plastics profile shapes
kitchenware	
3083	Laminated plastics plate & sheet
3084	Plastics pipe
3085	Plastics bottles
3086	Plastics foam products
3087	Custom compound purchased resins
3088	Plastics plumbing fixtures
3089	Plastics products, nec
31	**LEATHER AND LEATHER PRODUCTS**
311	**Leather Tanning and Finishing**
3111	Leather tanning and finishing
313	**Footwear Cut Stock**
3131	Footwear cut stock
314	**Footwear, Except Rubber**
3142	House slippers
3143	Men's footwear, except athletic
3144	Women's footwear, except athletic
3149	Footwear, except rubber, nec
315	**Leather Gloves and Mittens**
3151	Leather gloves and mittens
316	**Luggage**
3161	Luggage
317	**Handbags and Personal Leather Goods**
3171	Women's handbags and purses
3172	Personal leather goods, nec
319	**Leather Goods, NEC**
3199	Leather goods, nec
32	**STONE, CLAY, AND GLASS PRODUCTS**
321	**Flat Glass**
3211	Flat glass
322	**Glass and Glassware, Pressed or Blown**
3221	Glass containers
3229	Pressed and blown glass, nec
323	**Products of Purchased Glass**
3231	Products of purchased glass
324	**Cement, Hydraulic**
3241	Cement, hydraulic
325	**Structural Clay Products**
3251	Brick and structural clay tile

Code	Short Title
3253	Ceramic wall and floor tile
3255	Clay refractories
3259	Structural clay products, nec
326	**Pottery and Related Products**
3261	Vitreous plumbing fixtures
3262	Vitreous china table & kitchenware
3263	Semivitreous table &
3264	Porcelain electrical supplies
3269	Pottery products, nec
327	**Concrete, Gypsum, and Plaster Products**
3271	Concrete block and brick
3272	Concrete products, nec
3273	Ready-mixed concrete
3274	Lime
3275	Gypsum products
328	**Cut Stone and Stone Products**
3281	Cut stone and stone products
329	**Misc. Nonmetallic Mineral Products**
3291	Abrasive products
3292	Asbestos products
3295	Minerals, ground or treated
3296	Mineral wool
3297	Nonclay refractories
3299	Nonmetallic mineral products, nec
33	**PRIMARY METAL INDUSTRIES**
331	**Blast Furnace and Basic Steel Products**
3312	Blast furnaces and steel mills
3313	Electrometallurgical products
3315	Steel wire and related products
3316	Cold finishing of steel shapes
3317	Steel pipe and tubes
332	**Iron and Steel Foundries**
3321	Gray and ductile iron foundries
3322	Malleable iron foundries
3324	Steel investment foundries
3325	Steel foundries, nec
333	**Primary Nonferrous Metals**
3331	Primary copper
3334	Primary aluminum
3339	Primary nonferrous metals, nec
334	**Secondary Nonferrous Metals**
3341	Secondary nonferrous metals
335	**Nonferrous Rolling and Drawing**
3351	Copper rolling and drawing

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Code	Short Title
3353	Aluminum sheet, plate, & foil
3354	Aluminum extruded products
3355	Aluminum rolling and drawing, nec
3356	Nonferrous rolling and drawing, nec
3357	Nonferrous wiredrawing & insulating
336	**Nonferrous Foundries (Castings)**
3363	Aluminum die-castings
3364	Nonferrous die-castings exc. aluminum
3365	Aluminum foundries
3366	Copper foundries
3369	Nonferrous foundries, nec
339	**Misc. Primary Metal Products**
3398	Metal heat treating
3399	Primary metal products, nec
34	**FABRICATED METAL PRODUCTS**
341	**Metal Cans and Shipping Containers**
3411	Metal cans
3412	Metal barrels, drums, and pails
342	**Cutlery, Handtools, and Hardware**
3421	Cutlery
3423	Hand and edge tools, nec
3425	Saw blades and handsaws
3429	Hardware, nec
343	**Plumbing and Heating, Except Electric**
3431	Metal sanitary ware
3432	Plumbing fixture fittings and trim
3433	Heating equipment, except electric
344	**Fabricated Structural Metal Products**
3441	Fabricated structural metal
3442	Metal doors, sash, and trim
3443	Fabricated plate work (boiler shops)
3444	Sheet metal work
3446	Architectural metal work
3448	Prefabricated metal buildings
3449	Misc. metal work
345	**Screw Machine Products, Bolts, Etc.**
3451	Screw machine products
3452	Bolts, nuts, rivets, and washers
346	**Metal Forgings and Stampings**
3462	Iron and steel forgings
3463	Nonferrous forgings
3465	Automotive stampings
3466	Crowns and closures
3469	Metal stampings, nec
347	**Metal Services, NEC**
3471	Plating and polishing
3479	Metal coating and allied services
348	**Ordnance and Accessories, NEC**
3482	Small arms ammunition
3483	Ammunition, exc. for small arms, nec
3484	Small arms
3489	Ordnance and accessories, nec
349	**Misc. Fabricated Metal Products**
3491	Industrial valves
3492	Fluid power valves & hose fittings
3493	Steel springs, except wire
3494	Valves and pipe fittings, nec
3495	Wire springs
3496	Misc. fabricated wire products
3497	Metal foil and leaf
3498	Fabricated pipe and fittings
3499	Fabricated metal products, nec
35	**INDUSTRIAL MACHINERY AND EQUIPMENT**
351	**Engines and Turbines**
3511	Turbines and turbine generator sets
3519	Internal combustion engines, nec
352	**Farm and Garden Machinery Electric**
3523	Farm machinery and equipment
3524	Lawn and garden equipment
353	**Construction and Related Machinery**
3531	Construction machinery
3532	Mining machinery
3533	Oil and gas field machinery
3534	Elevators and moving stairways
3535	Conveyors and conveying equipment
3536	Hoists, cranes, and monorails
3537	Industrial trucks and tractors
354	**Metalworking Machinery**
3541	Machine tools, metal cutting types
3542	Machine tools, metal forming types
3543	Industrial patterns
3544	Special dies, tools, jigs & fixtures
3545	Machine tool accessories

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Code	Short Title
3546	Power-driven handtools
3547	Rolling mill machinery
3548	Welding apparatus
3549	Metalworking machinery, nec
355	**Special Industry Machinery**
3552	Textile machinery
3553	Woodworking machinery
3554	Paper industries machinery
3555	Printing trades machinery
3556	Food products machinery
3559	Special industry machinery, nec
356	**General Industrial Machinery**
3561	Pumps and pumping equipment
3562	Ball and roller bearings
3563	Air and gas compressors
3564	Blowers and fans
3565	Packaging machinery
3566	Speed changers, drives, and gears
3567	Industrial furnaces and ovens
3568	Power transmission equipment, nec
3569	General industrial machinery, nec
357	**Computer and Office Equipment**
3571	Electronic computers
3572	Computer storage devices
3575	Computer terminals
3577	Computer peripheral equipment, nec
3578	Calculating and accounting equipment
3579	Office machines, nec
358	Refrigeration and Service Machinery
3581	Automatic vending machines
3582	Commercial laundry equipment
3585	Refrigeration and heating equipment
3586	Measuring and dispensing pumps
3589	Service industry machinery, nec
359	**Industrial Machinery, NEC**
3592	Carburetors, pistons, rings, valves
3593	Fluid power cylinders & actuators
3594	Fluid power pumps and motors
3596	Scales and balances, exc. laboratory
3599	Industrial machinery, nec
36	**ELECTRONIC & OTHER ELECTRIC EQUIPMENT**
361	**Electric Distribution Equipment**
3612	Transformers, except electronic
3613	Switchgear and switchboard apparatus
362	**Electrical Industrial Apparatus**
3621	Motors and generators
3624	Carbon and graphite products
3625	Relays and industrial controls
3629	Electrical industrial apparatus, nec
363	**Household Appliances**
3631	Household cooking equipment
3632	Household refrigerators and freezers
3633	Household laundry equipment
3634	Electric housewares and fans
3635	Household vacuum cleaners
3639	Household appliances, nec
364	**Electric Lighting and Wiring Equipment**
3641	Electric lamps
3643	Current-carrying wiring devices
3644	Noncurrent-carrying wiring devices
3645	Residential lighting fixtures
3646	Commercial lighting fixtures
3647	Vehicular lighting equipment
3648	Lighting equipment, nec
365	**Household Audio and Video Equipment**
3651	Household audio and video equipment
3652	Prerecorded records and tapes
366	**Communications Equipment**
3661	Telephone and telegraph apparatus
3663	Radio & TV communications equipment
3669	Communications equipment, nec
367	**Electronic Components and Accessories**
3671	Electron tubes
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3676	Electronic resistors
3677	Electronic coils and transformers
3678	Electronic connectors
3679	Electronic components, nec
369	**Misc. Electrical Equipment & Supplies**
3691	Storage batteries
3692	Primary batteries, dry & wet
3694	Engine electrical equipment
3695	Magnetic and optical recording media
3699	Electrical equipment & supplies, nec

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Code	Short Title
37	**TRANSPORTATION EQUIPMENT**
371	**Motor Vehicles and Equipment**
3711	Motor vehicles and car bodies
3713	Truck and bus bodies
3714	Motor vehicle parts and accessories
3715	Truck trailers
3716	Motor homes
372	**Aircraft and Parts**
3721	Aircraft
3724	Aircraft engines & engines parts
3728	Aircraft parts & equipment, nec
373	**Ship and Boat Building & Repairing**
3731	Ship building and repairing
3732	Boat building and repairing
374	**Railroad Equipment**
3743	Railroad equipment
375	**Motorcycles, Bicycles, and Parts**
3751	Motorcycles, bicycles, and parts
376	**Guided Missiles, Space Vehicles, Parts**
3761	Guided missiles and space vehicles
3764	Space propulsion units and parts
3769	Space vehicle equipment, nec
379	**Misc. Transportation Equipment**
3792	Travel trailers and campers
3795	Tanks and tank components
3799	Transportation equipment, nec
38	**INSTRUMENTS AND RELATED PRODUCTS**
381	**Search and Navigation Equipment**
3812	Search and navigation equipment
382	**Measuring and Controlling Devices**
3821	Laboratory apparatus and furniture
3822	Environmental controls
3823	Process control instruments
3824	Fluid meters and counting devices
3825	Instruments to measure electricity
3826	Analytical instruments
3827	Optical instruments and lenses
3829	Measuring & controlling devices, nec
384	**Medical Instruments & Supplies**
3841	Surgical and medical instruments
3842	Surgical appliances and supplies
3843	Dental equipment and supplies
3844	X-ray apparatus and tubes
3845	Electromedical equipment
385	**Ophthalmic Goods**
3851	Ophthalmic goods
386	**Photographic Equipment & Supplies**
3861	Photographic equipment & supplies
387	**Watches, Clocks, Watchcases & Parts**
3873	Watches, clocks, watchcases & parts
39	**MISC. MANUFACTURING INDUSTRIES**
391	**Jewelry, Silverware, & Plated Ware**
3911	Jewelry, precious metal
3914	Silverware and plated ware
3915	Jewelers' materials & lapidary work
393	**Musical Instruments**
3931	Musical instruments
394	**Toys and Sporting Goods**
3942	Dolls & stuffed toys
3944	Games, toys, & children's vehicles
3949	Sporting & athletic goods, nec
395	**Pens, Pencils, Office, & Art Supplies**
3951	Pens and mechanical pencils
3952	Lead pencils and art goods
3953	Marking devices
3955	Carbon paper and inked ribbons
396	**Costume Jewelry and Notions**
3961	Costume jewelry
3965	Fasteners, buttons, needles, & pins
399	**Misc. Manufactures**
3991	Brooms and brushes
3993	Signs & advertising specialties
3995	Burial caskets
3996	Hard surface floor coverings, nec
3999	Manufacturing industries, nec

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TRANSPORTATION AND PUBLIC UTILITIES

Code	Short Title
40	**RAILROAD TRANSPORTATION**
401	**Railroads**
4011	Railroads, line-haul operating
4013	Switching and terminal services
41	**LOCAL AND INTERURBAN PASSENGER TRANSIT**
411	**Local and Suburban Transportation**
4111	Local and suburban transit
4119	Local passenger transportation, nec
412	**Taxicabs**
4121	Taxicabs
413	**Intercity and Rural Bus Transportation**
4131	Intercity & rural bus transportation
414	**Bus Charter Service**
4141	Local bus charter service
4142	Bus charter service, except local
415	**School Buses**
4151	School buses
417	**Bus Terminal & Service Facilities**
4173	Bus terminal & service facilities
42	**TRUCKING AND WAREHOUSING**
421	**Trucking & Courier Services, Ex. Air**
4212	Local trucking, without storage
4213	Trucking, except local
4214	Local trucking with storage
4215	Courier services, except by air
422	**Public Warehousing and Storage**
4221	Farm product warehousing & storage
4222	Refrigerated warehousing & storage
4225	General warehousing & storage
4226	Special warehousing & storage, nec
423	**Trucking Terminal Facilities**
4231	Trucking terminal facilities
44	**WATER TRANSPORTATION**
441	**Deep Sea Foreign Trans. of Freight**
4412	Deep sea foreign trans. of freight
442	**Deep Sea Domestic Trans. of Freight**
4424	Deep sea domestic trans. of freight
443	**Freight Trans. on the Great Lakes**
4432	Freight trans. on the Great Lakes
444	**Water Trans. of Freight, NEC**
4449	Water trans. of freight, nec
448	**Water Trans. of Passengers**
4481	Deep sea passegr. tr. ex. ferry
4482	Ferries
4489	Water passenger trans., nec
449	**Water Transportation Services**
4491	Marine cargo handling
4492	Towing and tugboat service
4493	Marinas
4499	Water trans. services, nec
45	**TRANSPORTATION BY AIR**
451	**Air Trans., Scheduled**
4512	Air trans., scheduled
4513	Air courier services
452	**Air Trans., Nonscheduled**
4522	Air trans., nonscheduled
458	**Airports, Flying Fields, & Services**
4581	Airports, flying fields, & services
49	**ELECTRIC, GAS, AND SANITARY SERVICES**
491	**Electric Services**
4911	Electric services
492	**Gas Production & Distribution**
4922	Natural gas transmission
4923	Gas transmission & distribution
4924	Natural gas distribution
4925	Gas production and/or distribution
493	**Combination Utility Services**
4931	Electric and other services

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Code	Short Title
4[illegible]9	Combination utilities, nec
494	**Water Supply**
4941	Water supply
495	**Sanitary Services**
4952	Sewerage systems
4953	Refuse systems
4959	Sanitary services, nec
496	**Steam and Air-Conditioning Supply**
4961	Steam and air-conditioning supply
497	**Irrigation Systems**
4971	Irrigation systems

WHOLESALE TRADE

Code	Short Title
5015	Motor vehicle parts, used
5093	Scrap and waste materials

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Enclosure B

STANDARD INDUSTRIAL CLASSIFICATION CODE

AGRICULTURE, FORESTRY, AND FISHING

Code	Short Title
01	**AGRICULTURAL PRODUCTION-CROPS**
011	**Cash Grains**
0111	Wheat
0112	Rice
0115	Corn
0116	Soybeans
0119	Cash grains, nec
013	**Field Crops, Except Cash Grains**
0131	Cotton
0132	Tobacco
0133	Sugarcane and sugar beets
0134	Irish Potatoes
0139	Field crops, except cash grains, nec
016	**Vegetables and Melons**
0161	Vegetables and Melons
017	**Fruits and Tree Nuts**
0171	Berry crops
0172	Grapes
0173	Tree nuts
0174	Citrus fruits
0175	Deciduous tree fruits
0179	Fruits and tree nuts, nec
018	**Horticultural Specialties**
0181	Ornamental nursery products
0182	Food crops grown under cover
019	**General Farms, Primarily Crop**
0191	General farms, primarily crop

Code	Short Title
02	**AGRICULTURAL PRODUCTION-LIVESTOCK**
021	**Livestock, Except Dairy and Poultry**
0211	Beef cattle feedlots
0212	Beef cattle, except feedlots
0213	Hogs
0214	Sheep and goats
0219	General livestock, nec
024	**Dairy Farms**
0241	Dairy farms
025	**Poultry and Eggs**
0251	Broiler, fryer, and roaster chickens
0252	Chicken eggs
0253	Turkey and turkey eggs
0254	Poultry hatcheries
0259	Poultry and eggs, nec
027	**Animal Specialties**
0271	Fur-bearing animals and rabbits
0272	Horses and other equines
0273	Animal aquaculture
0279	Animal specialties, nec
029	**General Farms, Primarily Animal**
0291	General farms, primarily animal

RETAIL TRADE

Code	Short Title
55	**AUTOMOTIVE DEALERS & SERVICE STATIONS**
551	**New and Used Car Dealers**
5511	New and used car dealers
552	**Used Car Dealers**
5521	Used car dealers
554	**Gasoline Service Stations**
5541	Gasoline service stations
555	**Boat Dealers**
5551	Boat dealers
556	**Recreational Vehicle Dealers**
5561	Recreational vehicle dealers
557	**Motorcycle Dealers**
5571	Motorcycle dealers
559	**Automotive Dealers, NEC**
5599	Automotive dealers, nec
59	**MISCELLANEOUS RETAIL**
598	**Fuel Dealers**
5983	Fuel oil dealers
5984	Liquefied petroleum gas dealers
5989	Fuel dealers, nec

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SERVICES

Code	Short Title
72	**PERSONAL SERVICES**
721	**Laundry, Cleaning, & Garment Services**
7211	Power laundries, family & commercial
7212	Garment pressing & cleaners' agents
7213	Linen supply
7215	Coin-operated laundries and cleaning
7216	Drycleaning plants, except rugs
7217	Carpet and upholstery cleaning
7218	Industrial launderers
7219	Laundry and garment services, nec
75	**AUTO REPAIR, SERVICES, AND PARKING**
753	**Automotive Repair Shops**
7532	Top & body repair & paint shops
7533	Auto exhaust system repair shops
7534	Tire retreading and repair shops
7535	Automotive glass replacement shops
7537	Automotive transmission repair shops
7538	General automotive repair shops
7539	Automotive repair shops, nec
754	**Automotive Services, Except Repair**
7542	Carwashes
7549	Automotive services, nec
80	**HEALTH SERVICES**
806	**Hospitals**
8062	General medical & surgical hospitals
8063	Psychiatric hospitals
8069	Specialty hospitals exc. psychiatric
807	**Medical and Dental Laboratories**
8071	Medical laboratories
8072	Dental laboratories
84	**MUSEUMS, BOTANICAL, ZOOLOGICAL GARDENS**
842	**Botanical and Zoological Gardens**
8422	Botanical and zoological gardens

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COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

IN REPLY PLEASE
REFER TO FILE

X5

VOL 11

October 16, 1990

Mr. Robert P. Ghirelli
Executive Officer
California Regional Water
Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

NPDES PERMIT NO. CA0061654
QUARTERLY PROGRESS REPORT (1990 Q3) R#1

As required by the NPDES Permit issued to Los Angeles County, we are reporting on our permit implementation activities to date.

The first-year requirements for the Santa Monica Bay Drainage Basin, as outlined in the permit, have been examined and a work plan prepared. The work plan details the activities to be performed by the Permittees and a time line for completion. To date, two meetings have been held among the Permittees to discuss the implementation of the first-year activities. The first meeting was held on August 21, 1990, (agenda and work plan enclosed - see Attachment A).

At our second Permittee meeting, on September 26, 1990, strong negative reaction was expressed by a majority of the Permittees regarding the proposed inventory of all through-the-curb connections. It was a consensus among the Permittees that obtaining this information would require each Permittee to literally "walk each street" within their jurisdiction. This was viewed as being a resource use of very limited value considering other more productive permit requirements.

0005225

Due to the concerns raised by the Permittees, a meeting was held on October 2, 1990, between Messrs. Brian Hooper, John Mitchell and Gary Hildebrand of this Department and yourself, Ms. Winnie Jesena and Mr. Xavier Swamikannu of your office to discuss through-the-curb connections. At the meeting, your staff concurred with the County that conducting a complete inventory of all through-the-curb connections at this time would not be an efficient use of available resources. It was agreed that the identification of existing through-the-curb connections could be performed on an as needed basis as part of the later monitoring program. Existing through-the-curb connections could also be identified during the course of an investigation to discover the source of an illegal discharge. The tracking of future through-the-curb connections will be investigated as a potential additional BMP.

Together with the various Permittees, we have been making arrangements with the various levels of staff within our organizations to enable us to begin the initial data gathering activities required during the first year of the permit.

We are also currently involved in establishing the computer system that will be used to receive, store, and manage the data to be gathered by the various Permittees. A number of database programs are being created that will be transmitted by floppy disk to each Permittee. Each Permittee will then enter the required data from within their jurisdictional boundaries into the database programs. This data will be returned to our Department for merging into the main database. A handout was given to the Permittees on October 2, 1990, detailing the format of our databases and the type of floppy disks to be provided to them. Enclosed for your review is a copy of this handout (see Attachment B).

A letter, dated July 25, 1990, (see Attachment C) was sent to your agency requesting a copy of all NPDES Permits issued in the Santa Monica Bay Drainage Basin. This data will be used to assist us in the process of identifying illegal discharges into the storm drain system. Upon receipt, this information will be included in our active data base supporting our permit mandated activities.

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If you have any questions, please contact Mr. Gary Hildebrand at (818) 458-5948.

Very truly yours,

T. A. Tidemanson
Director of Public Works

David Yamahara

DAVID YAMAHARA
Assistant Deputy Director
Waste Management Division

GWH:ldl/QPR

Enc.

cc: Permittees

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LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

NPDES PERMIT NO. CA0061654

FIRST YEAR ACTIVITIES

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Attachment A

WASTE DISCHARGE REQUIREMENTS/
STORMWATER/URBAN RUNOFF DISCHARGE PERMIT
(NPDES NO. CA0061654)

- SANTA MONICA BAY DRAINAGE BASIN -

AUGUST 21, 1990
AGENDA

1:00	I.	Welcome and Self Introductions	Brian Hooper
1:15	II.	Update on Status of the Permitting Process	John Mitchell
1:45	III.	First Year Activities for Santa Monica Bay Tributary Jurisdictions a) Define Drainage Areas b) Rainfall, Runoff, Water Quality Data c) Determination of Existing Best Management Practices d) Plan for Development of Stormwater/Urban Runoff Monitoring Program	Gary Hildebrand
3:00	IV.	Additional Questions and Concerns	John Mitchell Gary Hildebrand
3:30	V.	Future Meetings/Information Sharing During Compliance Activities	Gary Hildebrand
4:00	VI.	Adjournment	

IV/JKMAGENDA

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PRINTED ON RECYCLED PAPER

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LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

NPDES PERMIT NO. CA0061654

FIRST YEAR ACTIVITIES

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PRINTED ON RECYCLED PAPER

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NPDES PERMIT

Introduction

On June 18, 1990, the California Regional Water Quality Control Board, Los Angeles Region, adopted Waste Discharge Requirements for Stormwater/Urban Runoff Discharge for Los Angeles County and Co-Permittees (NPDES Permit No. CA0061654). The five-year permit includes all of Los Angeles County, with the exception of Antelope Valley. Permit compliance activities will take place in three phases according to the following schedule:

Phase I	Area	Starting Date
I.	Santa Monica Bay Tributary Drainage Area	July 1, 1990
II.	Upper San Gabriel and Los Angeles Rivers	July 1, 1992
III.	Lower San Gabriel and Los Angeles Rivers; Santa Clarita Valley	July 1, 1993

The intent of the permit is to control the water quality of flows from land drainage facilities for the protection of the beneficial uses of the receiving waters (lakes, rivers, groundwater, and the ocean). The County of Los Angeles is the Principal Permittee, with each of the incorporated cities, plus other entities with large and/or significant drainage areas under their control, functioning as Co-Permittees. The County Department of Public Works will be the lead for the County and thereby has the obligation to coordinate the required permit activities, including efforts of Co-Permittees, within both unincorporated and incorporated areas.

The permit has been drafted to obtain the information necessary to evaluate existing conditions and work toward compliance within the various watershed areas. Land uses and drainage areas must be fully defined and historical data for flow, rainfall, and water quality compiled. All drainage systems (which, by definition, includes street and road gutters) are to be inventoried and connections identified as to source. This is intended to assure awareness of existing discharges and result in either the permitting or exclusion of illegal or illicit discharges.

Initial controls for the improvement of water quality are to be attempted through Best Management Practices for discharges from various land uses, such as residential, commercial, and industrial.

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These BMPs may be structural, such as retention basins, wetlands, posting of signs at points of entry (catch basins, etc.), groundwater recharge facilities, or nonstructural, such as public education programs, spill response, increased cleaning and maintenance of drainage facilities, etc. Additionally, the control of pollutants and erosion materials from land development and other construction sites/activities must be addressed.

In order to facilitate our efforts, the Department of Public Works has assigned a coordinator from it's Waste Management Division to each Co-Permittee. Please see the appendix for a list of Co-Permittees and their associated coordinator. Your coordinator will be available to answer any questions or concerns you may have regarding your tasks under the first phase of the Permit. He/she will also be contacting you periodically to insure that the various activities are proceeding on schedule. Any information that you forward to the Department of Public Works relating to permit activities should be addressed to your coordinator.

The following pages outline the first year activities under the permit and actions required of each Co-Permittee.

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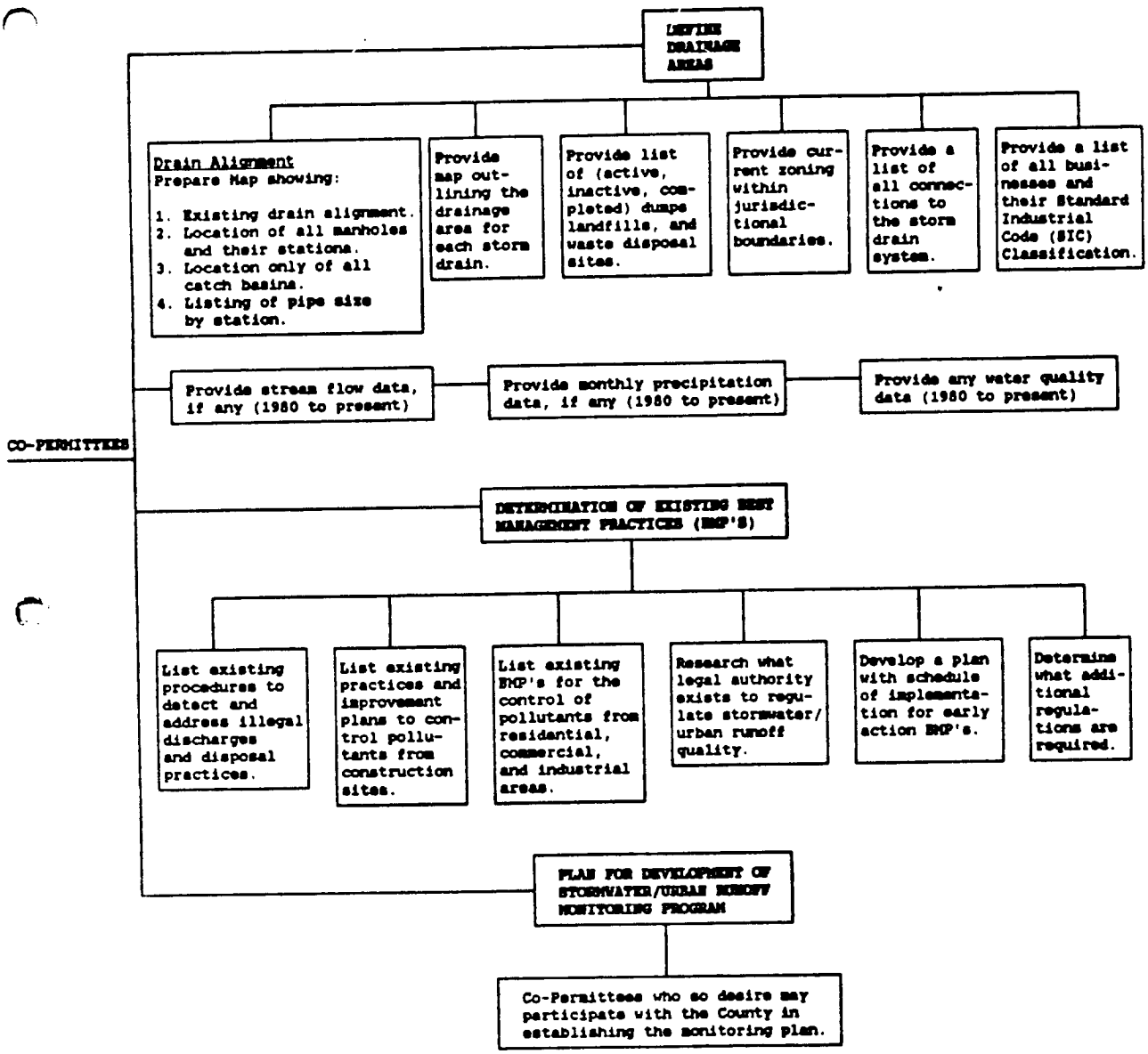
NPDES PERMIT

FIRST-YEAR CO-PERMITTEE ACTIVITIES



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NPDES PERMIT - ACTIVITY TIME LINE

PHASE I - FIRST YEAR

TASK	1990 AUG	SPT	OCT	NOV	DEC	1991 JAN	FEB	MAR	APR	MAY	JUN	JUL
1. DEFINE DRAINAGE AREAS												
1a Provide Drain Alignments (2.1.1)												
1b. Provide Drainage Areas (2.1.1)												
1c. Submit List of Disposal Facilities (2.1.3)												
1d. Submit Zoning Information (2.1.3)												
1e. Inventory of Storm Drain Connections (2.1.9)												
1f. List of Businesses with SIC Codes (2.1.3)												
2. PROVIDE RAINFALL, RUNOFF, WATER QUALITY DATA (2.1.1, 2.1.2, 2.1.4)												
3. DETERMINATION OF EXISTING BMP'S												
3a. Submit Completed BMP Reporting Forms* (2.1.5, 2.1.6, 2.1.7)												
3b. Submit Schedule for Early Action BMP's (2.1.8)												
3c. Determine Additional Regulations* Required (2.1.10)												
4. PLAN FOR DEVELOPMENT OF STORMWATER/ URBAN RUNOFF MONITORING PROGRAM* (2.1.9)												

*Task involves meeting of Co-Permittees.

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NPDES PERMIT
Co-Permittee Activities

1. Define Drainage Areas

The information to be gathered for delineation of the various drainage areas will be stored on a computerized mapping or geographical information system (GIS). In order to properly determine the various drainage areas, the following information is needed from each jurisdiction.

a. Drain Alignments

For all Co-Permittee owned and operated storm drain systems, a map (scale between 1"=400' to 1"=1,000') detailing the following information for each storm drain: alignment, location of all manholes and their associated station, location only of all catch basins, beginning and ending stationing, and stationing at points of entry for all laterals 36-inch in diameter and larger.

b. Drainage Areas

Any existing information that is available detailing the drainage area boundaries for each storm drain. The outer watershed boundary for the drainage area tributary to each storm drain 36" in diameter or greater is needed. For any storm drain under your jurisdiction that outlets into a storm drain belonging to another entity, the outer watershed boundary of your storm drain should be shown even though the size of its outlet may be less than 36" in diameter. This information should be provided on a map the same scale as used in (a) above.

c. Disposal Facilities

A list of active, inactive and completed dumps, landfills, and waste disposal sites. This list should include the name of each facility, its operator, current address, dates of operation, and type of material allowed into the facility. A site plan defining boundaries for each facility should be included.

d. Zoning

A map showing the current zoning within your jurisdiction. The map should be between 1"=400' to 1"=1,000' and consist of the zoning boundaries superimposed over a base map of the street alignment.

e. Storm Drain Connections

In order to properly locate and identify illegal dischargers and illegal connections, an inventory of all connections to the storm drain system is needed.

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According to the Federal Clean Water Act, the gutter is considered an extension of the storm drain system. Therefore, connections to the drainage system will be divided into two types i) through-the-curb connections and ii) pipes connecting to the storm drain.

i) through-the-curb connections - these are defined as any onsite drainage systems that flow through a closed conduit under the parkway and discharge through an opening in the curb to the gutter.

ii) pipes connecting to the storm drain - this covers all physical connections made to the storm drain including catch basin connector pipes. Along open channels, this would also include any pipes which discharge onto the channel right-of-way and those which discharge directly into or over the channel wall.

At present, we will be inventorying only pipe connections to the storm drain. Existing through-the-curb connections will be identified through the monitoring program during the conduction of an illegal discharge investigation.

A computerized database will be established to manage the data relating to connections. You will be provided with a floppy disk which will detail the manner in which the connection data is to be arranged. Having all Co-Permittees prepare their data using the same format will allow the Department of Public Works to easily merge the data onto the comprehensive system. The floppy disk will be forwarded to each Co-Permittee as soon as it is available.

Once the information concerning existing connections to date has been submitted, a monthly update must be submitted to the Department of Public Works providing a list of new and/or abandoned connections.

f. Standard Industrial Code (SIC) Classifications for Businesses

The Permit requires Permittees to identify the SIC codes for the various businesses contained within each drainage area. Therefore, each Co-Permittee is to provide a list of all businesses and their associated SIC codes for businesses contained within the Co-Permittee's jurisdiction. A computerized database will be established to manage this data. Each Co-Permittee will be provided with a floppy disk which will detail the manner in which the business information is to be arranged. Having all Co-Permittees prepare their data using the same format will allow the Department of Public Works to easily merge the data onto the comprehensive system. The floppy disk will be forwarded to each Co-Permittee as soon as it is available.

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Once the information concerning existing businesses has been submitted, a monthly update is to be submitted to the Department of Public Works providing a list of new and discontinued businesses.

2. Rainfall, Runoff, Water Quality Data

The Permit requires Permittees to submit data on flow, monthly precipitation, and water quality for the period 1980 to present. Please provide the above information, if any, from within your jurisdiction.

3. Determination of Existing Best Management Practices (BMP's)

One of the requirements during the first year of the Permit is the development of a plan for the implementation of early action BMPs. An overall plan will be prepared outlining the activities to be undertaken by each Co-Permittee. Therefore, preparation of this plan will involve cooperation from all Co-Permittee's.

a. Existing Practices and Procedures

The first step in this process involves the researching of your existing practices and procedures. For your convenience and to provide uniformity in the reporting process, a "Best Management Practices Reporting Form" is provided in the Appendix for each of the following areas: detection of illegal discharge/disposal practices, regulation of pollutants from construction sites, and any overall best management practices. This form allows you to list the various practices and procedures for each of the three areas along with the accompanying legal authority allowing you to enforce these practices and/or procedures.

Please be specific when detailing your procedures. For example, the statement "we control erosion from construction sites" is too general. We would need to know what your standards are for erosion control, how are they applied, under what conditions, etc. Likewise, for the legal authority, if you are referring to an existing

Federal, State, or local ordinance or the Uniform Building Code, please attach a copy of the ordinance or code. If a procedure is performed in your jurisdiction that is not mandated by any law but is merely an accepted service performed for the community, please indicate as such. Street sweeping would be an example of this type of procedure.

To assist you in this process and to answer any questions you may have, a meeting will be held for all interested Co-Permittees. Please contact your Coordinator for details.

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After all Co-Permittee's have returned their completed forms, a comprehensive report will be prepared outlining the practices and procedures performed by all Co-Permittees. This report will be forwarded to each Co-Permittee for review.

b. Schedule for Implementation of Early Action BMP's

In the next step, each Co-Permittee will be asked to prepare a plan with a schedule of implementation of all early action BMPs performed within its jurisdiction. The permit defines an "early action BMP" as "an existing stormwater/urban runoff quality management practice whose use has been optimized to the maximum extent possible." Accordingly, each Co-Permittee's plan will be reviewed and an overall basin wide report will be prepared by the Department of Public Works. After a public review period, and consideration of all pertinent comments, the final report will be prepared for submittal to the California Regional Water Quality Control Board, Los Angeles Region for their approval.

c. Additional Regulations Required

The last step in this process is the determination of what additional regulations are required to properly regulate illegal discharges and disposal practices into storm drains. A recommendation will be prepared for submittal to a review committee. The review committee will consist of the County and any other interested Co-Permittee. If interested, please contact your coordinator for details. Upon approval of the recommendation(s) by the review committee, each Co-Permittee will be requested to enact ordinances necessary to implement the provisions of the approved recommendation(s). A report will be prepared documenting the results of the above activity and the implementation plan for each Co-Permittee.

4. Plan for Development of Stormwater/Urban Runoff Monitoring Program

A committee will be established to develop the workplan for the monitoring program. The committee will consist of the County, RWQCB, and any interested Co-Permittee. The committee will establish the following: listing of constituents and parameters to be monitored, monitoring locations, and sampling methods. If you are interested in joining this committee, please contact your coordinator.

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APPENDIX

NPDES Permit Coordinator List

Best Management Practices Reporting Forms

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NPDES Permit Coordinators

CITY	COORDINATOR
Agoura Hills	Tim Piasky
Beverly Hills	Tim Piasky
Culver City	Tim Smith
El Segundo	Tim Smith
Hermosa Beach	Tim Smith
Inglewood	Tim Piasky
Los Angeles	Tim Smith
Manhattan Beach	Tim Smith
Palos Verdes Estates	Tim Piasky
Rancho Palos Verdes	Tim Smith
Redondo Beach	Tim Piasky
Rolling Hills Estates	Tim Smith
Rolling Hills	Tim Smith
Santa Monica	Tim Piasky
Thousand Oaks	Tim Piasky
Torrance	Tim Piasky
West Hollywood	Tim Smith
Westlake Village	Tim Piasky
Ventura County	Tim Piasky

Coordinator	Phone Number
Tim Smith	(818) 458-5966
Tim Piasky	(818) 458-5969

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revised 10/10/90

Waste Management Division	Phone Number
Dave Yamahara (Division Head)	(818) 458-3500
Mike Mohajer (Assist. Div. Head)	(818) 458-3502
Brian Hooper (Sup. C.E. IV)	(818) 458-5118

Stormwater Permit Program	Phone Number
John Mitchell	(818) 458-3537
Gary Hildebrand	(818) 458-5948
Lorraine Dansby	(818) 458-6972
Carmen Rios	(818) 458-3525
Tim Smith	(818) 458-5966
Tim Piasky	(818) 458-5969
Hassan El-Deeb	(818) 458-5968
Subodh Sinha	(818) 458-6971

CPA2

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revised 10/10/90

Page ____ of ____

City _____

Engineer _____

BEST MANAGEMENT PRACTICES REPORTING FORM

ILLEGAL DISCHARGES/DISPOSAL PRACTICES

Best Management Practices: Defined as any current practices that directly or indirectly reduce stormwater/urban runoff pollution into the storm drains.

What existing procedures are used to detect and address illegal discharges and disposal practices?

Procedure:

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Legal Authority:

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Page ____ of ____

City _____

Engineer_____

BEST MANAGEMENT PRACTICES REPORTING FORM

CONSTRUCTION SITES

Best Management Practices: Defined as any current practices that directly or indirectly reduce stormwater/urban runoff pollution into the storm drains.

What existing practices and improvement plans are used to control pollutants in stormwater/urban runoff from construction sites?

Procedure:

_____

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Legal Authority:

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City _____

Engineer_____

BEST MANAGEMENT PRACTICES REPORTING FORM

What activities currently used in your City could be considered Best Management Practices?

Best Management Practices: Defined as any current practices that directly or indirectly reduce stormwater/urban runoff pollution into the storm drains.

Procedure:

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Legal Authority (if any):

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Attachment B

LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS
NATIONAL POLLUTANT DISCHARGE REPORTING SYSTEM

SEPTEMBER 26, 1990

The Los Angeles County Department of Public Works is developing a series of computer programs that will allow participating agencies to enter information required by the NPDES Permit. These programs will be provided to the participating agencies in the following format:

1. IBM compatible PC running DOS 3.3 or greater
2. 3.5-inch 1.44mb floppy disk
3. dBase IV Version 1.1 run time programs.

Instructions for using the programs and for the delivery of recorded information to the Department will be provided with the programs. If you have any questions regarding the operation of the computer programs, please contact David Smith, Project Manager, Information Systems Division, at (818) 458-4127.

If you have any questions regarding the information to be collected by the programs, please contact Gary Hildebrand, Project Manager, Stormwater Discharge Program, Waste Management Division, at (818) 458-5948.

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COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

HOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

Attachment C

IN REPLY PLEASE REFER TO FILE WM-3

July 25, 1990

Dr. Robert Ghirelli, D. Env.
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NPDES PERMIT NO. CA0061654 (CI6948)

Reference is made to NPDES Permit No. CA0061654 (CI6948), issued to Los Angeles County. In order to properly identify legal and illegal dischargers to the storm drain system as required by the permit, the County requests the following information:

1. A copy of all NPDES permits issued for storm drain system discharges in the Santa Monica Bay drainage area. Also indicate the storm drain receiving the permitted discharge.

2. The most recent monitoring data associated with each permit.

In order that we meet the compliance dates outlined in the permit, please provide the information by October 31, 1990.

If you have any questions, please contact Hassan El-Deeb at (818) 458-3527.

Very truly yours,

T. A. TIDEMANSON
Director of Public Works

John K. Mitchell

JOHN K. MITCHELL
Water Quality Section
Waste Management Division

HED:slvii
PN006154

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COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

THOMAS A. TIDEMANSON, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

XS

90 JUL 27

IN REPLY PLEASE REFER TO FILE WM-3

July 25, 1990

Dr. Robert Ghirelli, D. Env.
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

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Very truly yours,

T. A. TIDEMANSON
Director of Public Works

John K. Mitchell

JOHN K. MITCHELL
Water Quality Section
Waste Management Division

HED:slvii
PN006154

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R0033315

WDJ

STATE OF CALIFORNIA

GEORGE DEUKMEJIAN, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CALIFORNIA 91754-2156
(213) 266-7500

June 13, 1990

Mr. Orville McCollom
Deputy Director of Public Works
County of Los Angeles
Department of Public Works
900 South Fremont Avenue
Alhambra, CA 91803-1331

TENTATIVE WASTE DISCHARGE REQUIREMENTS - STORMWATER/URBAN RUNOFF DISCHARGE PERMIT FOR COUNTY OF LOS ANGELES (NPDES NO. CA0061654)

On May 16, 1990, we transmitted tentative waste discharge requirements (WDRs) for stormwater/urban runoff discharges to water bodies in Los Angeles County and indicated that we received significant comments from Heal the Bay and the Natural Resources Defense Counsel (NRDC).

After considering comments and concerns from all parties, Board staff has revised the tentative WDRs where appropriate. Enclosed are copies of the revised tentative WDRs and Response to Comments. Changes made to the WDRs transmitted on May 16, 1990, are highlighted.

On June 18, 1990, in accordance with administrative procedures, the Board will consider adoption of the tentative requirements. We request that you or your representatives appear at the hearing to present testimony and/or answer questions regarding this matter. The meeting in which this hearing is a part will start at 9:30 a.m., in Room 1138, 107 South Broadway, Los Angeles, CA 90012.

If you have any questions, please call me at (213) 266-7510 or Xavier Swamikannu at (213) 266-7595.

Robert P. Ghirelli

ROBERT P. GHIRELLI, D.Env.
Executive Officer

cc: Bureau of Engineering, City of Los Angeles
Natural Resources Defense Council
Heal the Bay

Enclosures

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STAFF RESPONSE TO COMMENTS

HEAL THE BAY

Comment
The indicator organism, enterococcus, should be included among constituents of concern.
Response
Enterococci bacteria have been added as one of the constituents of concern in stormwater discharges.

Comment
[The permit] should include an overall goal statement.
Response
A new Finding that reads, "The objective of this permit is to develop a timely, comprehensive, and cost effective stormwater pollution control program to minimize pollutants in stormwater/urban runoff discharges to water bodies in Los Angeles County" has been added to reflect your suggestion.

Comment
Workplan for the urban runoff monitoring program should include sampling methodology ...
Response
Sampling methodology and monitoring frequency have been added to the workplan elements.

Comment
Add a section on the implementation of educational programs ...
Response
Provisions to include educational programs as early action BMPs are included in the permit. As a separate action, EPA and State have approved 319(h) Non-Point Source monies to fund a $300,000 countywide Los Angeles City/County Public Information Program.

Comment
A sanitary survey for high enterococci densities should be developed and implemented ...
Response
Board staff agree with the need to develop sanitary surveys to investigate sources of high enterococci densities in storm drains. The Santa Monica Bay Restoration Project will be conducting a pilot sanitary survey in its second year pathogen study. This survey when completed could serve as a model for Los Angeles County.

Comment
The RWQCB should summarize the pollutant loadings from permitted NPDES dischargers ...
Response
The Regional Board will maintain an information system and update pollutant loadings to water bodies from permitted dischargers, as indicated in the Finding. This system is being developed by UCLA under the first year storm drain study for the Santa Monica Bay Restoration Project, and current plans are to expand the system to include all of Los Angeles County.

Comment
We were upset to find no new monitoring during the first two years... At the very least, the runoff sampling equipment and methodologies should be tested...
Response
The two year gap between adoption of the permit and the augmentation of existing monitoring programs

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will allow time to determine needed modifications and evaluate existing protocols. The Santa Monica Bay Restoration Project storm drain study will develop a monitoring program and, evaluate and recommend sampling methodologies for the Santa Monica Bay watershed. Information gathered here can then be transfered to evaluate the countywide monitoring program.

Comment
We recommend that permit take a land use approach for all BMPs.
Response
We agree that it will be useful for permittees to select BMPs by land use patterns.

NATURAL RESOURCES DEFENSE COUNSEL (NRDC)

Comment
The term "early permit" is a misnomer ....
Response
We do not disagree. However, the term "early permit" has been used to describe the permit issued for municipal stormwater/urban runoff discharges before final regualtions have been promulgated by EPA.

Comment
The proposed permit requires too little. [More] monitoring is needed. ...permit must include numerical effluent limitations.
Response
The proposed permit is written to the intent of the Clean Water Act to achieve reductions in pollutant loads in stormwater\urban runoff discharges conveyed by storm drains. The monitoring of stormwater discharges in an area that encompasses 86 cities is an enormous undertaking. Much fine tuning will be required before an effective stormwater quality management program is in place.

Numerical water quality objectives for stormwater discharges will be included in the permit no later than by the first renewal and earlier when possible. Present efforts to control stormwater pollution must be approached on the basis of Best Management Practices (BMPs) which emphasize pollutant load reduction at the source rather than technological control at the "end of the pipe".

Comment
..maximum extent practicable", Section 402 (p) (3) (B) (iii), clearly means, ... no delay in phasing in effective management practices.
Response
The County of Los Angeles as well as several Co-Permittees have on-going practices that may be considered effective stormwater management practices. The permittees will continue to improve these, and implement additional practices that have been identified as effective.

Comment
Finally, the proposed permit moves too slowly.
Response
Los Angeles County encompassing a very large area and more than 86 municipalities serving a population about 14 million people will be totally involved in the stormwater management program within three years of issuance of the permit and will be fully under permit requirements within 6 years after issuance. Far from moving too slowly, the stormwater management program is an ambitious undertaking which will require the cooperation of the State, several local agencies, environmental groups, and the public to implement a workable program and accomplish the objectives.

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STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER No. _____

NPDES NO. CA0061654

WASTE DISCHARGE REQUIREMENTS
STORMWATER/URBAN RUNOFF DISCHARGE
for
LOS ANGELES COUNTY
and
CO-PERMITTEES

The California Regional Water Quality Control Board, Los Angeles, (Regional Board) finds :

1. The County of Los Angeles, in cooperation with the following cities : Agoura Hills, Beverly Hills, Culver City, El Segundo, Hermosa Beach, Inglewood, Los Angeles, Manhattan Beach, Rancho Palos Verdes, Redondo Beach, Rolling Hills Estates, Rolling Hills, Santa Monica, Torrance, West Hollywood, and Westlake Village, has submitted a report of waste discharge (NPDES permit application) dated March 15, 1990 for issuance of waste discharge requirements for the County of Los Angeles and other cities tributary to Los Angeles County (excluding Antelope Valley) under the National Pollutant Discharge Elimination System (NPDES Permit No. CA0061654).

2. The discharges consist of surface runoff generated from various land uses in all the hydrologic drainage basins which discharge into water courses flowing into water bodies in Los Angeles County. The quality of these discharges varies considerably and is affected by land use, basin hydrology and geology, season, and the frequency and duration of storm events. The constituents of concern and significance in these discharges are: total and fecal coliform and enterococci bacteria, total suspended solids, biochemical oxygen demand, oil and grease, heavy metals, nutrients, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, pesticides and herbicides, and petroleum hydrocarbons.

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3. The objective of this permit is to develop a timely, comprehensive, and cost-effective stormwater pollution control program to minimize pollutants in urban runoff/stormwater discharges to water bodies in Los Angeles County.

4. Due to the complexity and networking of drainage facilities within and tributary to Los Angeles County, the county and adjacent areas discharging storm water into Los Angeles County are divided and prioritized into five drainage basins for the implementation of the permit. The owners/operators of all facilities impacting stormwater quality will be ultimately a party to these waste discharge requirements. The County of Los Angeles together with the cities identified above, the initial parties filing for the system-wide permit, are 'Permittees', with the County of Los Angeles as the 'Principal Permittee' and the rest as 'Co-Permittees'. All other cities and recognized entities such as Caltrans, college/university campuses, hospitals, parks, agricultural areas, real estate developments and waste disposal facilities identified in this Order, are designated 'Co-Participants'. A 'Co-Participant' will be a 'Co-Permittee' upon becoming an active party to the permit.

   Attachments 1 and 2 show, respectively, the list of cities and a partial list of entities designated as Co-Participants for this permit. The list of entities will be revised as necessary.

5. The County of Los Angeles, as the 'Principal Permittee', will obtain the cooperation of 'Co-Participants' to become 'Co-Permittees'. The Regional Board has the discretion and authority to require non-cooperating cities and/or entities to become 'Co-Permittees' or obtain individual stormwater discharge permits, pursuant to 40 CFR 122.26 (a).

6. Los Angeles County as the 'Principal Permittee' is the permit coordinator responsible for general administration of this Order, and coordinating cooperation by 'Co-Permittees', including but not limited to the implementation of local self-monitoring programs and Best Management Practices, and the preparation and submittal of reports required by this Order.

7. Los Angeles County obtains its authority to :

   - control pollutants in stormwater discharge
   - prohibit illegal discharges and control spills
   - require compliance and carry out inspections

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of drainage facilities in the County of Los Angeles from the Los Angeles County Flood Control Act and various county ordinances which address industrial wastes and waste discharges within the unincorporated areas of Los Angeles County and contract cities. 'Co-Permittees' with the status of incorporated cities have various forms of legal authority in place, such as charters, State Code provisions for General Law cities, city ordinances and applicable portions of Municipal Codes and the State Water Code, to regulate stormwater/urban runoff discharges.

8. The division and prioritization of Los Angeles County and adjacent areas into five drainage basins for program implementation are based on hydrological characteristics of the watersheds, perceived importance and beneficial uses of water bodies, and the existence of an adequate infrastructure for program implementation. The five drainage basins are :

I	:	Santa Monica Bay Drainage Basin
II	:	Upstream Los Angeles River Drainage Basin, to and including Sycamore Canyon Channel (San Fernando Valley);
III	:	Upper San Gabriel River (San Gabriel Valley) Drainage Basin.
IV	:	Lower Los Angeles River Drainage Basin
V	:	Lower San Gabriel River Drainage Basin; and Santa Clarita Valley Basin.

Attachment 3 shows a map of Los Angeles County with the boundary delineations of the five drainage basins.

Attachment 4 shows Co-Participant cities in Los Angeles County (and their respective populations).

[Note: Detailed maps of the Los Angeles County storm drain system with boundary delineations of drainage basins are available for review at the Regional Board Office.]

9. A number of studies on stormwater/urban runoff pollution in the permit areas has been conducted by agencies such as the City of Los Angeles, the

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Southern California Coastal Water Research Project and the Southern California Association of Governments. These studies indicate stormwater/urban runoff contributes significantly to the deterioration of the quality of water bodies in Los Angeles County.

The University of California at Los Angeles, under the sponsorship of the Santa Monica Bay Restoration Project, is currently compiling and summarizing data and information on stormwater/urban runoff discharges for the Santa Monica Bay watershed.

10. The Los Angeles County Department of Public Works has an active surface water quality monitoring program in the permit area, comprising twenty-eight monitoring stations located at principal storm drains and water conservation facilities. The Surface Water Quality Monitoring Program comprises the collection and analysis of dry weather water samples for general minerals, pesticides, total petroleum hydrocarbons, heavy metals and bacteria (total and fecal coliform, KF streptococci and enterococci). Volatile organic constituents are tested semi-annually at selected stations. Stormwater runoff is monitored three to four times annually at twenty-one stations for minerals, pesticides, heavy metals (total and dissolved), bacteria, total and organic suspended solids, oil and grease, biochemical oxygen demand, total organic carbon and volatile organics.

11. The Los Angeles County Department of Public Works and some cities have on-going activities that reduce stormwater/urban runoff pollutant loads. These activities include periodic catch-basin cleaning and street sweeping, public information on proper disposal of household hazardous waste, and emergency responses to reports of illegal dumping, illicit disposal, illegal connections, and industrial waste spills. The Los Angeles County Department of Public Works also participates and coordinates action with local, State, and Federal agencies responding to spills and illegal dumping reports that threaten surface waters.

12. The Regional Board currently regulates industrial process and point source non-process wastewater and stormwater discharges to storm drain systems through NPDES permits. Point source discharges including stormwater will continue to be regulated by the Regional Board. An information system will be developed and maintained to update pollutant loadings to designated drainage facilities and water bodies from permitted point source discharges.

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be made accountable. The requirements in this Order will provide the necessary information while concurrently achieving reductions in pollutant loads to water bodies from stormwater/urban runoff discharges. Numerical water quality objectives will be developed by Board staff for consideration in the permit renewal process and utilized for the evaluation of Best Management Practices.

20. Due to the significance of the Los Angeles County Stormwater/Urban Runoff Program, the Regional Board, in recognition of the need for public involvement and participation in the development and implementation of an effective program will conduct at a minimum an annual workshop, prior to approving plans submitted by Permittees, to solicit comments and to inform the public of the progress of the program. Comments presented will be referred to Los Angeles County for response.

21. Stormwater/urban runoff discharges to drainage facilities that cross County boundaries and Regional Board jurisdictions, and which are regulated under NPDES permits, are the regulatory responsibility of those agencies issuing the permits.

22. The issuance of waste discharge requirements for this discharge is exempt from the provisions of the California Environmental Quality Act (CEQA); Chapter 3 (commencing with Section 21100) of Division 13 of the Public Resources Code in accordance with Water Code Section 13389.

The Board has notified the Permittees and interested agencies and persons of its intent to issue waste discharge requirements for this discharge and has provided them with an opportunity to submit their written views and recommendations.

The Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

This Order shall serve as a National Pollutant Discharge Elimination System permit pursuant to Section 402 of the Federal Clean Water Act, or amendments thereto, and shall take effect at the end of ten days from the date of its adoption provided the Regional Administrator, EPA, has no objections.

IT IS HEREBY ORDERED that the Permittees, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder,

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and the provisions of the Clean Water Act as amended and regulations and guidelines adopted thereunder, shall comply with the following:

1.0 COMPLIANCE

1.1 The Permittees and Co-Permittees shall comply with the requirements contained in this Order according to the following schedule:

	DRAINAGE BASIN	STARTING DATE FOR COMPLIANCE WITH REQUIREMENTS
I.	Santa Monica Bay	July 1, 1990
II.	Upper Los Angeles River (San Fernando Valley)	July 1, 1992
III.	Upper San Gabriel River (San Gabriel Valley)	July 1, 1992
IV.	Lower Los Angeles River	July 1, 1993
V.	Lower San Gabriel River and Santa Clarita Valley	July 1, 1993

2.0 REQUIREMENTS - YEAR 1

2.1 For each Drainage Basin, prepare and submit to the Regional Board within 12 months of the starting date for compliance, according to the schedule under 1.1:

2.1.1 Water quality data and flow data from 1980 to the present to facilitate identification of sources of pollutants present in discharges from the prioritized drainage basin. "Drainage areas" in the drainage basin are to be reported and the "drainage areas" associated with each drainage basin clearly identified.

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For purposes of stormwater/urban runoff, a "drainage area" is defined as a subdivision of a drainage basin which is unique in land use patterns, and pollutant characteristics and loadings.

2.1.2 The 90th percentile value for the water quality parameters, (i) Total Suspended Solids (TSS), and (ii) Oil and Grease, from the data set of all wet weather samples collected from 1980 to the present. These data will be used to establish guidance for early action control of stormwater pollution.

The 90th percentile for a given water quality parameter is defined as the concentration value exceeded in ten percent of the samples of the reference data set.

2.1.3 Additional information of a qualitative nature that would contribute to isolating and identifying sources of problems. Such information should include but not be limited to visual observations of factors exacerbating stormwater contamination, principal land use classifications and Standard Industrial Code (SIC) categories of facilities in "drainage areas", and a description of soils, dumps, landfills, waste disposal sites and Resource Conservation and Recovery Act (RCRA) facilities associated with each area.

2.1.4 Monthly precipitation data from rain gauge stations, relevant to the drainage basin, for the years 1980 to the present, and an estimate of the area of impervious surfaces (including paved areas and building roofs) within each "drainage area".

2.1.5 Documentation of existing procedures to detect and address illegal discharges and illicit disposal practices.

2.1.6 Documentation of existing practices and improvement plans to control pollutants in stormwater/urban runoff from construction sites.

2.1.7 Documentation of existing stormwater/urban runoff management practices and existing Best Management Practices (BMPs) for the control of pollutants in discharges from residential, commercial and industrial areas.

For purposes of this permit, a Best Management Practice is defined as a stormwater quality management practice that has been demonstrated to reduce stormwater/urban runoff constituents of concern in studies in the United States and

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elsewhere, or a stormwater/urban runoff quality management practice that can significantly control stormwater/urban runoff pollution.

2.1.8 Plan with schedule of implementation, for approval by the Executive Officer, of early action BMPs.

For purposes of this permit, an early action BMP is defined as an existing stormwater/urban runoff quality management practice that is optimized to the maximum extent practicable (MEP) in efficiency for the control of stormwater runoff pollution, such as improving the frequency of storm drain catchment basin cleaning or the stricter enforcement of existing regulations, or a BMP that is not specific to stormwater/urban runoff constituents or "drainage area" in its constituent removal capacity and can be applied on a system-wide basis, such as public outreach and educational programs.

For purposes of this permit, maximum extent practicable means to the maximum extent possible, taking into account equitable considerations of synergistic, additive and competing factors, including but not limited to gravity of the problem, fiscal feasibility, public health risks, societal concern, and social benefits.

The Principal-Permittee, in the submittal of plans and schedules to the Executive Officer, shall demonstrate that public input has been obtained.

For purposes of this permit, public input is demonstrated by, (i) disseminating the notice of availability of plans for review and comment, to the public at large, environmental groups, Federal, State and local officials and other interested parties, and (ii) addressing concerns expressed by the public.

The Board may modify the plans in response to public input received at the Board during its comment/review period. Permittees are required to implement the original or modified plan on approval by the Executive Officer.

2.1.9 A workplan for the development of a stormwater/urban runoff monitoring program, for approval by the Executive Officer, to include but not be limited to the following information :

- o listing of constituents and parameters to be monitored and the rationale for their choice.
- o listing of monitoring locations and the rationale for their choice.
- o listing of sampling methodology of choice and frequency of sampling for both wet weather and dry weather flow.

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- o supplementary information that influences the design of the monitoring plan.

The Principal-Permittee, in the submittal of the workplan to the Executive Officer, shall demonstrate that public input has been obtained.

2.1.10 Documentation that each Permittee, individually and/or jointly, through the establishment of a joint powers authority or a stormwater utility, possesses adequate legal authority to operate and manage stormwater/urban runoff quality management programs, and/or plans to obtain the necessary legal authority to regulate illegal discharges and illicit disposal practices into storm drains, and to prosecute violators.

3.0 REQUIREMENTS - YEAR 2

3.1 For each Drainage Basin, prepare and submit to the Regional Board, for approval by the Executive Officer, within 24 months of the starting date of compliance, according to the schedule under 1.1:

3.1.1 A monitoring program based on the approved workplan. This program shall be designed to:

- o detect accurately the constituents and parameters of concern, in discharges indicated in the workplan, and to identify their possible sources.
- o identify illegal dischargers and/or locations of illicit disposal practices.

Monitoring reports for this program shall be submitted according to the format and frequency to be approved by the Executive Officer.

3.1.2 Plan with schedule of implementation for additional BMPs, judged appropriate for each city or drainage basin, to control pollutants from residential, commercial and industrial sites to the maximum extent practicable.

Both structural and non-structural BMP measures are to be evaluated at the MEP standard. Examples of non-structural measures include catch basin cleaning, street sweeping and public education, while controls such as detention/retention basins,

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first flush diversions, grassy swales and porous pavements are examples of structural measures.

3.1.3 Plan with schedule of implementation of procedures to detect and eliminate illegal discharges and illicit disposal practices.

3.1.4 Plan with schedule of implementation of measures to control pollutants in surface runoff from construction sites.

The Principal Permittee, in the submittal of plans and schedules (items 3.1.2, 3.1.3, and 3.1.4) to the Executive Officer shall demonstrate that public input has been obtained. The Board may modify the plans in response to public input received at the Board during its comment/review period. Permittees are required to implement the original or modified plans on approval by the Executive Officer.

3.2 Evidence of satisfactory progress of implementation of plan and schedule for early action BMPs.

3.3 Evidence of all requisite legal authority to regulate illegal discharges and illicit disposal practices to drainage facilities, and to prosecute violators.

4.0 REQUIREMENTS - YEAR 3

4.1 For each Drainage Basin, submit to the Regional Board, within 36 months of the starting date of compliance, according to the schedule under 1.1, the following:

4.1.1 Evidence of satisfactory progress of implementation of plan and schedule for early action BMPs and additional BMPs.

4.1.2 Evidence of implementation and progress of procedures to detect and eliminate illegal discharges and eliminate illicit disposal practices.

4.1.3 Evidence of implementation and progress of measures to control pollutants in surface runoff from construction sites.

5.0 EXPIRATION AND RENEWAL

5.1 This Order expires on June 18, 1995.

5.2 The Permittees shall file a report of waste discharge (ROWD), not later than 180 days before the expiration date, as application for reissuance of

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waste discharge requirements. This report of waste discharge shall include but not be limited to the following:

5.2.1 Summary of the results of the monitoring program.

5.2.2 Summary of BMPs implemented and evaluations of their effectiveness.

5.2.3 Summary of procedures implemented to detect illegal discharges and illicit disposal practices and an evaluation of their effectiveness.

5.2.4 Summary of measures implemented to control pollutants in surface runoff from construction sites and an evaluation of their effectiveness.

5.2.5 Evaluation of the need for additional BMPs, source control, and/or structural control measures.

5.2.6 Proposed plan of stormwater/urban runoff quality management activities that will be undertaken during the term of the next permit.

I, Robert P. Ghirelli, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on June 18, 1990.

ROBERT P. GHIRELLI, D.Env.
Executive Officer

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ATTACHMENT 1

LIST OF CO-PARTICIPANT CITIES

Agoura Hills
Arcadia
Avalon
Baldwin Park
Bellflower
Beverly Hills
Burbank
Cerritos
Commerce
Covina
Culver City
Downey
El Monte
Gardena
Glendora
Hawthorne
Hidden Hills
Industry
Irwindale
La Habra Heights
La Mirada
La Verne
Lawndale
Long Beach
Lynwood
Maywood
Montebello
Norwalk
Palos Verdes Estates
Pasadena
Pomona
Redondo Beach
Rolling Hills Estates
San Dimas
San Gabriel
Santa Clarita
Santa Monica
Signal Hill
South Gate
Temple City
Torrance
Walnut
West Hollywood
Whittier

Alhambra
Artesia
Azusa
Bell
Bell Gardens
Bradbury
Carson
Claremont
Compton
Cudahy
Diamond Bar
Duarte
El Segundo
Glendale
Hawaiian Gardens
Hermosa Beach
Huntington Park
Inglewood
La Canada Flintridge
Lakewood
La Puente
Lancaster
Lomita
Los Angeles
Manhattan Beach
Monrovia
Monterey Park
Palmdale
Paramount
Pico Rivera
Rancho Palos Verdes
Rolling Hills
Rosemead
San Fernando
San Marino
Santa Fe Springs
Sierra Madre
South El Monte
South Pasadena
Thousand Oaks
Vernon
West Covina
Westlake Village

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ATTACHMENT 2

LIST OF ENTITIES (PARTIAL LIST)

Caltrans
Army Corps of Engineers
Railroad Rights of Way
Federal Hospitals

The State University System
University of California Campuses
National Forest Service
Federal Military Facilities

[This list will be updated during the permit process to indicate actual identity of agencies and entities.]

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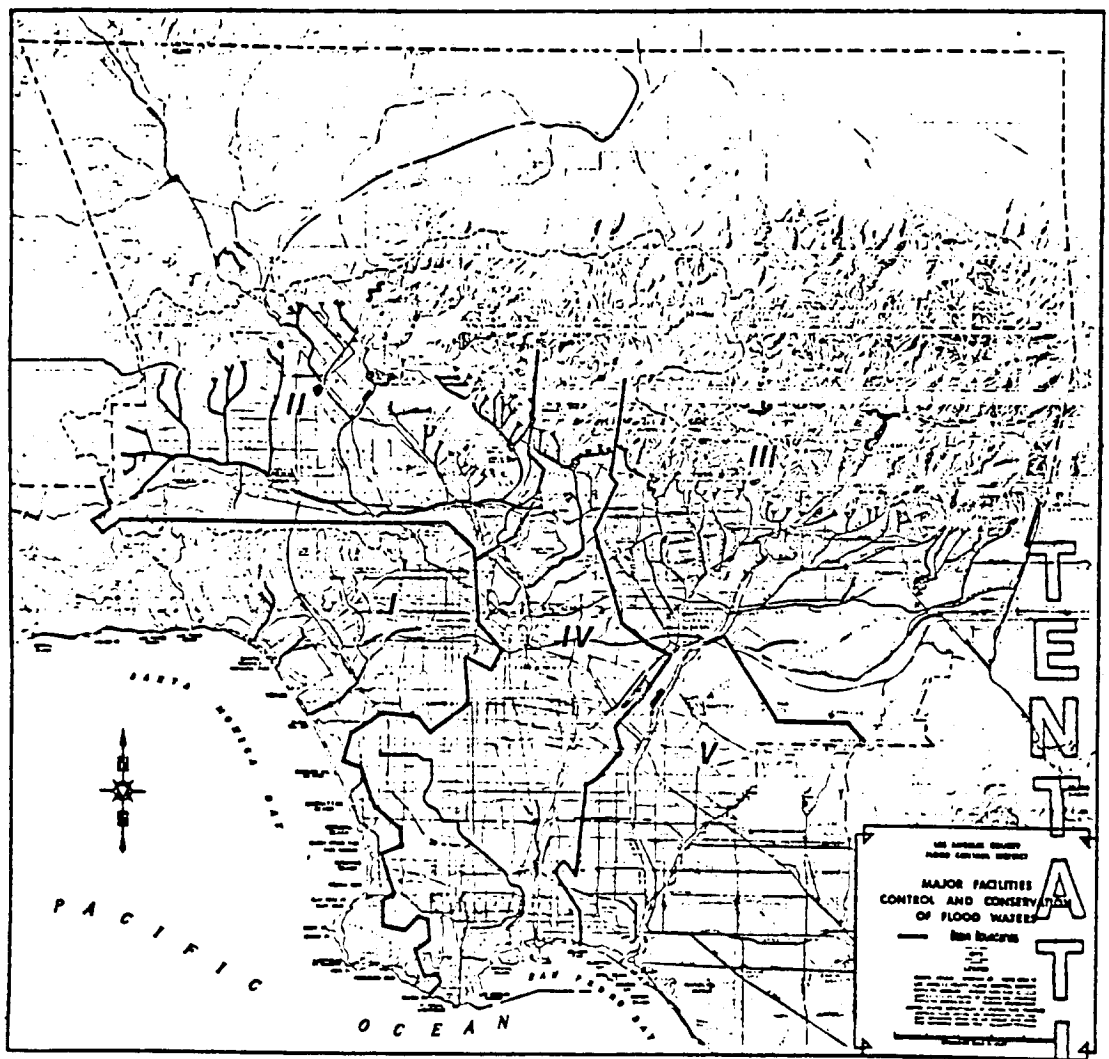
ATTACHMENT 3

DELINEATIONS OF DRAINAGE BASIN BOUNDARIES FOR
LOS ANGELES COUNTY



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ATTACHMENT 4

CITIES (AND POPULATIONS) TRIBUTARY TO DRAINAGE BASINS

Santa Monica Bay

Agoura Hills	19,000	Rancho Palos Verdes	46,000
Beverly Hills	34,000	Redondo Beach	64,700
Culver City	40,950	Rolling Hills	2,090
El Segundo	15,750	Rolling Hills Estates	7,875
Hermosa Beach	19,750	Santa Monica	96,500
Inglewood	102,300	Thousand Oaks	104,400
Los Angeles	3,400,500	Torrance	142,200
Manhattan Beach	35,300	West Hollywood	38,400
Westlake Village	8,025	Palos Verdes Estates	15,000

Upper Los Angeles River

Burbank	93,800	Glendale	166,100
Hidden Hills	1,950	Los Angeles	3,310,057
San Fernando	20,700		

Upper San Gabriel River

Alhambra	74,900	Arcadia	49,100
Azusa	38,250	Baldwin Park	63,300
Bradbury	930	Claremont	36,550
Covina	43,250	Diamond Bar	74,120
Duarte	21,350	El Monte	95,400
Glendora	47,400	Industry	370
Irwindale	1,230	La Canada Flintridge	20,800
La Habra Heights	5,450	La Puente	33,550
La Verne	30,500	Monrovia	34,000
Montebello	58,200	Monterey Park	64,600
Pasadena	132,200	Pomona	119,000
Rosemead	47,700	San Dimas	32,500
San Gabriel	34,900	San Marino	13,800
Sierra Madre	11,250	South El Monte	18,700
South Pasadena	24,500	Temple City	31,900
Walnut	26,400	West Covina	94,200

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Lower Los Angeles River

Alhambra	74,900	Bell	28,250
Bell Gardens	38,300	Carson	88,800
Commerce	11,700	Compton	93,000
Cudahy	20,700	Downey	86,800
El Segundo	15,750	Gardena	50,900
Glendale	166,100	Hawthorne	67,400
Huntington Park	51,200	Inglewood	102,300
La Canada Flintridge	20,800	Lakewood	76,500
Lawndale	27,300	Lomita	20,300
Los Angeles	3,400,500	Lynwood	53,700
Maywood	24,650	Montebello	58,200
Monterey Park	64,600	Palos Verdes Estates	15,000
Paramount	44,450	Pasadena	132,200
Pico Rivera	57,300	Rancho Palos Verdes	46,000
Redondo Beach	64,700	Rolling Hills	2,090
Rolling Hills Estates	7,875	Signal Hill	8,150
South Gate	79,200	South Pasadena	24,500
Torrance	142,200	Vernon	80

Lower San Gabriel River

Artesia	14,950	Bellflower	60,900
Cerritos	58,400	Downey	86,800
Hawaiian Gardens	12,350	La Habra Heights	5,450
Lakewood	76,500	La Mirada	42,600
Long Beach	419,800	Norwalk	90,800
Paramount	44,450	Pico Rivera	57,300
Santa Clarita	115,700	Santa Fe Springs	16,400
Signal Hill	8,150	Whittier	74,100

Population estimates are taken from Report 89 E-1 published by the State of California Department of Finance.

The cities of Avalon (Pop: 2,490), Lancaster (Pop: 82,200), and Palmdale (Pop: 45,850) which are within Los Angeles County are not part of this permit.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, CA 94105

28 FEB 1990

In Reply
Refer to: W-5-2

Robert Ghirelli
Executive Officer
California Regional Water Quality
Control Board, Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Mr. Ghirelli:

The purpose of this letter is to summarize Region 9's position with respect to your current efforts to issue an NPDES permit for municipal stormwater discharges in the Los Angeles area prior to promulgation of EPA's permit application regulations.

As you will recall, an initial draft permit for stormwater was prepared by Regional Board staff in November, 1989 and Region 9 expressed certain concerns regarding this permitting activity in a letter from Harry Seraydarian to you dated November 16, 1989. Subsequently, a series of meetings was held to discuss stormwater permitting which involved the City and County of Los Angeles, representatives of the State Board, the Los Angeles Regional Board and Region 9. The initial draft permit was revised several times as a result of the discussions.

We believe that with some relatively minor modifications, the latest draft (Revision #6 dated February 8, 1990) is approvable by Region 9. Two of our major concerns with previous drafts have been the timetable for implementation of the permit requirements and the provisions for public participation in the decision-making.

The latest draft permit adequately addresses our concern regarding the timetable for implementation of the permit requirements. In the implementation schedule for each geographic area, the latest draft permit requires submittal within 2 years (rather than 3) of the plan to reduce pollutant discharges to the "maximum extent practicable." This is now similar to EPA's proposed regulations which would require submittal of a stormwater management plan within 2 years. Of course, we are still concerned that implementation would be delayed for certain areas of the County. However, given the size of the area being

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permitted, we believe that the implementation timetable is acceptable.

With regards to public participation, we would prefer that the Board (rather than the County as proposed) provide for the necessary public participation in the development of the various plans which are required by the permit. However, we could concur with your proposal if certain minimum requirements are specified regarding an adequate demonstration of public participation by the County. In its submittal to the Board, the County should demonstrate for each plan that:

1) a public meeting was held to discuss the plan,
2) notice of the meeting was widely disseminated to the public at large, environmental groups, Federal, State and local officials and other interested parties, and
3) the concerns expressed by the public were addressed by the County. If concerns were raised which were not addressed, the County should provide reasons why these concerns were not addressed.

In addition, the permit should include a statement which requires implementation of the plans after approval/modification by the Regional Board.

In a separate letter to Catherine Tyrrell dated February 9, 1990, we also suggested some minor editorial changes to the permit.

Let me emphasize in closing that Region 9 supports your efforts to issue an NPDES permit for stormwater runoff in the Los Angeles area as soon as possible. We believe that this action will expedite the overall efforts to address existing water quality degradation in the Los Angeles area (and particularly in the sensitive Santa Monica Bay area) which is caused at least in part by pollutants in stormwater runoff.

Should you have any questions, please call me at (415) 705-2079 or refer your staff to Eugene Bromley of the Sludge, Pretreatment and Stormwater Section at (415) 705-2160.

Sincerely,

Keith Takata

Keith A. Takata
Acting Director
Water Management Division

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COMPARISON OF THE STORM WATER PROGRAM WITH THE HAZARDOUS WASTE AND POLLUTION PREVENTION PROGRAMS

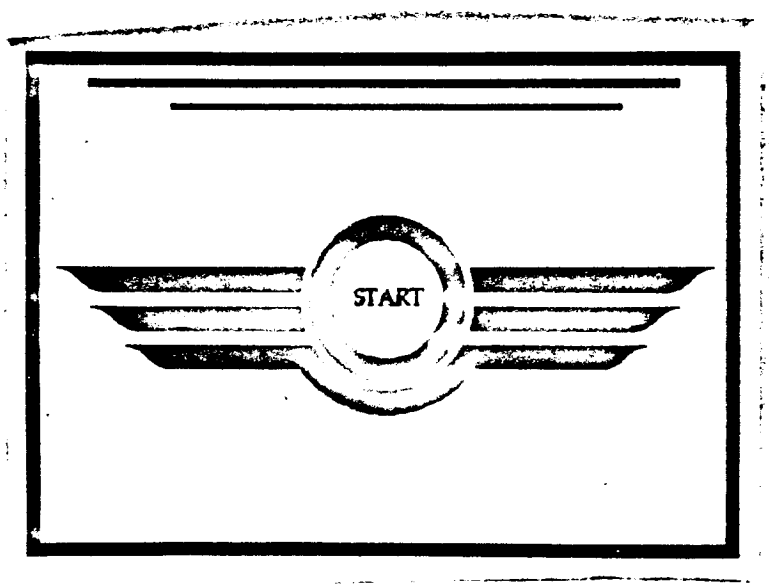
JULY 1994

PREPARED BY

PAVLOVA N. VITALE

FOR

PRESENTATION TO THE CALIFORNIA STORM WATER TASK FORCE



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i. List of Agency Contacts
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i. List of Agency Contacts
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I INTRODUCTION AND PURPOSE STATEMENT

America's awakening to the fact that human impacts on the natural environment can have serious consequences, has led to a large number of corrective actions in the form of regulatory programs (Figure 1). The results of these regulatory programs have been both good and bad. The good news is that the air is cleaner, the water purer and the land is treated with greater care than 20 years ago. The bad news is that the cost to implement these programs are ever increasing to the regulatory agencies and to the regulated community. The goal of any regulatory program is best achieved through enhancement of already existing practices.

This report will compare the most recently established storm water program with the already established and continually expanding hazardous waste and pollution prevention programs.

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II REGULATORY BACKGROUND

A. HAZARDOUS WASTE MANAGEMENT PROGRAM

The hazardous waste program in California began with the Resource Conservation and Recovery Act (RCRA). RCRA is a federal statute that was enacted in 1976 and amended the Solid Waste Disposal Act of 1965. RCRA focused on improving methods of solid and hazardous waste disposal. RCRA is implemented by the Environmental Protection Agency (EPA) and has been amended several times resulting in a wider scope of requirements for the proper management of both hazardous and non-hazardous waste. The Federal Hazardous Waste Program is found in Subtitle C of RCRA.

RCRA requires the states to develop their own hazardous waste management program and to enact the necessary legislation to regulate hazardous waste within their jurisdiction. California's hazardous waste program is implemented by the Department of Toxic Substances Control (DTSC) and was authorized by EPA in 1992. California's state legislation include the Health and Safety Code, Title 22 and recently enacted legislation. Municipalities are also involved in regulating hazardous waste. In 1986, the California legislature passed Assembly Bill (AB) 2498 requiring all municipalities in California to prepare and implement hazardous waste management plans (HWMP) to regulate hazardous waste, including household hazardous waste, within their jurisdiction. The HWMP together with memoranda of understanding between the municipalities and DTSC bring about a coordinated effort to properly manage hazardous waste in California.

B. POLLUTION PREVENTION PROGRAM

In 1989, California's legislature passed the Hazardous Waste Source Reduction and Management Review Act, more commonly known as Senate Bill (SB) 14. SB 14 is the first piece of legislation in California to require hazardous waste generators to consider source reduction as the preferred method of managing hazardous waste. SB 14 promotes source reduction over recycling and treatment because source reduction avoids the liability associated with generating and managing hazardous waste. Furthermore, SB 14 is not the typical "command and control" legislation that dictates specific levels of hazardous waste reduction. Instead, SB 14 requires generators to examine their current hazardous waste management practices for hazardous waste minimization opportunities and to prepare and implement plans that detail the waste minimization alternatives for their processes. SB 14 was amended in 1992 by Senate Bill (SB) 1726 thus broadening the applicability of SB 14. The primary agency that implements the pollution prevention program is DTSC.

In 1990 Congress enacted the Federal Pollution Prevention Act setting forth the Federal Policy promoting pollution prevention through source reduction (Figure 6). The Act further states that pollution that can not be prevented should then be recycled in an environmentally sound manner, and that pollution that can not be prevented or recycled should then be treated in an environmentally safe manner. In addition, any disposal or release of pollutants into the environment should be employed only as a last resort and

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should also be conducted in an environmentally safe manner (i.e. permitted).

C. STORM WATER PROGRAM

The storm water program in California began as a result of the enactment of the 1987 Clean Water Act (CWA) amendments. Before the 1987 CWA amendments, very few industries were regulated for storm water discharges, and there was not an established storm water program. The 1987 CWA amendments brought about the development of the storm water program in California.

The CWA is a federal statute that was enacted in 1972 to amend the Federal Water Pollution Control Act of 1948 to control the discharge of any pollutant from a point source into waters of the nation by implementing the National Pollutant Discharge Elimination System (NPDES) Program. The NPDES Program sets forth permitting requirements for point source discharges to waters of the nation (Figure 5). The NPDES Program is implemented by EPA or by delegated states. California was delegated by EPA to implement the NPDES Program in 1973. The agencies involved in implementing the NPDES Program (i.e. permitting point source discharges) in California are the State Water Resources Control Board and the nine Regional Boards.

The CWA has been amended several times since 1972, widening the requirements and their applicability to point source discharges. For example, the 1987 amendments required EPA to develop regulations for permit applications for storm water discharges associated with industrial activities and municipal storm drain systems serving a population of 100,000 or more. As a result of the 1987 amendments to the CWA, EPA promulgated the storm water regulations in November 1990. Consequently, the State Water Resources Control Board adopted two general permits: the General Permit for Storm Water Discharges Associated with Industrial Activities, and the General Permit for Storm Water Discharges Associated with Construction Activities. Furthermore, municipal permits were adopted individually by the Regional Boards.

III APPLICABILITY AND IMPLEMENTATION OF THE PROGRAMS

A. HAZARDOUS WASTE PROGRAM

Most of the regulations dealing with hazardous waste are found in Code 40 of the Federal Regulations Parts 260-264, Title 22 Division 4.5 of the California Code of Regulations, the Health and Safety Code, and Title 26 of the California Code of Regulations. Title 26 incorporates all of Title 22 regulations applicable to hazardous waste management as well as applicable sections from other titles, such as those for water and Cal-OSHA, which also apply to hazardous wastes and hazardous materials.

In addition to the Federal regulations, California has adopted more stringent regulations to regulate hazardous waste. As a result you will often see that the regulations make reference to RCRA hazardous waste and non-RCRA hazardous waste. Hazardous waste is defined in

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Federal and State regulations as a solid waste which because of its quantity, concentration, or physical characteristics may either:

1. Cause or significantly contribute to an increasc in mortality or an increase in serious irreversible, or incapacitating reversible illness.

2. Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

3. A waste which meets any of the criteria for identification of a hazardous waste such as toxicity, flammability, reactivity, and corrosivity.

EPA has developed three lists that include hundreds of chemical compounds that are considered to be hazardous. When a chemical compound becomes a waste, it is compared to EPA's lists. If the chemical compound is listed, the chemical compound is automatically considered to be a RCRA regulated hazardous waste and must be managed in compliance with hazardous waste regulations. California has added several chemical compounds to EPA's lists. These additional chemical compounds are referred to as "California only" regulated hazardous wastes. Waste oil for example, is not listed in EPA's lists but it is listed in California's lists. As a result, waste oil is considered to be a non-RCRA or "California only" regulated hazardous waste. Furthermore, if a chemical compound is not listed on any of the lists, it should be analyzed to see if it exhibits any of the four characteristics of a hazardous waste. If the chemical compound exhibits any of the four characteristics, it is then considered a hazardous waste.

The hazardous waste regulations apply to facilities that generate hazardous waste (generators), facilities that treat, store, or dispose of hazardous waste on-site (TSDF's), and facilities that transport hazardous waste (transporters) (Figure 4). Generators of hazardous waste are required to obtain an identification number (EPA I.D. No.) from DTSC, obtain a hazardous waste generator permit or license from the municipality, store the waste on-site for no longer than 90 days, store the waste in containers that are in good condition and lined with a material that is compatible with the waste, keep the containers tightly closed, label the containers with the words "hazardous waste" and include the composition, and physical state of the waste, name and address of the generator, and the date of accumulation of the waste. Generators are also required to weekly inspect areas where the hazardous waste are stored and look for deterioration of the containers and containment systems, spills, and leaks, to develop and implement a contingency plan, and to prepare manifests prior to shipping the waste off-site for treatment or disposal.

Due primarily to the enactment of SB 2498 requiring municipalities to develop a plan to manage hazardous waste, including household hazardous waste, within their jurisdiction, local government agencies permit and inspect generators of hazardous waste for compliance with State and local hazardous waste regulations. In addition, local government manages

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household hazardous waste, by establishing permanent, and mobile household hazardous waste collection facilities. These facilities accept household hazardous waste from home owners and from small quantity generators. The household hazardous waste is often comprised of waste oil, leftover paints, paint thinners, pesticides, and empty containers. Waste oil is sent off-site for recycling, leftover paints are used to paint over graffiti, the paint thinners are either reused or sent off-site to be recycled, and the rest of the waste may be sent to a landfill for disposal. These facilities are also required to comply with generator requirements for proper handling and storage of the hazardous waste. Also, these facilities are inspected by DTSC for compliance with generator requirements.

TSDF's are required to comply with the generator requirements listed above and to obtain either a RCRA or a non-RCRA TSDF permit from DTSC. In general, TSDF permits allow facilities such as oil recycling facilities, resource recovery facilities and hazardous waste landfills to accept hazardous waste from generators. TSDF's in turn, may either treat the waste to render it non-hazardous for ultimate disposal, or treat the waste to render it usable and sell it as product, or reuse it as fuel in a process. There are additional requirements for TSDF's. In general, these requirements include installation of secondary containment, proper management and use of containers, allowable volume of hazardous waste to be treated, stored or disposed of on-site, specific treatment technologies for the hazardous waste, allowable storage time of the hazardous waste, extensive record keeping and reporting requirements, routine inspections of the active areas of the facility, and installation of emergency communication devices and alarm systems. TSDF permits (RCRA or non-RCRA) are enforced primarily by DTSC. Also, on a case by case basis DTSC inspects TSDF's in conjunction with the local government agencies and with EPA.

Transporters of hazardous waste (transporter) are the critical link between the generator and the ultimate off-site TSDF. Transporters are required to comply with Subtitle C of RCRA, the Hazardous Materials Transportation Act and with Title 22 and Health and Safety Code transporter requirements. A transporter is defined as any person engaged in transporting hazardous waste by air, rail, highway or water. Transporters are required to obtain an EPA I.D. No., a hauler's license from DTSC, obtain liability insurance in the event of an emergency, deliver the exact amount of hazardous waste accepted from the generator to the TSDF, maintain for three years copies of manifest records of all the hazardous transported, notify the Office of Emergency Services if involved in a spill of hazardous waste. Transporters are routinely inspected by the California Highway Patrol, and by DTSC.

B. POLLUTION PREVENTION PROGRAM

According to SB 14, generators that produce more than 12,000 kg per year of hazardous waste or that produce more than 12 kg per year of extremely hazardous waste are required to develop a Hazardous Waste Management Performance Report (Report), a Source Reduction Evaluation Review and Plan (Plan), and a Progress Report. The Report is a retrospective document that contains a description of the generators's current hazardous

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waste management practices. The Plan is a prospective document that contains an evaluation of the generator's hazardous waste streams and a list of possible source reduction measures. In general, the Plan includes the facility's general information such as standard industrial classifiation (SIC) code, type of industrial activity, ownership of the facility, an estimate of the quantity of hazardous waste generated at the site, an evaluation of potential source reduction opportunities, a time table for implementing selected source reduction measures and a four year numerical goal to be met by implementing the source reduction measures. The Progress Report includes an assessment on how effective the selected measures were at reducing hazardous waste production and releases to all environmental media (air, land, and water).

Generators that produce more than 500 kg per year but less than 12,000 kg per year of hazardous waste are required to complete a Compliance Checklist. In the checklist, the generator is required to list the facility's current hazardous waste management practices and to propose source reduction measures. The Compliance Checklist requirement is aimed solely for small quantity generators.

C. STORM WATER PROGRAM

As stated in the Regulatory Background Section, the SWRCB and its nine regional boards have been delegated to implement the NPDES program in California. As a result of the Clean Water Act's 1987 amendments, EPA promulgated storm water regulations on November 1990. The regulations state that the storm water discharges from eleven categories of industries need to obtain an NPDES Permit (Figure 7). As a result, the SWRCB adopted the General Permit for Storm Water Discharges Associated with Industrial Activities and the General Permit for Storm Water Discharges Associated with Construction Activities. These General Permits are enforced by nine Regional Water Quality Control Boards. In addition, the regulations state that municipalities serving a population of 100,000 or more are required to obtain an NPDES Permit. As a result, the regional boards adopted individual NPDES Permits for the municipalities within their jurisdiction.

The General Permit for Storm Water Discharges Associated with Industrial Activities applies to 11 categories of industries. Five of the eleven categories of industries are identified by SIC code (Fugure 7). The General Permit for Storm Water Discharges Associated with Industrial Activities requires dischargers to develop and implement a storm water pollution prevention plan (SWPPP) and to develop and implement a monitoring program. The SWPPP should outline best management practices(BMP's), more commonly known as pollution prevention practices, that the facility will implement to prevent pollutants from being discharged from the facility in storm water run-off. The monitoring program requires the discharger to visually inspect areas of the facility where pollution prevention practices have been implemented and to evaluate how well the pollution prevention measures are working. The facility, commonly referred to as the discharger, is also required to visually inspect the facility's discharge locations and look for evidence that

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pollutants may be discharged. In addition, the discharger is required to collect storm water samples and have the samples analyzed for the presence of pollutants. Once dischargers have obtained the information from implementing the monitoring plan, the dischargers are required to continually strive to eliminate discharges of pollutants in storm water from their facilities.

The General Permit for Storm Water Discharges Associated with Construction Activities applies to construction that involves land disturbance of five acres or more, and to construction activities that involve land disturbance of less than five acres if the construction project is part of a large (five acres or more) common plan of development or sale. The permit requires dischargers to develop and implement a pollution prevention plan that outlines BMP's, that will prevent pollutants (sediment, lubricants, and related construction materials) from being discharged from the site in storm water run-off.

The municipal NPDES Permits require municipalities to develop and implement Storm Water Management Plans, Storm Water and Receiving Water Monitoring Plans, and enact the necessary legal authority to prohibit discharges of pollutants into the municipal storm drain systems. The primary goal of the municipal storm water programs is to reduce pollutant loadings in receiving waters from urban run-off.

These permits do not contain effluent limits and do not specify methods of compliance primarily because the storm water program focuses on pollutant elimination through pollution prevention. The least expensive way to eliminate discharges of pollutants in storm water is through source reduction.

IV COMPARISON OF THE PROGRAMS

The hazardous waste and the storm water program have resulted from Federal mandates (Figure 2). These programs complement each other both at the local level and at the state level. For example, both the storm water program and the hazardous waste management program both regulate RCRA TSDF's, generators, transporters and to some extent municipalities (Figure 3). The hazardous waste regulations require that hazardous waste be stored in sound leak proof containers and to maintain the containers closed at all times. Compliance with this requirement may be listed as a pollution prevention measure in the facility's SWPPP. The hazardous waste regulations also require facilities to conduct weekly inspections of areas in the facility where hazardous waste is handled. One of these weekly inspections may also be used to meet the annual inspection requirement of the Storm Water Annual Report. Furthermore, several components in the plans, reports, and checklists that generators are required to develop for pollution prevention may also be used to comply with the storm water regulations. For example, source reduction measures proposed or in place at a facility could also be included in the facility's SWPPP. If there is less waste generated, there is a great possibility that there won't be waste stored outside the facility and exposed to storm water.

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Municipalities can also benefit by integrating the municipal storm water program with the municipal hazardous waste program. In inspecting generators for compliance with hazardous waste regulations, municipalities could at the same time inspect for compliance with local storm water ordinances. Municipalities would thus conduct dual media inspections (land, and water) and cut down on the types of inspections of facilities and on the costs that would be associated with developing separate inspection programs.

At the state level, the storm water program and hazardous waste programs can benefit by exchanging information on commonly regulated facilities. For example, DTSC's databases include SIC codes of facilities currently under permit. This database can be used by the SWRCB and the Regional Boards to target non-filers. Also, information on any enforcement action taken by either of the state agencies on commonly regulated facilities is beneficial. For example, if a facility is being charged with violating hazardous waste regulations, there may be a possibility that the facility may also be violating storm water requirements.

Furthermore, the broadness and non-specificity of the storm water regulations should be taken advantage to incorporate and enhance existing regulatory programs such as the hazardous waste program and the pollution prevention program.

V RECOMMENDATIONS / CONCLUSION

In conclusion, there is a great need to integrate the existing hazardous waste, pollution prevention and the storm water programs at the local and state level. These three environmental programs have the goal of protecting human health and the environment Both local and state government agencies should explore in more detail the possibility that the hazardous waste, pollution prevention and storm water programs can be either coordinated or integrated to better achieve the programs' goal.

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VI REFERENCES

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A. HAZARDOUS WASTE MANAGEMENT PROGRAM

i. List of Agency Contacts
ii. Order Form for the Regulations
iii. List of Guidance Documents

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A. HAZARDOUS WASTE PROGRAM:

SOLID WASTE DISPOSAL ACT

RESOURCE CONSERVATION AND RECOVERY ACT

HEALTH AND SAFETY CODE

CALIFORNIA CODE OF REGULATIONS, TITLE 22, DIVISION 4.5

CODE OF FEDERAL REGULATIONS ; TITLE 40; PARTS 260-264

EPA NOTIFICATION OF HAZARDOUS WASTE ACTIVITY

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B. POLLUTION PREVENTION PROGRAM

i. List of Agency Contacts
ii. Order Form for the Regulations
iii. List of Guidance Documents

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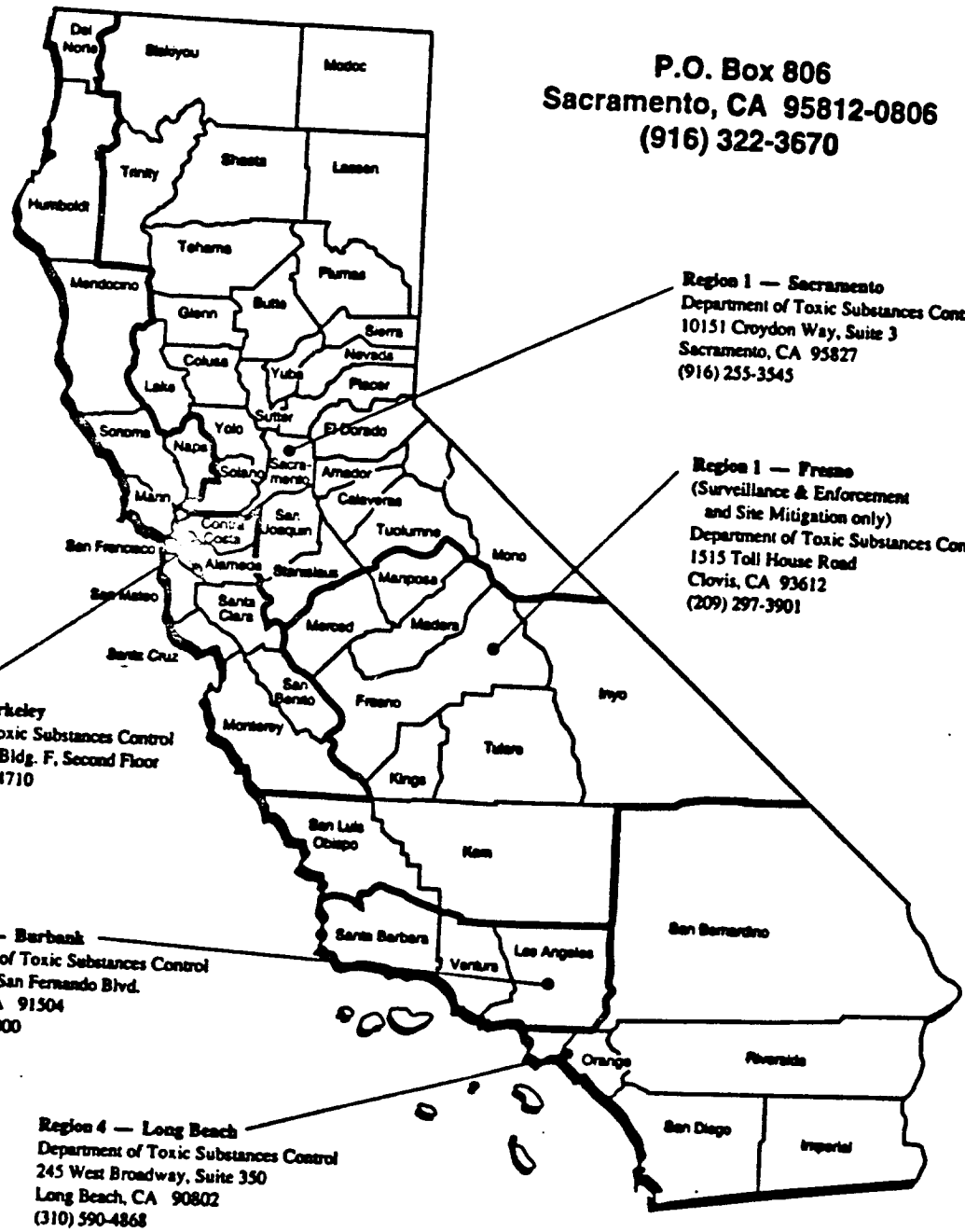
California Environmental Protection Agency

Department of Toxic Substances Control



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All reports are available at no cost to businesses, individuals, and government agencies throughout California. Videos are appropriately priced. Current and obsolete publications are available as references at the California Department of Toxic Substances Control (DTSC) Library and at select California Repository libraries.

HAZARDOUS WASTE SOURCE REDUCTION AND MANAGEMENT REVIEW ACT (SB14)—*The preferred approach to waste minimization is source reduction. Source reduction is any activity that prevents or reduces the generation of hazardous waste: it does not mean reducing the volume or toxicity of an already generated waste.*

Order #	Title
001	**Guidance Manual for the Hazardous Waste Source Reduction and Management Review Act of 1989 (Includes Appendices)** (1993, 159 pp.) The Source Reduction Act requires generators to examine current hazardous waste generating processes for hazardous waste minimization opportunities and create a plan to implement workable alternatives. Generators of hazardous waste in excess of amounts specified in the Act must prepare a Source Reduction Evaluation Review and Plan, a Hazardous Waste Management Performance Report, and a Progress Report according to a fixed time schedule.
002	**SB 14 Update** (1993, 3 pp.) Informs readers of the latest changes affecting the implementation of the Hazardous Waste Source Reduction and Management Review Act of 1989. This issue discusses the availability of new regulations, future planning document call-ins, additional uses of source reduction planning, and the results from last year's survey.
003	**Changes for 1993 to the Hazardous Waste Source Reduction and Management Review Act of 1989** (1993, 2 pp.) This brochure summarizes the requirements for a generator who is subject to the Act. Included is information about the amendments proposed by Senate Bill 1726 adopted by Statutes of 1992 as Chapter 853.
004	**Hazardous Waste Source Reduction Compliance Checklist** (1993, 21 pp.) SB 1726 amends SB 14 and required the Department to develop a compliance checklist as a substitute format for the Source Reduction Evaluation Review and Plan. The Compliance Checklist can be used by generators and small businesses who are newly captured under SB 1726.

WASTE MANAGEMENT FACT SHEETS—*Specific information on handling, transport, storage, treatment, and/or disposal.*

Order #	Title
100	**Asbestos Handling, Transport, and Disposal** (1993, 8 pp.) The regulation of asbestos waste in California including waste classification, analytical methods, handling, transport, licensing, fees, and taxes.
101	**PCB Handling, Treatment, and Disposal** (1992, 6 pp.) PCB regulations in California along with additional material on PCB classification, handling, treatment, disposal, and the differences between State and U.S. EPA PCB regulations.
102	**Handling and Transport of Spent Lead-Acid Storage Batteries** (1991, 5 pp.) Discusses special provisions developed by the Department to encourage the recycling of spent lead-acid batteries including storage, transport, and handling.
103	**Used Oil: Handling, Storage, and Transport for Recycling** (1992, 8 pp.) Discusses California regulations on handling, storage, and transport of used oil for recycling: it's easier, less costly, and more environmentally desirable than disposal options.
104	**Used Oil Filters: Handling, Storage, and Transport for Recycling** (1992, 4 pp.) Both the expense of managing and disposing of used oil filters as hazardous waste and testing them to see if they are hazardous can be avoided if they are recycled in accordance with these California requirements.
105	**Lighting Wastes** (1992, 2 pp.) Discusses storage, transportation, recycling, and disposal of spent fluorescent light tubes and high intensity discharge lamps.
106	**Contaminated Container Regulations** (1993, 4 pp.) Discusses California regulations on management of containers that previously held hazardous materials. The regulations set forth a definition of "empty container" and established management practices that, if met, would exempt "empty" containers from further regulation.

WASTE MINIMIZATION FACT SHEETS—*A summary of waste minimization methods for specific industries.*

Order #	Title
200	**Waste Minimization Can Work for You** (1992, 4 pp.) A summary of general hazardous waste minimization definitions and techniques for businesses.
201	**Aerospace Industry** (1992, 4 pp.)
202	**Automotive Paint Shops** (1992, 4 pp.)
203	**Automotive Repair Shops** (1989, 4 pp.)
204	**Building Construction** (1992, 4 pp.)
205	**Commercial Printing Industry** (1992, 4 pp.)
206	**Metal Finishers** (1991, 4 pp.)
207	**Paint Formulators** (1992, 4 pp.)
208	**Pesticide Formulating Industry** (1992, 4 pp.)
209	**Printed Circuit Board Manufacturers** (1992, 4 pp.)
210	**Decorative Plating with Trivalent Chrome** (1992, 6 pp.)
211	**Research and Educational Institutions** (1993, 4 pp.)
212	**Ceramic Products** (1993, 4 pp.)

WASTE AUDIT STUDIES—*Full scale assessments of specific industries that show where waste minimization methods can be most effective.*

Order #	Title
300	**Automotive Paint Shops** (1987, 99 pp.)
301	**Automotive Repairs** (1987, 69 pp.)
302	**Building Construction Industry** (1990, 108 pp.)
303	**Commercial Printing Industry** (1989, 137 pp.)
304	**Drug Manufacturing and Processing Industry** (1989, 224 pp.)

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WASTE AUDIT STUDIES (continued)

305 **Fabricated Metal Products Industry** (1989, 188 pp.)

306 **Fiberglass-Reinforced and Composite Plastic Products** (1989, 164 pp.)

307 **General Medical and Surgical Hospitals** (1988, 182 pp.)

308 **Gold, Silver, Platinum, and Other Precious Metals Product and Reclamation** (1990, 198 pp.)

309 **Marineyards for Maintenance and Repair** (1989, 156 pp.)

310 **Mechanical Equipment Repair Shops (Includes Addendum)** (1990, 87 pp.)

311 **Metal Finishing Industry (Includes Addendum)** (1988, 236 pp.)

312 **Nonagricultural Pesticide Application Industry** (1991, 116 pp.)

313 **Paint Manufacturing Industry** (1989, 130 pp.)

314 **Pesticide Formulating Industry** (1987, 160 pp.)

316 **Printed Circuit Board Manufacturers** (1989, 234 pp.)

317 **Research and Educational Institutions** (1988, 144 pp.)

318 **Stone, Clay, Glass, and Concrete Products Industries** (1991, 120 pp.)

319 **Thermal Metal Working Industry** (1990, 195 pp.)

HAZARDOUS WASTE MINIMIZATION CHECK-LIST AND ASSESSMENT MANUALS—*Assessment manuals developed to aid manufacturers in evaluating their shops for waste minimization opportunities.*

Order #	Title
400	**Automotive Repair Shops** (1988, 47 pp.)
402	**Metal Finishing Industry** (1993, 143 pp.)
403	**Paint Formulators** (1991, 40 pp.)
404	**Pesticide Formulators** (1990, 20 pp.)
405	**Printed Circuit Board Manufacturers** (1991, 31 pp.)
406	**Auto Paint Shops** (1992, 12 pp.)
407	**Building Construction** (1992, 28 pp.)
408	**Ceramic Products** (1993, 27 pp.)
409	**Marine Ship and Pleasure Vessel Boat Yards** (1993, 30 pp.)

WASTE MINIMIZATION ASSESSMENTS OF SPECIFIC FACILITIES

Order #	Title
500	**Aerospace Waste Minimization Project—Final Report** (1987, 133 pp.) A feasibility study was conducted to identify and evaluate waste minimization technologies applicable to the aerospace and electronics industries. Eight waste stream categories were targeted for the application of waste minimization technologies and alternative management strategies.
504	**Pollution Prevention Technologies at General Dynamics—Pomona, California** (1991, 9 pp.) A variety of waste minimization technologies were technically and economically evaluated at an aerospace facility. Technologies range from computerized printed circuit board plating to solvent distillation.
522	**Waste Reduction Strategies for the Printed Circuit Board Industry** (1987, 115 pp.) An assessment of the feasibility of achieving significant reductions of hazardous waste generated by the printed circuit board industry.
516	**Reduction of Solvent Wastes in the Electronics Industry** (1988, 85 pp.) Hewlett Packard's San Jose facility was used as a model to study the techniques required to reduce the volume and type of organic solvent wastes in the electronics industry. Up to a 70% reduction in organic solvent waste volume at the facility could be realized, thus saving the company up to $414,000 per year in disposal and chemical purchase costs.
502	**Disposal of Heavy Metal Waste Sludges in Ceramic Products** (1990, 103 pp.) A laboratory-scale test to determine the feasibility of incorporating heavy metal sludges into manufacturing ceramic products. The process can be economical and is technically sound.
519	**Pollution Prevention Assessment of the Office of the State Printer** (1991, 42 pp.) Provides the findings of a pollution prevention assessment of the State Printing Plant and can serve as a waste minimization guideline for printers in California.
521	**Waste Minimization: Small Quantity Generators at Los Angeles International Airport** (1990, 49 pp.) Summarizes the results of a study that involved visits to five representative small-quantity generators and targeted waste minimization of used oil and jet fuel, cleaning operations, and paint stripping.

WASTE STREAM SPECIFIC INFORMATION

Order #	Title
511	**Metal Waste Management Alternatives—1989 Symposium Proceedings** (1989, 252 pp.) Contains papers delivered at two symposia in September 1989. The papers discuss metal waste disposal restrictions and alternatives to disposal such as waste prevention and current recycling technologies.
513	**Reducing California's Metal-Bearing Waste Streams** (1989, 174 pp.) Analyzes alternatives to land disposal of California's hazardous metal waste streams and focuses on methods that prevent waste generation. Source reduction, recycling, and treatment strategies are examined.
604	**Guide to Oil Waste Management Alternatives for Used Oil, Oily Wastewater, Oily Sludge, and Other Wastes Resulting from the Use of Oil Products—Final Report** (1988, 220 pp.) Presents the results of a study of oil waste management alternatives. Includes regulations, established and emerging technologies, current practices, economics and environmental impacts of oil waste management.
606	**Guide to Solvent Waste Reduction Alternatives—Final Report** (1986, 222 pp.) Practical waste management alternatives to land disposal that have potential for reducing the amount and/or toxicity of solvent waste generated.

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LOCAL GOVERNMENT

Order #	Title
507	**Hazardous Waste Reduction: A Step-by-Step Guidebook for California Cities** (1992, 180 pp.) Outlines the essential elements of a successful city run, multimedia waste minimization program. It is designed to walk the user through the steps the city can take to implement and reduce hazardous materials use and hazardous waste typically generated by city operations.
520	**Waste Minimization Opportunities for Selected City of Los Angeles Hazardous Waste Generating Operations** (1990, 143 pp.) Summarizes a joint effort between the City of Los Angeles and the DTSC to identify and evaluate waste minimization opportunities for selected city operations.
509	**Low Cost Ways to Promote Hazardous Waste Minimization: A Resource Guide for Local Governments (Includes Resource Appendix B)** (1988, 102 pp.) Explains why and how to set up an educational outreach program. Provides complete resource listings for 28 low-cost activities. Model resolution, useful tables, and informative appendices are included.
512	**Minimizing Hazardous Wastes: Regulatory Options for Local Governments** (1989, 94 pp.) Describes regulatory framework that can be used to promote hazardous waste minimization at the local level in California. Explores the role of direct requirements, indirect regulatory inducements, and positive incentives. Model resolution and useful appendices included.
514	**Reducing Industrial and Commercial Toxic Air Emissions by Minimizing Waste—The Role of Air Districts** (1990, 120 pp.) Designed to assist Air Pollution Control Districts in reducing toxic air emissions and explains how waste minimization results in lower toxic air emissions.
515	**Reducing Industrial Toxic Wastes and Discharges: The Role of POTWs** (1988, 101 pp.) Explains importance of POTW (Publicly Owned Treatment Works) involvement in hazardous waste minimization. Provides educational and technical assistance and regulatory options for reducing hazardous pollutants. Model resolution and useful appendices are included.
523	**Final Report—Source Reduction and Technical Assistance Program** (1992, 40 pp.) Describes the effort to develop a program to train a city's planning and building inspection staff to recognize industries that will generate hazardous waste so they can refer businesses to a technical assistance program. The project had mixed success and contains valuable recommendations for other agencies considering similar programs.

FURTHER WASTE MINIMIZATION INFORMATION

Order #	Title
505	**Hazardous Waste Minimization Bibliography** (1991, 76 pp.) References are organized in four sections: (1) general hazardous waste minimization topics, (2) industry-specific, (3) material-specific, and (4) available abstracts from the previous three sections. All references are listed in alphabetical order by title.
506	**Incinerable Hazardous Waste Minimization Project Fact Sheet** (1992, 8 pp.) Provides an interim update for the project using 1990 data taken from the manifest system.
508	**Incinerable Waste Minimization Workshops Proceedings** (1991, 251 pp.) A compilation of the papers presented at two workshops held in January 1991. Areas covered include: regulations, source reduction, recycling strategies and opportunities, alternative technologies for petroleum refineries, electronics industry, aerospace industry, and chemical and paint manufacturers.
510	**No-Waste Lab Manual for Educational Institutions** (1991, 115 pp.) A laboratory manual for introductory chemistry courses incorporating procedures that produce little or no toxic waste. This is accomplished by the use of consecutive chemical reactions so that the production of one reaction is used as the starting material for the next.
517	**Waste Minimization for Hazardous Materials Inspectors: Introductory Text with Self-Testing Exercises (Module I), Assessment Procedures (Module II, Unit 1), and Metal Finishing Industry (Module III)** (1991, 182 pp.) Module I is written for use by both experienced and novice hazardous materials inspectors who wish to learn more about hazardous waste minimization. Module II provides basic information in conducting a self-assessment, and Module III focuses on some of the viable waste minimization alternatives for certain metal finishing operations. (Videotape also available—See Order #1500)
518	**Waste Minimization Assessment Procedures: For the Generator (Module II, Unit 2)** (1991, 81 pp.) Provides the hazardous waste generator with procedures for conducting a self-assessment and introduces the provisions of Senate Bill 14, the Hazardous Waste Source Reduction and Management Review Act of 1989.
525	**Working With Small Businesses—A Case Study in Developing a Small Business Pollution Prevention Program** (1993, 73 pp.) Developed by the City of Anaheim Public Utilities and Fire Departments and DTSC to assist small business owners and operators in dealing with a variety of environmental issues.

RESOURCE RECOVERY—*Information on the use, reuse, or reclamation of hazardous constituents.*

Order #	Title
600	**California Waste Exchange Directory** (1993, 50 pp.) Listing of commercial recyclers.
602	**California's Compilation of Hazardous Waste Recycling Laws** (1992, 17 pp.) Lists excerpts from the California Hazardous Waste Control Law specific to recycling in California. Laws specific to the recycling of used oil are not included.

WASTE EVALUATION—*Evaluations of waste to determine whether they are hazardous based on interpretive guidance of Federal and California criteria.*

Order #	Title
700	**Regulation of Ethylene Glycol Wastes in California: A Regulatory Interpretation** (1991, 27 pp.) Provides the DTSC interpretation of existing statutory and regulatory authority as it pertains to ethylene glycol.

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LAND DISPOSAL INFORMATION

Order #	Title
850	**Land Disposal Restrictions Bulletins** (April 1990, September 1990, March 1991, and December 1992, 14 pp.) An update on California's Treatment Standards and Land Disposal Restrictions.
851	**Cleanup Wastes Under RCRA/Non-RCRA** (1991, 174 pp.) A guidance document on Federal and State land disposal restrictions for wastes generated from site remediation, corrective action, or other types of cleanup activities.
852	**Land Disposal Restrictions Handbook** (1992, 101 pp.) Provides an overview of the Land Disposal Restrictions (LDRs) for hazardous waste. It serves as a guide to the requirements and treatment standards associated with these restrictions and contains general information about the variances and exemptions available under this program.
853	**Guidance Manual: Petitioning for Treatability Variance from Hazardous Waste Treatment Standards** (1991, 173 pp.) A treatability variance can be issued if the hazardous waste cannot be treated to meet treatment standards due to technical reasons. This document outlines essential information that must be included in the variance application.

HAZARDOUS WASTE DATA AND INFORMATION ANALYSIS

Order #	Title
900	**California's Exports and Imports of Hazardous Waste—1986 to 1988** (1990, 162 pp.) Looks at California's interstate and international shipments of hazardous waste from 1986-1988. International shipments are focused mainly on maquiladora waste (waste from American companies operating in Mexico).
901	**California's Nonrecurrent Hazardous Waste Reports** (1990, 148 pp.) One hundred seventy-six sites for nonrecurrent hazardous waste are described through a variety of narration, data tables, and graphs to illustrate methods used by the DTSC to manage this source of hazardous waste. The historical and current status data were utilized to project future quantities of nonrecurrent hazardous waste generated and treated over the next 20 years.
902	**Commercial Hazardous Waste Facilities for Recycling, Treatment, and Disposal** (1993, 120 pp.) Directory to assist California hazardous waste generators, industry, and the general public in assessing the current recycling, treatment, and land disposal options available in California and other states. The directory offers suggestions for locating commercial recycling/treatment/disposal facilities.

PLANNING—*Evaluations of waste generators, facilities, and future needs.*

Order #	Title
1000	**Capacity Assurance Plan for Hazardous Waste Management** (1989, 126 pp.) Outlines the program that California will follow to meet its integrated hazardous waste management needs in accordance with the Federal government's requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
1001	**Status Report on Hazardous Waste Management in California — A Draft Report** (1989, 143 pp.) Summarizes the quantities of hazardous waste generated in California industry, government, and households for the year 1987. A large fraction of this waste was recycled. Future projections for the year 1995 show that adequate capacity is expected to exist in each hazardous waste management category except incineration.

GRANTS—*Findings of DTSC Grant Projects.*

Order #	Title
1101	**California Hazardous Waste Reduction Grant Program—Grant Application Manual (Updated Annually)** (1994, 56 pp.) Provides information on how to submit a properly prepared application to the California Hazardous Waste Reduction Grant Program that is managed by the Office of Pollution Prevention and Technology Development.
1102	**Hazardous Waste Reduction Technology Research, Development, and Demonstration Grant Program** (1993, 1 p.) Brief description of the Grant Program. Fifteen to twenty grants are usually awarded each year.
1155	**Hazardous Waste Reduction Program Abstracts (1985-1991)** (94 pp.) A compilation of the abstracts from the Hazardous Waste Reduction Grant projects completed since 1985. Over 125 projects have received funding totaling over $7 million. The compiled abstracts serve to transfer technology awareness to industry, consultants, regulators, and the public.

BIENNIAL REPORTS TO THE CALIFORNIA STATE LEGISLATURE

Order #	Title
1206	**Alternative Technologies for Recycling and Treatment of Hazardous Wastes (Third Biennial)** (1986, 186 pp.) It is a guide for hazardous waste generators seeking alternative waste management techniques and serves as a resource for the public and policy makers in government and industry. The technologies and economics described are critical considerations for the formulation of California's hazardous waste management policy.
1203	**Economic Implications of Waste Reduction, Recycling, Treatment and Disposal of Hazardous Wastes (Fourth Biennial)** (July 1988, 126 pp.) Reports on the cost/benefit of reducing hazardous waste in industry. Cost comparisons of site mitigation activities, industry waste minimization, and future liabilities of hazardous waste disposal are discussed.
1202	**Alternative Technologies for the Minimization of Hazardous Waste (Fifth Biennial)** (1990, 140 pp.) Reports on activities relating to innovative hazardous waste minimization, recycling, and treatment technologies.
501	**Pollution Prevention in California—An Overview of California's Pollution Prevention Programs (Sixth Biennial)** (1992, 110 pp.) An overview of California's multimedia pollution prevention programs at the State and local government levels. Industry pollution prevention case studies show how business responds to the pressure to reduce wastes.

ALTERNATIVE TECHNOLOGY—*New and innovative alternative technologies.*

Order #	Title
1200	**Application of the Polysilicate Technology to Heavy Metal Wastestreams** (1987, 33 pp.) The polysilicate treatment technology has been applied to a variety of waste streams containing heavy metals. It differs from conventional forms of solidification/fixation/stabilization by forming a metal metasilicate as a by-product. It is still semi-empirical in nature and requires further research.

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ALTERNATIVE TECHNOLOGY
(continued)

1201 **Final Report on CCBA (Coordinate Chemical Bonding Project) Phase III** (1988, 24 pp.)
The goal of this successful project was to demonstrate that when mixing industrial sludges containing metal ions with highly absorptive clay, in proper proportions and at elevated temperatures, the metal ions will fuse into the clay's silica structure and render the resulting material nonhazardous.

1204 **Laboratory Scale Tests of the Circulating Bed Combustion of Spent Potliners—Final Report (Includes Project Summary)** (1988, 76 pp.)
Spent potliner (SPL) is a solid waste by-product of aluminum smelters that contains soluble species of cyanides and fluorides. The circulating bed combustor process treats SPL reducing both cyanide and leachable fluoride levels by specialized thermal treatment processes.

1207 **UV/Hydrogen Peroxide Treatment for Destruction of Pesticide Laden Waste—Final Report (Includes Project Summary)** (1987, 30 pp.)
This system has been reported to be effective in degrading organic contaminants in water by a chemical oxidation process. The study focuses on the destruction of low level, aqueous pesticide wastes.

1208 **UV/Ozone Treatment of Pesticides and Groundwaters** (1988, 36 pp.)
A discussion of a demonstration project using the Ultrox Ultraviolet light enhanced oxidation technique for a variety of organic contaminants including pesticides, halogenated compounds, phenols, benzene, and other aromatics.

1209 **Composting for Treatment of Pesticide Rinseates—Final Report (Includes Project Summary)** (1988, 63 pp.)
This study tests the viability of aerobic composting as a treatment option for low level pesticide wastes previously stored in evaporation ponds or in a landfill.

1215 **The Construction and Assessment of a Biological System for Biodegradation and Recycling of Pesticide Waste** (1993, 57 pp.)
Experimental results and data of a biologically based, electromechanical system that uses horse manure as a source of microbes to biodegrade pesticide waste.

1216 **Pesticide Rinsates: Biodegradation Technology (Technology Brief)** (1993, 4 pp.)
Describes a biologically based, electromechanical system that uses horse manure as a source of microbes to biodegrade pesticide rinsates.

1210 **Chlorinated Solvent Recovery from Groundwater Using Contaminated Ambersorb XE-340 Carbonaceous Resin Adsorbent—Final Report (Includes Project Summary)** (1991, 7 pp.)
Presents findings and conclusions of using Ambersorb XE-340 carbonaceous resin adsorbent to remove 1,1,1-trichloroethane (TCA) and trichloroethylene (TCE) from groundwater.

1211 **Reclamation of Waste Foundry Sands: Fresno Valves and Castings, Inc. Waste San Reclamation Project** (1992, 4 pp.)
Describes a project involving the reconditioning and reuse of most of the waste sand.

1212 **Alternative Technology Demonstration Project Report—Use of Kerr McGhee Chemical Corporation Boiler Fly Ash as a Feedstock in the Manufacturing of Southwestern Portland Cement**
This project determined that the use of Kerr McGhee fly ash as an ingredient in the manufacture of Portland Cement resulted in a cement product that effectively stabilized hazardous levels of nickel and vanadium present in the ash ingredient.

1213 **Alternative Technology Demonstration Project Report—Separation of Phosphor Powder, Glass and Endcaps to Enable Recycling of Spent Fluorescent Lamp Tubes** (1993, 12 pp.)
A full-scale demonstration of this effective system was conducted with Mercury Technologies, Incorporated.

1214 **Water Based Ink Wastes: Biodegradation Technology (Technology Brief)** (1993, 4 pp.)
Describes a biologically based electromechanical system that uses horse manure as a source of microbes to biodegrade water based ink wastes.

1217 **California Environmental Technologies and Services Directory** (updated annually) (1993, 272 pp.)
The Directory consists of an alphabetical listing of over 1,100 California environmental companies and a series of technology matrices giving detailed information about the company's involvement in the environmental industry.

TREATMENT STANDARDS—*Treatment standards established by the U.S. EPA pursuant to the Resource Conservation and Recovery Act (RCRA) will be adopted by the DTSC for RCRA wastes. The DTSC is developing treatment standards for non-RCRA wastes. The following treatment standards reports are available:*

Order #	Title
800	Proposed Treatment Standards for Metal-Containing Aqueous Wastes (1988, 312 pp.)
801	A Proposed Treatment Standard for Non-RCRA Aqueous and Liquid Organic Waste Vol. I & II (1990, 73 pp.)
802	Treatment Standards for Asbestos-Containing Wastes (1990, 62 pp.)
803	Treatment Levels for Auto Shredder Wastes (1989, 88 pp.)
804	Treatment Standards for Foundry Sand (1989, 101 pp.)
805	Treatment Standards for Non-RCRA Fly Ash, Bottom Ash, Retort Ash, Baghouse Waste, and Gas Scrubber Waste (1990, 131 pp.)
806	Landfill Criteria for Nonliquid Hazardous Waste (1988, 109 pp.)
808	Treatment Standards for Non-RCRA Organic Containing Petroleum Hazardous Wastes (1992, 220 pp.)
809	Development of Treatment Standards for Non-RCRA Solvent Waste (1989, 99 pp.)
810	Treatment Standards for PCB Wastes (1988, 142 pp.)
812	Implementation of SB 2093, Chapter 1417, Statutes of 1988, Health and Safety Residuals Repository (1990, 82 pp.)
813	Proposed Treatment Standards for Solid Wastes with Metals (1989, 195 pp.)
814	Treatment Standards for Solids with Organics (1991, 63 pp.)
815	Treatment Standards for Liquid Redox Waste (1990, 98 pp.)

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REMEDIAL TECHNOLOGY DEMONSTRATION REPORTS—*Independent technical evaluations of new, innovative, hazardous waste remedial technologies. Reports include details of bench-, plot-, or full-scale demonstration projects. The findings result in a Department conclusion regarding the project feasibility and provide the technical basis for any future permits for commercial operation. Reports are grouped by type of treatment.*

Order #	Title

BIOLOGICAL

1300 Above-Ground Bioremediation of Biphenyl and Diphenyl Oxide Contaminated Soil (1991, 8 pp.)
Two pilot-scale demonstrations were conducted to evaluate the effectiveness of above-ground bioremediation of soil contaminated with a mixture of biphenyl and diphenyl oxide. The tests demonstrated that the addition of water and nutrients, and the tilling of the soil reduced the concentrations of the contaminants by about 50-60 percent with or without the addition of exogenous bacteria.

1303 Biological Remediation of a Fuel Contaminated Soil Site in Carson, California—Protek Environmental, Inc. (1990, 7 pp.)
Diesel fuel-contaminated soil was biologically treated above ground in treatment cells. Total petroleum hydrocarbons were reduced from 1,064 mg/kg to 2 mg/kg in 90 days in the treatment cells. Similar removal occurred in the control cell.

1304 Bioremediation of Used Oil-Contaminated Soil at Two Caltrans Maintenance Yards—Groundwater Technology Corporation (1990, 10 pp.)
Provides results for full-scale bioremediation at two sites. At one site, a single pile was treated with an aqueous nutrient solution and passive aeration. At the second site, one pile was treated with an aqueous nutrient solution and active aeration while a second pile was used as a control. All piles showed some removal of hydrocarbons.

CHEMICAL

1305 Chemical Reduction of Hexavalent Chromium Contaminated Soils for a Site in Bakersfield, California (1991, 6 pp.)
Full-scale tests were conducted to determine the effectiveness of a chemical reduction process to treat hexavalent chromium-contaminated soils. The process was successful at reducing the concentration levels of hexavalent chromium by an average of 95.8 %.

1306 Hydrogen Peroxide/Catalyst Oxidation Process from a Gasoline Contaminated Site in Fullerton, California—Ensotech, Inc. (1990, 20 pp.)
Full-scale field tests were conducted to evaluate the effectiveness of Ensotech, Inc.'s hydrogen peroxide/catalyst process to treat soil contaminated with gasoline from a leaking underground fuel tank. Test results show significant reductions in gasoline concentrations in soil but no significant difference between the Ensotech process and the control.

PHYSICAL

1301 AquaDetox/SVE Integrated System for Groundwater and Soil Contaminated with Volatile Organic Compounds in Burbank, California (1991, 22 pp.)
An evaluation of the AquaDetox/Soil Vapor Extraction (SVE) Integrated System developed by AWD Technologies, Inc. The evaluation included calculating the contaminant removal efficiencies of the AquaDetox and SVE systems separately. The AquaDetox system removed 99.87 percent of the volatile organic compounds from the contaminated groundwater. The SVE system removed 99.65 percent of the volatile organic compounds from the air that was vacuum extracted from the contaminated soil.

1313 Soil Washing Technology for Low Volatility Petroleum Hydrocarbons—Verl's Construction Company (1990, 6 pp.)
A full-scale field demonstration of a portable soil washing system owned and operated by Verl's Construction Company was conducted at the Peterson Tractor site in San Leandro, California. Removal efficiencies of oil and grease as high as 71% were measured during a single pass through the washer.

STABILIZATION

1302 Bench-Scale Demonstration of a Metal Stabilization Process for a Site in Commerce, California—Silicate Technology Corporation (1990, 8 pp.)
Bench-scale tests were conducted to evaluate the effectiveness of Silicate Technology Corporation's process to stabilize soluble metals in lead contaminated soil from a hazardous waste site. The treated soils showed significant reductions in soluble lead concentrations.

1307 Metal Stabilization Process for Municipal Waste-To-Energy Ash—Lassen College (1990, 15 pp.)
A three-part demonstration was conducted to evaluate the effectiveness of a sodium silicate/cement-based process used to stabilize heavy metal contaminated fly and bottom ash generated by a municipal solid waste-to-energy cogeneration facility. Results show the process has the potential to reduce soluble heavy metal concentration to below the California regulatory limits.

1308 Portland Cement Stabilization Process for Lead-Contaminated Soil (1991, 7 pp.)
Six cubic-foot batches of lead-contaminated soil were treated with differing ratios of Portland Cement. Average soluble lead concentrations were significantly reduced.

1310 Silicate Stabilization Process for Heavy Metal Contaminated Soil at the Tamco Steel Site—Solids Treatment Systems, Inc. (1990, 7 pp.)
A full-scale demonstration of a silicate stabilization process was conducted. Soil contaminated with lead, zinc, and cadmium were treated by the Trezek or Lopat process. All leachable metal concentrations were reduced to below their respective hazardous waste thresholds.

1314 A Stabilization Process for Soils Contaminated with Metals and Petroleum Hydrocarbons—Benz/Gabbita Consulting Services (1990, 10 pp.)
Bench-scale demonstration tests evaluated the effectiveness of a stabilization process to treat lead and petroleum hydrocarbons in a soil matrix. The ability of the process to stabilize total petroleum hydrocarbons could not be confirmed.

1315 Sulfide Stabilization Technology for Copper-Contaminated Soil—Toxco Incorporated (1990, 7 pp.)
Copper-contaminated soil was treated with a sulfide precipitation process that created reactive sulfides at levels that classified the treated soil as a RCRA waste. The pH was above the hazardous waste threshold of 12.5.

THERMAL

1311 Soil Cleanup System for a Diesel Contaminated Site in Kingvale, California—Earth Purification Engineering, Inc. (1990, 15 pp.)
Full-scale field tests were conducted to determine the effectiveness of Earth Purification Engineering Inc.'s Soil Cleanup System to treat diesel fuel contaminated soil and to estimate the level of stack air emissions from the treatment. The system was successful at removing the diesel contamination from the soil, but did not achieve good destruction of the diesel in the stack gases.

1312 Soil Detoxification Utilizing an Existing Aggregate Drier—South Coast Asphalt Products Company (1990, 3 pp.)
Simple feasibility tests using an existing rotary drier at an asphalt batch plant were coordinated in 1986. Results of the demonstration indicated high gasoline removal but poor combustion of the gasoline vaporized from the soil.

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REMEDIAL TECHNOLOGY DEMONSTRATION REPORTS—THERMAL (continued)

1316 Thermal Treatment of Hydraulic Fluid Contaminated Soil (1991, 12 pp.)
Tests were conducted to determine the effectiveness of U.S. Waste Thermal Processing's Mobile Thermal Processor, Model 100, to treat hydraulic fluid-contaminated soil and to measure the level of stack air emissions from the treatment. The Model 100 successfully removed hydraulic fluid from the soil and achieved good destruction and removal of the contaminants from the stack gases.

1317 Thermal Treatment of Petroleum Hydrocarbon-Contaminated Soil (1991, 42 pp.)
A demonstration of Ogden Environmental Services' Circulating Bed Combustor for the remediation of soil contaminated with fuel oil #6 was conducted. Total petroleum hydrocarbons in the treated soil (bed and fly ash) were below or slightly above the U.S. EPA Method 418.1 detection limit of 5 parts per million.

1318 Thermal Treatment Process for a Diesel-Contaminated Site in San Diego, California (1991, 14 pp.)
A full-scale field test was conducted to determine the effectiveness of Earth Purification Engineering, Inc.'s Soil Cleanup System to treat diesel fuel-contaminated soil. The system successfully removed the diesel contamination from the soil to below the established cleanup level of 1,000 mg/kg.

1319 Thermal Treatment Process for Fuel Contaminated Soil—U.S. Waste Thermal Processing (1990, 30 pp.)
Tests were conducted to determine the effectiveness of a mobile thermal processing unit to treat petroleum fuel contaminated soil. The tests were successfully performed on synthetically prepared gasoline and diesel contaminated soil.

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OTHER REMEDIAL TECHNOLOGY INFORMATION

Order #	Title
1350	**Remedial Technology Applications Matrix for Soils and Sludges** (1991, 16 pp.) The Remedial Technology Applications Matrix was developed to identify treatment technologies applicable to treating contaminated soils and sludges that should be considered for hazardous waste site cleanup.
1351	**Site Cleanup Treatment Technologies** (1992, 82 pp.) Designed to provide "Superfund" site managers, engineers, and planners with current information on the capability and availability of treatment systems to remediate hazardous waste sites. The summary information was obtained from the responses to the 1991 Solicitation of Interest (SOI) as part of the Remedial Technology Assessment Program (RTAP). The responses are from treatment technology developers and vendors who have, or are in the process of, developing treatment systems applicable to site remediation.

VIDEOS

SOURCE REDUCTION

Order #	Title	Price
1400	**Hazardous Waste Minimization: Planning for Success** (1991, 3 hours, 2 tapes) An interactive videoconference on SB 14: The Hazardous Waste Source Reduction and Management Act of 1989.	25.00

WASTE MINIMIZATION

Order #	Title	Price
1500	**Waste Minimization for Inspectors (Videotape of a slide show)** (1991, 44 minutes) A three-section videotape of a slide show that provides a basic introduction to waste minimization and assessment procedures, and an excellent overview of waste minimization processes involved in metal cleaning, metal finishing, and printed circuit board manufacturing.	15.00
1501	**Why Waste?: Waste Minimization for Today's Businesses** (1990, 28 minutes) Defines waste minimization and illustrates waste minimization successes in several different types of businesses. Source reduction and recycling case studies illustrate the environmental and economic benefits of implementing waste minimization programs. Is useful for training sessions and seminars focusing on innovative ways for reducing hazardous waste.	15.00

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B. POLLUTION PREVENTION PROGRAM:

FEDERAL POLLUTION PREVENTION ACT OF 1990

HAZARDOUS WASTE SOURCE REDUCTION AND MANAGEMENT REVIEW ACT

POLLUTION PREVENTION 1993: A YEAR IN REVIEW

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C. STORM WATER PROGRAM

i. List of Agency Contacts
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C. STORM WATER PROGRAM:

CLEAN WATER ACT

CODE OF FEDERAL REGULATIONS; TITLE 40; PARTS 122, 123, 124

GENERAL PERMIT FOR STORM WATER DISCHARGES ASSOCIATED WITH INDUSTRIAL ACTIVITY

SANTA ANA REGIONAL WATER QUALITY CONTROL BOARD QUESTION AND ANSWER DOCUMENT FOR THE GENERAL INDUSTRIAL STORM WATER PERMIT

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Storm Water Contacts for the State and Regional Boards

STATE WATER RESOURCES CONTROL BOARD
Division of Water Quality Regional Water
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977
(916) 657-0919 FAX: (916) 657-2388
Contact: Bruce Fujimoto

1) NORTH COAST REGION
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2) SAN FRANCISCO BAY REGION
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4) LOS ANGELES REGION
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5S) CENTRAL VALLEY REGION
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THIS ATTACHMENT REPLACES:

- Attachment 2 of the Industrial Permit Package
- Attachment 1 of the Construction Permit Package
- Attachment 1 of the Group Monitoring Plan Instructions
- Attachment 1 of the Annual Report for Industrial Activities

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Miscellaneous

- Environmental Impacts of Stormwater Discharges, a National Profile (EPA 841-R-92-001, June 1992)
- Ninth Circuit United States Court of Appeals Opinion regarding AMC v. EPA, (May 27, 1992) and NRDC v. EPA, (June 4, 1992)
  - Ninth Circuit Storm Water Decision Fact Sheet (September 3, 1992)
- Phase II Deadline Extension Fact Sheet (December 3, 1992)
- Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity (EPA, July 1991)
- Typical Values of Annual Storm Events Statistics for Rain Zones of the United States ("Urban Targeting and BMP Selection", EPA Region V, November 1990)
- List of EPCRA (SARA Title III) Section 313 Water Priority Chemicals
- List of Reportable Quantities for Hazardous Substances Under CERCLA
- State NPDES Program Status (October 1992)
- List of State and EPA Regional Storm Water Contacts (April 1993)
- List of Storm Water Related Resources (i.e., other hotlines, clearinghouses, electronic bulletin boards, catalogs, and libraries)
- Urban Runoff Management Information/Education Products (Version 1)

Forms

- Form 1 (general information)
- Form 2F (storm water discharges)
- Form 2C (process wastewater discharges)
- Form 2E (non-process wastewater discharges)
- Form 2D (new sources)
- Notice of Intent (NOI)
- Notice of Termination (NOT)

NOT Available Through the Hotline

- Storm Water Management for Industrial Activities, Developing Pollution Prevention Plans and Best Management Practices (EPA-832-R-92-006, September 1992)
  - Call NTIS (703) 487-4650, order number PB 92-235969 ($35), or
  - Education Resource Information Center/Clearinghouse (614) 292-6717, order number 477N ($26.75)
- Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices (EPA-832-R-92-005, September 1992)
  - Call NTIS (703) 487-4650, order number PB 92-235951 ($35), or
  - Education Resource Information Center/Clearinghouse (614) 292-6717, order number 482N ($22.50)
- Guidance Manual for the Preparation of NPDES Permit Applications for Storm Water Discharges Associated with Industrial Activity (EPA-505/8-91-002, April 1991)
  - Call NTIS (703) 487-4650, order number PB 92-199058 ($35)
- Guidance Manual for the Preparation of Part 1 of the NPDES Permit Applications for Discharges From Municipal Separate Storm Water Systems (EPA -505/8-91-003A, April 1991)
  - Call NTIS (703) 487-4650, order number PB 92-114578 ($35)
- Investigation of Inappropriate Pollutant Entries Into Storm Drainage Systems, A User's Guide (EPA/600/R-92/238, January 1993)
  - Call the Center for Environmental Research Information (513) 569-7562

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VII LIST OF FIGURES

1. HOW GOVERNMENT TRACKS THE LIFE OF A CHEMICAL
2. THE HAZARDOUS WASTE AND WATER QUALITY FEDERALLY MANDATED PROGRAMS
3. ENVIRONMENTAL PERMITS REQUIRED OF GENERATORS, AND TSDF'S
4. TYPES OF HAZARDOUS WASTE PERMITS
5. TYPES OF WATER QUALITY PERMITS
6. POLLUTION PREVENTION HIERARCHY
7. CATEGORIES OF INDUSTRIES REQUIRING COVERAGE UNDER THE GENERAL INDUSTRIAL STORM WATER PERMIT

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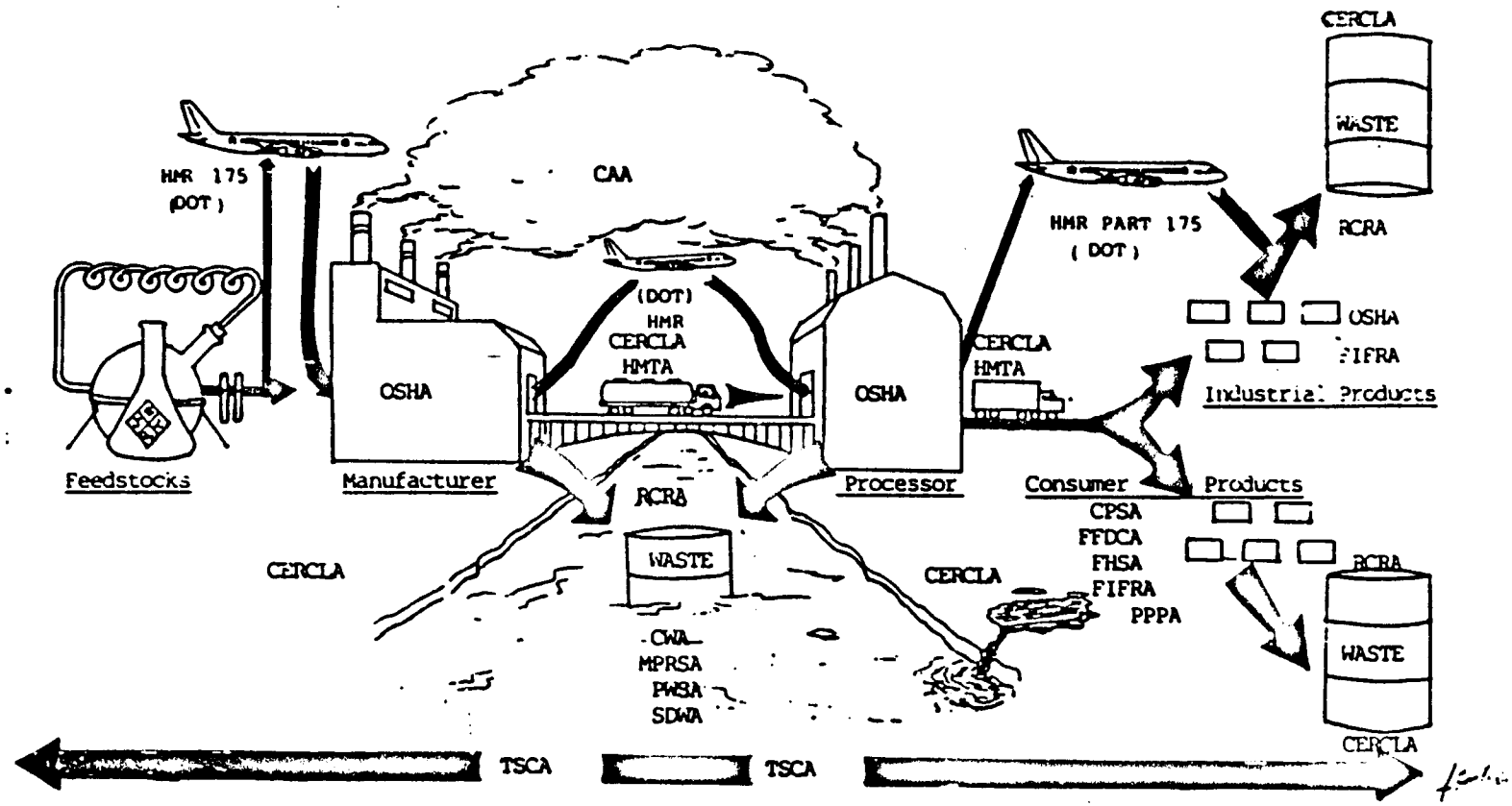
FIGURE 1

HOW GOVERNMENT TRACKS THE LIFE OF A CHEMICAL



CAA = CLEAN AIR ACT
CPSA = CONSUMER PRODUCT SAFETY ACT
CWA = CLEAN WATER ACT
FFDCA = FED. FOOD DRUG & COSMETIC ACT
FHSA = FED. HAZARDOUS SUBSTANCES ACT
FIFRA = FED. INSECTICIDE FUNGICIDE & RODENTICIDE ACT
CERCLA = COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION & LIABILITY ACT

HMTA = HAZARDOUS MATERIALS TRANSPORTATION ACT
MPRSA = MARINE PROTECTION RESEARCH & SANCTUARIES ACT
OSHA = OCCUPATIONAL HEALTH & SAFETY ACT
PPPA = POISON PREVENTION PACKAGING ACT
PWSA = PORTS & WATERWAYS SAFETY ACT
RCRA = RESOURCE CONSERVATION & RECOVERY ACT
TSCA = TOXIC SUBSTANCES CONTROL ACT
SDWA = SAFE DRINKING WATER ACT
HMR = Hazardous Materials Regulation Part 175
DOT = Department of Transportation regulations

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FIGURE 2

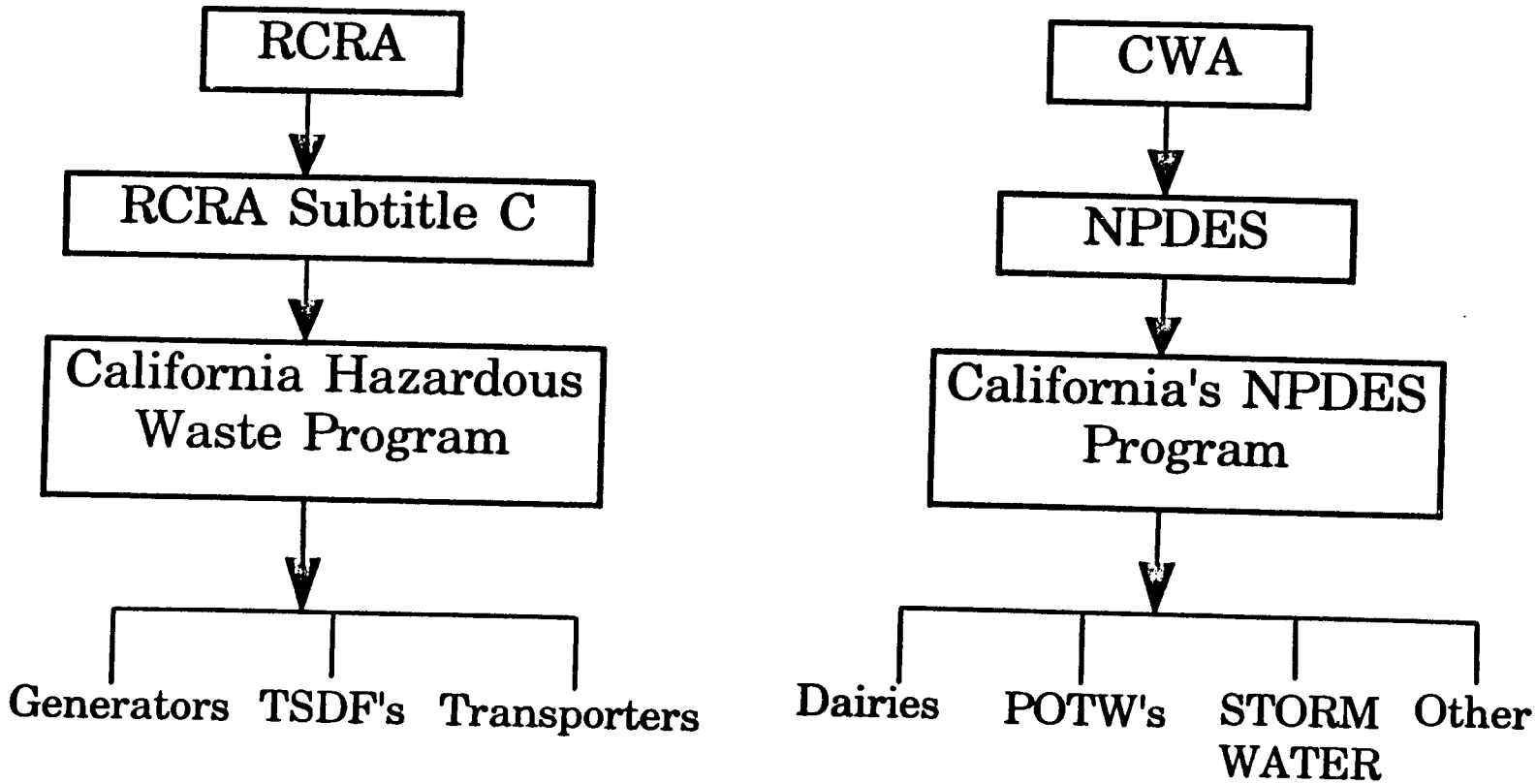

FIGURE 3

ENVIRONMENTAL PERMITS REQUIRED

HAZARDOUS WASTE GENERATORS AND TREATMENT AND DISPOSAL FACILITIES

PERMIT	LEGAL AUTHORITY	AGENCY CONTACT	COVERED ACTIVITY	REQUIREMENT
Hazardous waste generator activity notification (EPA ID No.), Local agency Permit, & General Storm Water Permit if Generators' SIC is listed in the regulations or Individual NPDES or WDR Permit if discharges to surface water, ground water or land occur.	RCRA Subtitle C, 40 CFR, CA Health and Safety Code, CCR Title 22, Title 23, Porter Cologne, and 40 CFR Part 122, 123, & 124	DTSC, Local environmental agency (DEHS, EMA, etc), RWQCB or SWRCB	Generation of hazardous waste and storage less than 90 days before transport. For Example: Dry Cleaners, Manufacturing Companies, Auto body and Auto Repair Shops, Photo Processors, Printing Operations. Also, areas that may be exposed to storm water	Generator must first obtain an EPA ID No., complete manifest forms before shipping waste off-site, complete annual report, and waste minimization report where applicable. Also completion of NOI, development of SWPPP, and Monitoring Plan
Permit by Rule (PBR), & General Industrial Storm Water Permit if facilities SIC is listed in the regulations or Individual NPDES or WDR Permit if discharges to surface water, ground water or land occur.	CA Health and Safety Code, CCR Title 22, Title 23, Porter Cologne, and 40 CFR Part 122, 123, & 124	DTSC, Local sewering agency, and RWQCB, or SWRCB	On-site treatment of hazardous waste, utilizing simple hazardous waste pretreatment for fixed or transportable treatment technologies. For example, metal precipitation, neutralization, bioremediation, etc. Also, areas that may be exposed to storm water	Requires meeting a series of requirements such as corrective action and financial responsibility in order to operate a pretreatment fixed or transportable treatment unit. Also completion of NOI, development of SWPPP, and Monitoring Plan
RCRA TSDF Permit or non-RCRA TSDF Permit, and the General Industrial Storm Water Permit or Individual NPDES or WDR Permit if discharges to surface water, ground water or land occur.	RCRA, 40 CFR, Health and Safety Code, CCR Title 22, Title 23, Porter Cologne, and 40 CFR Part 122, 123, & 124	DTSC and RWQCB, or SWRCB	Storage of hazardous waste on-site for more than 90 days, treatment, and disposal of hazardous waste on-site. For example: Incinerators, commercial off-site facilities, etc. Also, areas that may be exposed to storm water	Two part application: A: General information, and B: Specific operation, design, safety, financial assurance, and closure plans. Also completion of NOI, development of SWPPP, and Monitoring Plan

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FIGURE 4

PERMITTING HIERARCHY (and Related Fee Rates)	Affected Businesses
1. Full Permit (fee rates vary by size and type of facility)	All RCRA facilities, incinerators, and land disposal
2. Standardized Permit (fee rates same as full, vary by size and type of facility)	All non-RCRA commercial off-site Treatment and storage 25201.6
3. PBR ($1,140 a year plus one-half fee for amendments, Annual inflation adj.)	Specified non-RCRA onsite facilities 67450.11
4. Conditional Authorization ($1,140 a year plus one-half fee for amendments, Annual inflation adj.)	Many PBR eligibles If listed physical trtmt process low concentration (750 ppm) Quantity limit for some waste <5,000 gal/45,000 lbs/month
5. Conditional Exemption ($100 initial year, $50 a year thereafter)	All PBR eligible under 55 gals/500 lbs/ month 25201.5, plus specified wastes/treatment processes

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FIGURE 5

WATER QUALITY

PERMIT	LEGAL AUTHORITY	CONTACT	COVERED ACTIVITY	REQUIREMENTS
Sewer Discharge Permits (Including extensions and connection)	Water Clean Water Act 40 CFR Local Ordinance	Local Sewering Agencies and /or City Public Works Agency	Discharge of non-domestic waste-water to municipal sewer system, construction or maintenance of sewer extensions. *For Example: Metal Plating Shops Carwashes,Photoprocessors,Hospitals, Pharmaceutical Companies*	Discharge of pollutants to municipal sewer system and adherence to allowed pollutant limitations and flow levels, construction and maintenance of extensions in accordance with design specifications.
Storm Water Discharge Permits (NPDES)	Water Clean water Act CA Water Code 40 CFR CCR Title 22 CCR Title 23	SWRCB,RWQCB, US EPA Region 9	Discharge of industrial, agricultural & commercial runoff from non-point sources to storm drains, Channels, Tributaries,Rivers. *For Example: Construction Sites, City Yards, Agricultural Operations*	Monitor quality of storm water;operate under Best Management Practices (BMP) to minimize storm water pollutants.
Waste Discharge Requirement (WDR)	Water Clean Water Act 40 CFR CA Water Code CCR Title 22 CCR Title 23	RWQCB DEHS(Septic tanks)	All waste water discharges to the ground. *For Example: POTWs, Manufacturing, Industrial Agricultural and Commercial Facilities. (includes septic systems)*	Establishes effluent standards and requires monitoring reports.
Surface Water Discharge Permit (NPDES)	Water Clean Water Act 40 CFR, CA Water Code, CCR Title 22 CCR Title 23	RWQCB/ US EPA Region 9	All surface waste water discharges For Example: POTWs, *Manufacturing, and Commercial Facilities.*	Establishes effluent standards and requires monitoring reports.

FIGURE 6

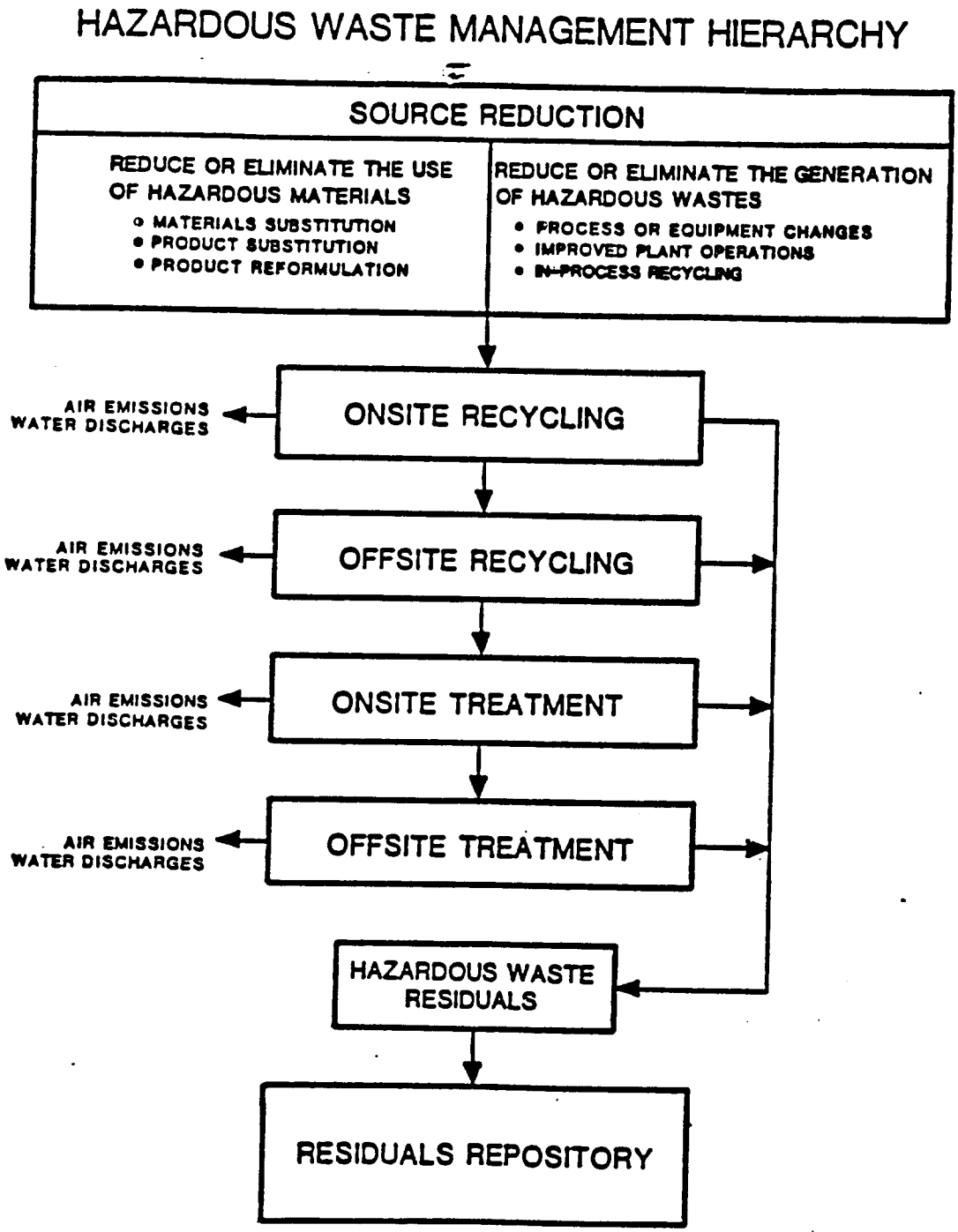

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FIGURE 7

What are the ten categories of industries that are regulated by the General Industrial Storm Water Permit?

The ten categories of industries are the following:

1. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards;

2. Facilities classified as SIC 24 (except 2434), 26 (except 265 and 267) 28 (except 283), 29, 31, 32 (except 323), 33, 3441, 373;

3. Facilities classified as SIC code 10 through 14, including active or inactive mining operations and oil and gas exploration, production, processing, or treatment operations, that discharge storm water that has come into contact with overburden, raw materials, intermediate products, wastes or by- products located on the site of such operations;

4. Hazardous waste treatment, storage, or disposal facilities that are operating under interim status or a permit under subtitle C of RCRA;

5. Landfills, land application sites and open dumps that receive or have received any industrial waste (waste that is received from any of the facilities described by any of the 10 categories).

6. Facilities involved in the recycling of materials, including metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards, including and limited to those facilities classified by SIC code 5015, 5093;

7. Steam electric power generating facilities, including coal handling sites;

8. Transportation facilities classified by SIC codes 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations.

9. Sewage treatment plants with design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR part 403.

10. Facilities classified by SIC codes 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25 and that have areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water.

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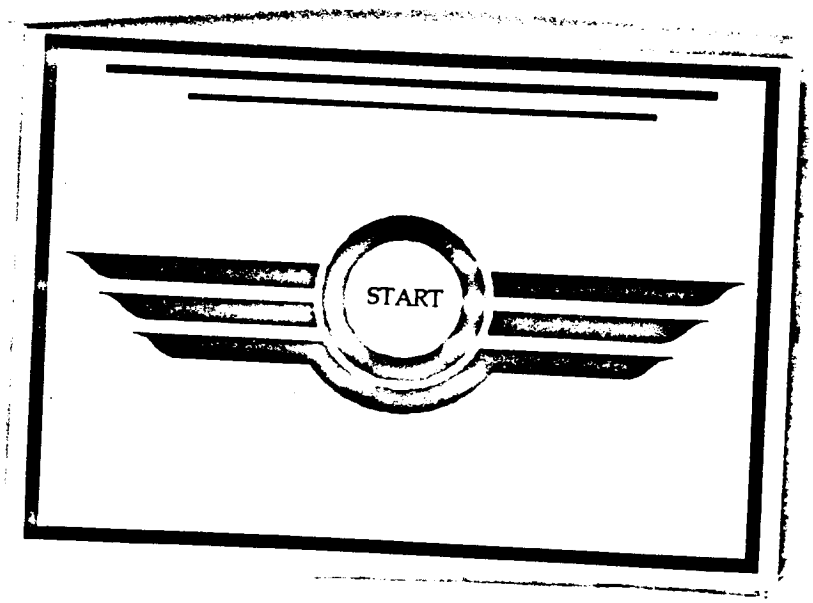

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1990 WATER QUALITY ASSESSMENT (WQA)

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Division of Water Quality
State Water Resources Control Board

April 4, 1990

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Region 4

Rivers and Streams

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
TAPO CANYON CREEK	403.41	0	10	0	0	10	MI	Yes	High TDS and sulfate Agricultural runoff	Non-Point	. . . . .
TRIUNFO CANYON CREEK	404.24	0	7	0	0	7	MI	Yes	Suspected sedimentation	Non-Point	X X
TUJUNGA WASH	405.21	0	10	0	0	10	MI	Yes	Urban runoff	Non-Point	. . . . .
VENTURA RIVER (LOWER)	402.10	0	0	6	0	6	MI	Yes	Low dissolved oxygen/high ammonia Fish kills/excessive plant growth Spills	Point & Non-Point	X X . . X . X
VENTURA RIVER (UPPER)	402.20	9	0	0	0	9	MI	Yes			. . . . .
VERDUGO WASH	405.21	0	8	0	0	8	MI	Yes	Urban runoff	Non-Point	. . . . .
WALNUT CREEK	405.41	0	13	0	0	13	MI	Yes	Urban runoff	Non-Point	. . . . .
WHEELER CANYON CREEK	403.21	0	6	0	0	6	MI	Yes	Objectives violated		. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
AH PAH CREEK	105.11	0	0	0	4	4	MI				. . . . .
ALBION RIVER	113.40	0	14	0	0	14	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
AMERICANO CREEK	115.30	0	0	7	0	7	MI	Yes	SEDIMENTATION, LOW DISSOLVED OXYGEN AND HIGH AMMONIA LEVELS FROM NPS DISCHARGES HAVE IMPAIRED FISH AND WILDLIFE HABITAT		. X . . X . X
APPLEGATE RIVER, MIDDLE FORK	102.30	0	0	0	14	14	MI				. . . . .
ATASCADERO CREEK	114.11	0	7	0	0	7	MI				. . . . .
BARKER CREEK	106.25	0	0	0	6	6	MI				. . . . .
BARLOW CREEK	114.11	0	0	1	0	1	MI	Yes	FISH AND WILDLIFE HABITAT HAS BEEN IMPAIRED DUE TO INDUSTRIAL WASTE DISCHARGES. ENFORCEMENT ACTIONS PENDING		. X . . X . X
BEAR CREEK	112.30	0	0	0	19	19	MI				. . . . .
BEAR RIVER	112.20	0	25	0	0	25	MI	Yes	DATA INDICATE QUALITY IS INTERMEDIATE. LISTING NOT NEEDED AT THIS TIME		. . . . .
BEAUGHTON CREEK	105.50	2	0	4	0	6	MI	Yes	FISHERY HABITAT IMPAIRED DUE TO INDUSTRIAL WASTE DISCHARGES. REMEDIAL ACTIONS UNDERWAY		. X . . X . X
BEAVER CREEK	105.35	0	0	0	8	8	MI				. . . . .

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KEY TO WATER QUALITY ASSESSMENT

TABLE 1

1 Region 2

2 Rivers and Streams

Report Date : 12/08/89

3 Water Body Name	4 Hydro Unit #	5 Water Quality Condition: Good	Intermediate	Impaired	Unknown	6 Total Size	Units	7 Fact Sheet	8 Problem Description	9 Problem Source	10 Federal Lists: 1 D	3 H	3 S	3 L	3	3	3	1	1	0	0	0	1	1	.	3	4	4	4	4	9	1
ALAMEDA CREEK	204.30	0	0	27	0	27		Yes	Threat of recreational impacts		X	X	.	.	X	.	X															
ALAMITOS CREEK	205.40	0	0	14	7	21		Yes	Fish population decline Spawning impairment Objectives violated		X	X	.	.	X	.	X															
ARROYO DE LA LAGUNA	204.30	0	0	5	0	0		Yes	Threat of objectives violated		.	.	.	.	.	.	.															
CORTE MADERA CREEK	206.20	0	0	0	14	14					.	.	.	.	.	.	.															
COYOTE CREEK (REG 2)	205.30	26	34	0	0	60		Yes	Threat of drinking water impairment Threat of recreational impacts Threat of objectives violated		X	X	.	.	X	.	X															
GUADALUPE CREEK	205.40	0	0	6	0	6		Yes	Fish population decline Elevated fish tissue levels Spawning impairment		.	X	.	.	X	.	X															
GUADALUPE RIVER	205.40	0	0	12	0	12		Yes	Fish population decline Elevated fish tissue levels Spawning impairment		X	X	.	.	X	.	X															
LAGUNITAS CREEK	201.13	0	22	0	0	22		Yes			.	.	.	.	.	.	.															
LOS GATOS CREEK (REG 2)	205.40	0	0	0	20	20		Yes			.	.	.	.	.	.	.															
NAPA RIVER	206.50	0	15	40	0	55		Yes			.	X	.	.	X	.	X															
PESCADERO CREEK (REG 2)	202.40	21	0	0	0	21		Yes			.	.	.	.	.	.	.															

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
											.	3	4	4	4	4	9		
BUTTE VALLEY WETLAND	105.81	0	0	0	3000	3000	AC				.	.	.	.	.	.	.	.	.
CLEAR LAKE RESERVOIR NWR	105.93	0	0	0	1890	1890	AC				.	.	.	.	.	.	.	.	.
LOWER KLAMATH NWR	105.91	0	0	0	9345	9345	AC				.	.	.	.	.	.	.	.	.
TULE LAKE NWR	105.92	0	0	0	3825	3825	AC				.	.	.	.	.	.	.	.	.

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REGION 1

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7. Fact Sheet	This column indicates whether a fact sheet (a State Board management tool) has been prepared. Fact sheets have been created for waterbodies classified as impaired, or if the waterbody is of high priority.
8. Problem Description/Comments	"Problem Description/Comments" has been used to give a brief explanation of the reason for particular classification.
9. Problem Source	The problem source, for waterbodies with water quality problems, is either Point or Nonpoint or both. Where left blank, no problems have been identified.
10. Federal Lists	Environmental Protection Agency lists required by various sections of the Clean Water Act. An X in the list column indicates that the waterbody or a portion thereof appears on the indicated list.
131.11	Segments which may be affected by toxic pollutants, or segments with concentrations of toxic pollutants that warrant concern.
303(d)	List of Water Quality Limited Segments where numeric or narrative water quality objectives are not being maintained and/or where beneficial uses are not fully protected after application of Best Available Treatment/Best Control Technology (BAT/BCT).
304(M)	So-called "mini-list" of waters not meeting State adopted numeric water quality objectives due to toxic sources after implementation of BAT/BCT.
304(S)	So-called "short-list" of waters not achieving water quality standards due to point source discharges of toxic pollutants after implementation of BAT/BCT.
304(L)	So-called "long-list" of waters designated as impaired because narrative or numeric objectives are violated or beneficial uses are impaired similar to CWA Section 303(d).
314	A list of lake priorities for restoration.
319	A list of impaired surface waterbodies from nonpoint source problems due to both toxic and nontoxic pollutants.

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WATER QUALITY ASSESSMENT
KEY TO LISTING

The elements of the Water Quality Assessment are keyed to the numbered elements on the following Water Quality Assessment example.

Element	Definition
1. Region #	Regional Board Number
2. Waterbody Type	Waterbodies in the State are categorized under one of the following headings listed below:

Type of Waterbody

Wetlands
Rivers and Streams
Oceans
Lakes
Ground Water
Estuaries
Bays and Harbors

3. Waterbody Name	Name of the waterbody. This is the same name as used in the Basin Plans. There are, however, additional waters presented in the WQA that have not yet been incorporated into the Basin Plans.
4. Hydro Unit #	Hydrologic Unit from Basin Maps. Geographical locations of water resource.
5. Water Quality Condition	Waterbodies are classified under four columns titled Good, Intermediate, Impaired, or Unknown based on the rationale for Water Quality Classification shown in Table I. Each waterbody is listed under one or more of these columns to indicate its water quality.
6. Total Size	The total size of each waterbody measured in the units shown below. Where other units are used, they are indicated.

Type of WaterBody	Units
Wetlands	Acres
Rivers and Streams	Miles
Oceans	Miles
Lakes	Acres
Ground Water	Square miles
Estuaries	Acres
Agricultural Drains	Miles
Bays and Harbors	Acres

The WQA assesses an extensive number of wetlands, rivers, lakes, estuaries and bays, ground water, and ocean waters. It is impractical to provide a detailed description of each waterbody's quality in this report. While the table entries are brief, they synthesize a substantial amount of data on the quality of the State's waters.

V. THE BAY-DELTA PROCEEDINGS AND THE WATER QUALITY ASSESSMENT

In classifying waterbodies within their geographical regions, the San Francisco and Central Valley Regional Boards have determined that the Bay-Delta and the major tributaries that feed the Delta (the Sacramento River, the American River, and the San Joaquin River) do not support all beneficial uses of these waters. Declining fish populations and fish or shellfish tissue contamination are the primary water resource concerns.

This assessment is based on data available to the Regional Boards and the State Board at the time of listing. Information compiled by these Regional Boards for the WQA and additional information are being used by the State Board in their review of water quality and flow standards needed to protect the Bay and Delta. These proceedings will result in a new Bay-Delta water quality control plan, a State policy for regulating pollutants, and a new water right decision.

The Bay-Delta was assessed without the benefit of a final Bay-Delta plan. The WQA will be reconsidered on an annual basis. This annual review process will allow the Regional Boards and the State Board to evaluate new information made available in the Bay-Delta proceedings.

Bay-Delta waterbodies in the WQA are highlighted by "shading" and have a "B/D" identifier in the far right column. A complete discussion of the importance of the Bay-Delta and its particular water quality problems can be found in the appendix.

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D. **Unknown**

The condition cf the water quality reflects a lack of data, either actual or through observation.

The Regional Boards have prepared Fact Sheets consisting of important water quality information for the following waterbodies: (1) those designated "impaired", (2) those removed from the "impaired" category or from a federal list, (3) those on the U. S. Environmental Protection Agency (EPA) 304(l) candidates' list, (4) those known to have controversial classifications, and (5) those considered to be of high priority for any reason.

Fact sheets provide additional detail on the nature and source of water quality problems, summarize current and projected remedial or protective actions, and estimate future funding needs. The Fact Sheet column denotes whether a supporting document is available. Additional information on specific waterbodies is available at the Regional Boards or the State Board.

The federal lists column identifies waterbodies included on a particular list. The 304(l) lists contained in this document are the State Board's recommendations to U. S. Environmental Protection Agency (EPA). EPA will review the lists and make the final determination as to which waterbodies will be on the 304(l) lists.

IV. WHAT DO THESE CLASSIFICATIONS MEAN?

Caution must be used in examining the water quality classifications. In many cases, impaired waterbodies will exhibit vastly different degrees of impairment. For example, the American River and the New River are both listed as impaired, yet each has very different degrees of impairment. The American River is listed as impaired because of infrequent episodes of acute toxicity to aquatic organisms associated with storm induced urban runoff. Urban runoff may also be responsible for the elevated levels of some pesticides in fish tissue. Past mining activity is probably responsible for chronic toxic effects not associated with urban runoff and for elevated levels of mercury in some fish. The New River is highly contaminated, carrying seriously polluted water from Mexico.

There are also waterbodies high in certain constituents as a result of natural conditions such as alkaline lakes. These waterbodies are normally not listed as impaired because they do not support certain beneficial uses, except in cases where the beneficial use is listed in the Basin Plan.

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II. INTEGRATION OF REGIONAL WATER QUALITY ASSESSMENTS

The statewide WQA is made up of nine regional WQAs. Each of the nine Regional Boards reviewed and edited that portion of the statewide 1989 WQA pertaining to their respective region. Each regional WQA then went through a formal public adoption process. The State Board has made some changes to the Regional Board's WQA based upon staff recommendations and testimony or written comments received during two public hearings.

III. KEY TO THE 1990 WQA

The WQA includes the name of the waterbody, the hydrologic unit number (used for surface waters representing a subdivision of hydrologic basins developed by the Department of Water Resources) and the classification of the water quality condition. These classificiations are defined as:

A. **Good:**

Waters support and enhance the designated beneficial uses.

B. **Intermediate:**

Waters generally support beneficial uses with an occasional degradation of water quality. For example, a water resource has occasional degradation of water quality determined from ambient water quality data. This category also includes waterbodies with suspected impairment where data are inadequate to form a definite conclusion on the condition.

C. **Impaired**

Waterbodies cannot reasonably be expected to attain or maintain applicable water quality standards. An impaired condition may be obvious such as consistent and continued exceedance of adopted objectives or when beneficial uses are not protected. Certain cases, however, required the evaluation of many sources of data to arrive at a best professional judgement. Impaired waterbodies are determined on the following bases: (1) designated uses are not supported; (2) water quality impairment is moderate to severe; (3) designated use is compromised or limited; (4) the aquatic community is known to contain toxic substances in concentrations hazardous to human health (e.g., health advisories); (5) the aquatic community is not fully supported or is severely stressed; (6) fish kills are frequent or toxicity tests show repeated acute or chronic toxicity; or (7) a numerical measurement exceeds a specified criterion or objective.

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WATER QUALITY ASSESSMENT NARRATIVE SUMMARY

I. INTRODUCTION

The Water Quality Assessment (WQA) is a statewide catalog of California waterbodies, listed according to geographical region and waterbody type. It provides a description of each waterbody's current water quality and the nature and source of possible impairments.

This document is an updated version of the WQA adopted by the State Water Resources Control Board (State Board) in February 1989. It is designed to be an evolving document with waterbodies to be added or deleted from specific classifications as additional information becomes available.

The information in the WQA integrates surface water and nonpoint source data bases (includes both surface and ground waters), which are required by the Federal Water Pollution Control Act, Sections 305(b) and 319. Prior to adoption of the 1989 WQA, development and maintenance of these two water quality data bases were separate State Board activities. Combining the two allows a more thorough assessment of the State's water quality.

In addition to reporting the condition of the State's waters and satisfying federal reporting requirements, the WQA is an important component of the California Clean Water Strategy (CWS) since it provides the foundation for identifying high priority waterbodies where corrective and/or preventative actions are needed. The aim of the CWS is to direct the State Board and the Regional Water Quality Control Boards' (Regional Boards) efforts to those waterbodies where they will have the greatest impact.

The format of the 1990 WQA is easily readable. Water condition classifications are described as "good" - "intermediate" - "impaired" - "unknown". Individual waterbodies are listed by: (a) the Region in which they are located, and (b) the type of water resource represented, such as wetlands, rivers, streams, and lakes. In some cases, an entire waterbody is included under one classification. In other cases segments of waterbodies are listed separately because of unique differences or problems that distinguish a particular segment. Water quality problems for each waterbody are described when known or suspected.

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SWR-Coastal - FYI

AF - 2/21/91
XS 2/28/91
MPW - 3/4/91
MH - 3/8/91
3/11/91

TO: All Section and Unit Chiefs

DATE: 2-20-91

FROM: Anne Saffell
Planning Unit

RE: 1990 Water Quality Assessment Report

Attached is a copy of the 1990 Statewide Water Quality Assessment Report for use in your Unit(s).

Within the tables for each Region, waterbodies are sorted by type (rivers, lakes, ground water, estuaries, bays and harbors, and Areas of Special Biological Significance). Useful information, such as waterbody location (hydrologic unit), waterbody size, water quality, and brief problem descriptions and sources are provided. The EPA Federal List designations are also noted, so you can determine whether a waterbody is water quality limited, impaired due to toxics, nonpoint sources of pollution, etc. These Federal Lists are defined on page vi of the report. This information can be very useful in locating waterbodies, and in the development of permits and policies. For example, in the NPDES Program Workplan, it states that implementation of the Clean Water Strategy must be given top priority within the workload for the NPDES Program. If waterbodies are water quality limited or are on the 304(1) short lists, TMDL and wasteload allocations, permitting and compliance activities for these waterbodies are to be priority activities under NPDES Program resources.

Please let me know if you will need any more copies for your staff who may need a personal copy for regular use. I will also be glad to answer questions about the information contained in this report, and the applicability for use in your program.

Deb Smith or

Planning also has copies of all of the other Regional Boards' Basin Plans if you or your staff need to reference these reports.

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STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 90-33

ADOPTION OF WATER QUALITY ASSESSMENT INCORPORATING FEDERAL CLEAN WATER ACT SECTIONS 303(d), 304(l), 314, AND 319 LISTS AND 40 CODE OF FEDERAL REGULATIONS, SECTION 131.11

WHEREAS:

1. The State Water Resources Control Board (State Board) is developing a list of prioritized water quality issues as part of the Clean Water Strategy.

2. The Water Quality Assessment provides information necessary for the development of the Clean Water Strategy.

3. The Water Quality Assessment has been compiled from the nine regional Water Quality Assessments adopted by the respective California Regional Water Quality Control Board (Regional Board).

4. Duly noticed public hearings were conducted on January 31, 1990 and February 15, 1990 for the purpose of public review and comment on the draft statewide Water Quality Assessment and appropriate changes were made to the assessment.

5. A proposed Water Quality Assessment document was made available to the public on January 2, 1990.

6. Section 304(l) of the Clean Water Act, as amended in 1987, requires each state to submit various lists of waterbodies impacted by pollutants to the U.S. Environmental Protection Agency (EPA).

7. The Water Quality Assessment includes the Clean Water Act Section 303(d), 304(l), 314, and 319 lists and the list required under 40 Code of Federal Regulations (CFR), Section 131.11 for the State of California.

8. All waterbodies identified as affected by nonpoint sources constitute the Nonpoint Source Assessment Report.

THEREFORE BE IT RESOLVED:

1. That the 1990 update of the State of California's Water Quality Assessment is approved, including the lists for Sections 303(d), 304(l), 314, and 319 of the Clean Water Act and 40 CFR 131.11 that are incorporated therein.

2. That the Executive Director is authorized to transmit the lists for Sections 303(d), 304(l), 314, and 319 of the Clean Water Act and 40 CFR 131.11 to EPA to satisfy the requirements of that Act.

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3. That the 1990 update of the Water Quality Assessment is complete.

4. That the State Board may review the lists for Sections 303(d), 304(1), 314, and 319 of the Clean Water Act, once the Clean Water Strategy development is complete and the State Board's priorities are made clear.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on April 4, 1990.

Maureen Marche
Administrative Assistant to the Board

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1992

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Estuaries

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 0 M S L
BALLONA WETLANDS	405.13	0	0	150	0	150	AC	Yes	Fishery and wildlife habitat impairment Wetlands alteration Rare and endangered species impairment	Point & Non-Point	. X . . X . X
COLORADO LAGOON	405.12	0	0	13	0	13	AC	Yes	High coliform counts Elevated shellfish tissue levels	Non-Point	X X . . X . X
DOMINGUEZ CHANNEL TIDAL PRISM	405.12	0	0	8	0	8	MI	Yes	Elevated shellfish tissue levels Urban runoff Historic DDT deposition to sediment	Point & Non-Point	X X . . X . X
LOS ANGELES RIVER (TIDAL PRISM)	405.12	0	3	0	0	3	MI	Yes	Urban runoff	Non-Point	. . . . .
MALIBU LAGOON	404.31	0	0	29	0	29	AC	Yes	Eutrophication Threat of recreational impacts Fish kills	Point & Non-Point	. X . . X . X
MCGRATH LAKE ESTUARY	403.11	0	40	0	0	40	AC	No	Suspected pesticides	Non-Point	. . . . .
MUGU LAGOON	403.11	0	0	1500	0	1500	AC	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Sedimentation	Non-Point	X X . . X . X
SAN GABRIEL RIVER (TIDAL PRISM)	405.15	0	0	3	0	3	MI	Yes	Elevated fish tissue levels Fish abnormalities Threat of toxic bioassays	Point & Non-Point	X X . . X . X
SANTA CLARA RIVER ESTUARY	403.00	0	0	0	60	60	AC	No			

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STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Report Date : 06/09/92

Region 4

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
VENTURA RIVER ESTUARY	402.10	0	0	10	0	10	AC	Yes	Eutrophication Threat of public health concern Threat of rare & endang. species impair.	Non-Point	.	.	.	.	X	.	X	.	.

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STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Report Date : 06/09/92

Region 4

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3	3	3	3	1
ACTON VALLEY	403.55	0	20	2	0	22	SQMI	Yes	Drinking water impairment Threat of drinking water impairment	Non-Point	.	.	.	.	.	.	.	.
ARROYO SANTA ROSA VALLEY	403.63	0	6	0	0	6	SQMI	Yes	Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.	.
COASTAL PLAIN - L.A.	405.10	450	21	29	0	500	SQMI	Yes	Drinking water impairment Saltwater intrusion Fuel leaks/VOC pollution	Point & Non-Point	.	.	.	.	.	.	.	.
CONEJO VALLEY	403.64	0	4	0	0	4	SQMI	Yes	Threat of drinking water impairment	Non-Point	.	.	.	.	.	.	.	.
CONEJO-TIERRA REJADA VOLCANIC AREAS		0	0	0	0	0		Yes	Areal extent unknown		.	.	.	.	.	.	.	.
HIDDEN VALLEY	404.26	2	1	0	0	3	SQMI	Yes	Threat of drinking water impairment	Non-Point	.	.	.	.	.	.	.	.
HUNGRY VALLEY	403.43	3	1	0	0	4	SQMI	Yes	Threat of drinking water impairment High naturally occurring elements	Non-Point	.	.	.	.	.	.	.	.
LAS POSAS VALLEY	403.62	41	37	1	0	79	SQMI	Yes	Drinking water impairment Objectives violated Threat of objectives violated	Non-Point	.	.	.	.	.	.	.	.
LOCKWOOD VALLEY	403.44	15	5	0	0	20	SQMI	Yes	Threat of objectives violated High naturally occurring elements	Non-Point	.	.	.	.	.	.	.	.
LOWER SANTA CLARA RIVER VAL.(VENTURA CO)	403.11	0	146	100	0	246	SQMI	Yes	Drinking water impairment Threat of drinking water impairment Objectives violated	Point & Non-Point	.	.	.	.	.	.	.	.

Region 4

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
MALIBU AREA	404.21	0	0	1	0	1	SQMI	Yes	Drinking water impairment Objectives violated	Non-Point	. . . . .
OJAI VALLEY	402.32	10	3	0	0	13	SQMI	Yes	Threat of drinking water impairment	Non-Point	. . . . .
PLEASANT VALLEY	403.12	13	34	0	0	47	SQMI	Yes	Threat of drinking water impairment Threat of objectives violated	Non-Point	. . . . .
RUSSELL VALLEY	404.25	0	1	0	5	6	SQMI	Yes	Threat of drinking water impairment		. . . . .
SAN FERNANDO VALLEY	405.21	90	32	50	20	192	SQMI	Yes	Drinking water impairment Designated EPA Superfund site Fuel leaks/VOC pollution	Point & Non-Point	. . . . .
SAN GABRIEL VALLEY	405.41	72	40	88	0	200	SQMI	Yes	Drinking water impairment Designated EPA Superfund site Fuel leaks/VOC pollution	Point & Non-Point	. . . . .
SIMI VALLEY	403.67	0	0	25	0	25	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
THOUSAND OAKS AREA	403.68	0	5	0	0	5	SQMI	Yes	Threat of drinking water impairment	Non-Point	. . . . .
TIERRA REJADA VALLEY	403.65	0	0	0	1	1	SQMI	Yes			. . . . .
UPPER OJAI VALLEY	402.31	0	3	0	0	3	SQMI	Yes	Threat of objectives violated	Non-Point	. . . . .
UPPER SANTA ANA VALLEY (LA COUNTY)	481.20	0	10	20	0	30	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
UPPER SANTA CLARA RIVER VALLEY (LA CO.)	403.51	53	37	0	0	90	SQMI	Yes	Threat of drinking water impairment Threat of objectives violated	Non-Point	. . . . .

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Region 4

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Ground Water

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
VENTURA RIVER VALLEY	402.10	0	5	5	0	10	SQMI	Yes	Drinking water impairment Threat of drinking water impairment	Point & Non-Point	. . . . .

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Region 4

Lakes and Reservoirs

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D M S L
BELVEDERE PARK LAKE	405.15	0	2	0	0	2	AC	Yes	Elevated fish tissue levels Eutrophication	Non-Point	. . . . . X .
BIG SANTA ANITA RESERVOIR	405.33	0	0	0	17	17	AC	No			. . . . .
BOUQUET RESERVOIR	403.52	628	0	0	0	628	AC	No			. . . . .
CALABASAS LAKE	404.21	0	21	0	0	21	AC	Yes	Eutrophication Sedimentation	Non-Point	. . . . .
CASITAS LAKE	402.20	0	2720	0	0	2720	AC	No	Turbidity violations	Non-Point	. . . . . X X
CASTAIC LAKE	403.51	2630	0	0	0	2630	AC	Yes			. . . . .
CASTAIC LAKE LAGOON	403.51	0	197	0	0	197	AC	Yes	Recreational impacts Coliform exceedences Eutrophication	Non-Point	. . . . . X X
COGSWELL RESERVOIR	405.43	0	0	0	160	160	AC	No	Drained		. . . . .
CRYSTAL LAKE	405.43	0	0	5	0	5	AC	Yes	Eutrophication Low water level Recreational impacts		. . . . X X X
DRY CANYON RESERVOIR	403.51	0	0	0	58	58	AC	No	Intermittent - currently dry		. . . . .
ECHO PARK LAKE	405.15	0	15	0	0	15	AC	Yes	Threat of elevated fish tissue levels	Non-Point	. . . . . X .
EL DORADO PARK LAKE	405.15	0	22	0	0	22	AC	Yes	Threat of elevated fish tissue levels		. . . . . X .

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STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Lakes and Reservoirs

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3 1	3 0	3 0	3 0	3 1	3 4	3 4	3 4	3 6	3 9
ELEANOR LAKE	404.26	0	8	0	0	8	AC	Yes	Eutrophication Urban runoff	Non-Point	.	.	.	.	.	.	X	X						
ELIZABETH LAKE	403.51	0	0	90	0	90	AC	Yes	Eutrophication Receding water level due to drought Suspected elevated coliform levels	Non-Point	.	.	.	.	X	X	X							
GARVEY RESERVOIR	405.41	0	0	0	1610	1610	AC		Drained for maintenance		.	.	.	.	.	.	.							
HARBOR PARK LAKE	405.12	0	0	50	0	50	AC	Yes	Elevated fish tissue levels Eutrophication Health advisory in affect-chlordane> FDA	Non-Point	X	X	.	.	X	X	X							
HOLLENBECK PARK LAKE	405.15	0	0	0	5	5	AC	Yes	Lake is drained for maintenance		.	.	.	.	.	.	.							
HUGHES LAKE	403.51	0	0	40	0	40	AC	Yes	Lake is drying up due to drought Public health concern	Non-Point	X	X	.	.	X	X	X							
LEGG LAKE	405.41	70	0	0	0	70	AC	Yes			.	.	.	.	.	.	.							
LINCOLN PARK LAKE	405.15	0	5	0	0	5	AC	Yes	Eutrophication		.	.	.	.	.	.	X	.						
LINDERO LAKE	404.23	0	14	0	0	14	AC	Yes	Elevated fish tissue levels	Non-Point	.	.	.	.	.	.	.							
LIVE OAK RESERVOIR	405.40	0	0	0	77	77	AC	No	Intermittent - currently dry		.	.	.	.	.	.	.							
MALIBU LAKE	404.24	0	55	0	0	55	AC	No	Elevated fish tissue levels Suspected eutrophication Sedimentation	Non-Point	.	.	.	.	.	X	.							
MATILIJA RESERVOIR	402.20	0	124	0	0	124	AC	No	Sedimentation Eutrophication	Non-Point	.	.	.	.	.	X	.							

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Report Date : 06/09/92

Lakes and Reservoirs

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1	0	0	0	0	1	1	.	3	4	4	4	4	9	1
NORRIS RESERVOIR	405.43	0	0	0	420	420	AC	Yes	Presently being drained		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PACOIMA RESERVOIR	405.22	0	0	0	68	68	AC	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PECK ROAD PARK LAKE	405.41	0	80	0	0	80	AC	Yes	Elevated fish tissue levels	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PIRU LAKE	403.40	1240	0	0	0	1240	AC	No		Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
POLLIWOG PARK POND	405.12	0	0	0	2	2	AC	Yes			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUDDINGSTONE RESERVOIR	405.52	0	0	490	0	490	AC	Yes	Elevated fish tissue levels Recreational impacts	Non-Point	X	.	.	.	X	X	X															
PYRAMID RESERVOIR	403.43	1360	0	0	0	1360	AC	Yes			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN ANTONIO RESERVOIR	481.23	0	0	0	139	139	AC	No	Intermittent - currently dry		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN DIMAS RESERVOIR	405.44	0	0	0	16	16	AC	No	Intermittent - currently dry		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN GABRIEL RESERVOIR	405.43	500	0	0	0	500	AC	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAWPIT RESERVOIR	405.41	0	0	0	9	9	AC	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SHERWOOD LAKE	404.26	0	184	0	0	184	AC	Yes	Suspected elevated fish tissue levels	Non-Point	.	.	.	.	.	.	X	X														
SILVER LAKE RESERVOIR	405.15	78	0	0	0	78	AC	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TUJUNGA RESERVOIR	405.23	0	0	0	84	84	AC	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Lakes and Reservoirs

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
UPPER VAN NORMAN RESERVOIR	405.21	448	0	0	0	448	AC	No			.	.	.	.	.	.	.	.	.
WESTLAKE LAKE	404.25	0	156	0	0	156	AC	Yes	Suspected elevated fish tissue levels Suspected eutrophication	Non-Point	.	.	.	.	.	X	X		

Region 4

Ocean and Open Bays

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 0 M S L
ANACAPA ISLAND	406.10	21280	0	0	0	21280	AC	Yes	Area of special biological significance		. . . . .
NEARSHORE - POINT MUGU TO LATIGO POINT		11710	0	0	0	11710	AC	Yes	Area of special biological significance		. . . . .
SAN CLEMENTE ISLAND	406.50	80512	0	0	0	80512	AC	Yes	Area of special biological significance		. . . . .
SAN NICOLAS ISLAND AND BEGG ROCK	406.20	102528	0	0	0	102528	AC	Yes	Area of special biological significance Threat of military impacts		. . . . .
SANTA BARBARA ISLAND	406.30	14000	0	0	0	14000	AC	Yes	Area of special biological significance		. . . . .
SANTA CATALINA ISLAND (AREAS 1-4)	406.40	17936	0	0	0	17936	AC	Yes	Area of special biological significance		. . . . .
SANTA MONICA BAY (CO. LINE TO PT FERMIN)	405.13	0	239500	16500	0	256000	AC	Yes	Elevated fish tissue levels Sediment contamination Recreational impacts (surf zone)	Point & Non-Point	X X . . X . X

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STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Report Date : 06/09/92

Region 4

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 0 3 0 3 3 0 4 3 3 0 4 3 3 0 4 9 1 M S L
ALISO CREEK (L.A. RIVER TRIBUTARY)	405.21	0	15	0	0	15	MI	Yes	Urban runoff	Non-Point	. . . . .
ALISO CREEK (S. CLARA RIV. TRIB. VEN CO)	403.21	0	0	0	9	9	MI	Yes			. . . . .
ARROYO CONEJO	403.68	0	3	0	7	10	MI	Yes	Suspected fisheries habitat degradation	Point	. . . . .
ARROYO LAS POSAS	403.62	0	8	0	0	8	MI	Yes		Point & Non-Point	X X
ARROYO SANTA ROSA	403.64	0	0	0	8	8	MI	Yes			. . . . .
ARROYO SECO	405.15	0	7	1	10	18	MI	Yes	Transient shelters in channel Urban runoff/illegal dumping in channel Public health concern	Non-Point	X . . . X . X
ARROYO SIMI	403.63	0	15	0	0	15	MI	Yes		Point & Non-Point	X . . . . .
BALLONA CREEK	405.13	0	6	0	0	6	MI	Yes	Coliform exceedences Public health concern Urban runoff	Non-Point	X . . . . .
BEARDSLEY WASH	403.61	0	0	5	0	5	MI	Yes	Agricultural wastewater Sedimentation DDT, DDE, DDD in sediment	Non-Point	X X . . X . X
BOUQUET CANYON CREEK	403.51	17	0	0	0	17	MI	Yes			. . . . .
BROWNS CREEK	405.21	0	2	0	0	2	MI	Yes	Urban runoff	Non-Point	. . . . .
BULL CREEK	405.21	0	10	0	0	10	MI	Yes	Urban runoff	Non-Point	. . . . .

R0033401

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Report Date : 06/09/92

Region 4

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 0 M S L
BURBANK-WESTERN CHANNEL	405.21	0	6	0	0	6	MI	Yes	Urban runoff High ammonia	Point & Non-Point	. . . . .
CALLEGUAS CREEK	403.11	0	0	11	0	11	MI	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Objectives violated	Non-Point	X X . . X . X
CANADA DE LOS ALAMOS	403.43	0	0	0	6	6	MI	Yes			. . . . .
CANADA LARGA	402.10	0	0	0	5	5	MI	Yes	Intermittent stream		. . . . .
CASTAIC CREEK	403.51	8	0	0	0	8	MI	Yes			. . . . .
CATTLE CANYON CREEK	405.43	16	0	0	0	16	MI	Yes			. . . . .
COMPTON CREEK	405.15	0	8	0	0	8	MI	Yes	Urban runoff	Non-Point	. . . . .
CONEJO CREEK	403.12	0	10	0	0	10	MI	Yes	Chloride objective exceeded High phosphate and ammonia Threat of fish kills	Point & Non-Point	. . . . .
COYOTE CREEK (S. GABRIEL RIV. TRIBUTARY)	405.15	0	17	0	0	17	MI	Yes	High nutrients, coliform, and TDS from the upper watershed (Region 8) Urban Runoff	Point & Non-Point	. . . . .
COYOTE CREEK (VEN.RIV.TRIB.)	402.20	3	0	0	0	3	MI	Yes			. . . . .
DOMINGUEZ CHANNEL	405.12	0	7	0	0	7	MI	Yes	Objectives violated Threat of toxic bioassay results	Point & Non-Point	X X
GORMAN CREEK	403.43	0	12	0	0	12	MI	Yes	High fluoride	Non-Point	. . . . .

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R0033402

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Report Date : 06/09/92

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3
HOPPER CREEK	403.41	0	10	0	0	10	MI	Yes	Objectives violated High TDS	Non-Point	.	.	.	.	.	.	.
HOT SPRINGS CANYON CREEK	403.41	0	5	0	0	5	MI	Yes	Objectives violated High fluoride and boron	Non-Point	.	.	.	.	.	.	.
LION CREEK	402.20	9	0	0	0	9	MI	Yes			.	.	.	.	.	.	.
LITTLE SESPE CREEK	403.32	0	5	0	0	5	MI	Yes	Objectives violated High sulfur and TDS	Non-Point	.	.	.	.	.	.	.
LOCKWOOD CREEK	403.44	0	11	0	0	11	MI	Yes	Objectives violated High boron	Non-Point	.	.	.	.	.	.	.
LOS ANGELES RIVER (LOWER)	405.15	0	28	0	0	28	MI	Yes	Urban runoff Threat of drinking water impairment	Point & Non-Point	X	.	.	.	.	.	.
LOS ANGELES RIVER (UPPER)	405.21	0	18	7	0	25	MI	Yes	Urban runoff Localized high VOCs and ammonia Threat of drinking water impairment	Point & Non-Point	X	X	.	.	X	.	X
MADEA CREEK	404.24	0	7	0	0	7	MI	Yes	Suspected sedimentation	Non-Point	X	.	.	.	.	.	X
MALIBU CREEK	404.21	0	6	3	0	9	MI	Yes	Fish population decline Spawning impairment Sedimentation	Non-Point	.	.	.	.	.	.	.
MATILIJA CREEK	402.20	7	0	0	0	7	MI	Yes			.	.	.	.	.	.	.
MATILIJA CREEK (NORTH FORK)	402.20	5	0	0	0	5	MI	Yes			.	.	.	.	.	.	.

Report Date : 06/09/92

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4 Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
MATILIJA CREEK (UPPER NORTH FORK)	402.20	0	0	0	9	9	MI	Yes			. . . . .
PACOIMA WASH	405.21	0	14	0	0	14	MI	Yes	Urban runoff	Non-Point	. . . . .
PIRU CREEK	403.42	55	4	0	0	59	MI	Yes	TDS, sulfate, boron objectives sometimes exceeded	Non-Point	. . . . .
PIRU CREEK (SOUTH FORK)	403.44	0	3	0	0	3	MI	Yes	Naturally occurring sulfur enrichment		. . . . .
POLE CANYON CREEK	403.51	0	7	0	0	7	MI	Yes	Objectives violated High sulfate and TDS		. . . . .
REVOLON SLOUGH	403.11	0	0	9	0	9	MI	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Threat of drinking water impairment	Non-Point	X X . . X . X
RIO HONDO	405.41	0	20	0	0	20	MI	Yes	Urban runoff Organic chemicals	Non-Point	X . . . . .
SAN ANTONIO CREEK (CROSSES INTO RWQCB 8)	481.23	0	0	0	23	23	MI	Yes			. . . . .
SAN ANTONIO CREEK (VENTURA TRIBUTARY)	402.20	16	0	0	0	16	MI	Yes	Intermittent flow		. . . . .
SAN FRANCISQUITO CANYON CREEK	403.51	20	0	0	0	20	MI	Yes			. . . . .

R0033403

R0033404

STATE WATER RESOURCES CONTROL BOARD 1992 WATER QUALITY ASSESSMENT

Region 4

Rivers and Streams

Report Date : 06/09/92

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3
SAN GABRIEL RIVER (EAST FORK)	405.43	15	0	0	0	15	MI	Yes	Threat of recreational impacts Unpermitted dumping of trash and debris	Non-Point	.	.	.	.	.	.	.
SAN GABRIEL RIVER (LOWER) S. of Firestone	405.15	0	9	9	0	18	MI	Yes	Toxic bioassay results High ammonia Urban runoff	Point & Non-Point	X	X	.	.	.	.	.
SAN GABRIEL RIVER (NORTH FORK)	405.43	6	0	0	0	6	MI	Yes	Threat of recreational impacts		.	.	.	.	.	.	.
SAN GABRIEL RIVER (UPPER)	405.41	0	42	0	0	42	MI	Yes	Urban runoff Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.
SAN GABRIEL RIVER (WEST FORK)	405.43	18	0	0	0	18	MI	Yes	Threat of recreational impacts Threat of fisheries habitat degradation		.	.	.	.	.	.	.
SAN JOSE CREEK	405.41	0	16	0	0	16	MI	Yes	Urban runoff	Point & Non-Point	.	.	.	.	.	.	.
SANTA ANA CREEK	402.20	10	0	0	0	10	MI	No			.	.	.	.	.	.	.
SANTA CLARA RIVER	403.00	0	79	0	0	79	MI	No	Urban and agricultural runoff Localized exceedences of sulfate, chloride, and nitrate objectives	Non-Point	.	.	.	.	.	.	.
SANTA PAULA CREEK	403.20	14	0	2	0	16	MI	Yes	Natural oil seeps in the area Fisheries habitat degradation	Non-Point	.	.	.	.	.	.	.
SESPE CREEK	403.30	45	0	0	0	45	MI	Yes			.	.	.	.	.	.	.
SISAR CREEK	403.21	5	0	2	0	7	MI	Yes	Natural oil seeps in the area	Non-Point	.	.	.	.	.	.	.

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
BIG RIVER	113.30	0	40	0	0	40	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
BIG SALMON CREEK	113.40	0	0	0	1	1	MI				. . . . .
BIG SULFER CREEK	114.26	18	0	0	0	18	MI				. . . . .
BLACK BUTTE RIVER	111.73	0	0	0	25	25	MI				. . . . .
BLUE CREEK	105.11	22	0	0	0	22	MI				. . . . .
BLUE WATERHOLE CREEK	113.70	0	4	0	0	4	MI				. . . . .
BOHEMIAN CREEK	114.11	0	1	0	0	1	MI				. . . . .
BROWNS CREEK	106.31	0	0	0	21	21	MI				. . . . .
BRUSH CREEK	113.64	0	0	0	12	12	MI				. . . . .
BUCKEYE CREEK	113.83	0	15	0	0	15	MI				. . . . .
BULL CREEK	111.31	0	12	0	0	12	MI				. . . . .
BULLWINKLE CREEK	108.20	1	3	0	0	4	MI				. . . . .
BUNNER LAKE CREEK	103.13	0	0	0	1	1	MI				. . . . .
CAMPBELL CREEK	106.11	0	0	0	6	6	MI				. . . . .
CANNON CREEK	109.30	0	5	0	0	5	MI				. . . . .
CARR CREEK	106.25	0	0	0	6	6	MI				. . . . .

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ATTACHMENT 4

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Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
COFFEE CREEK	106.40	16	0	0	0	16	MI				. . . . .
COLD CREEK	114.32	0	0	0	5	5	MI				. . . . .
COLGAN CREEK	114.21	0	5	0	0	5	MI				. . . . .
COON CREEK	113.50	0	2	0	0	2	MI				. . . . .
COTTANEVA CREEK	113.12	0	5	0	0	5	MI				. . . . .
DEADWOOD CREEK	106.31	0	0	0	6	6	MI				. . . . .
DEAN CREEK	111.32	0	0	0	7	7	MI				. . . . .
DRY CREEK	114.24	12	0	0	16	28	MI				. . . . .
DUTCH BILL CREEK	114.11	0	8	0	0	8	MI				. . . . .
EEL RIVER	111.00	0	200	0	0	200	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES. DATA DOES NOT JUSTIFY LISTING		. . . . .
EEL RIVER, EAST BRANCH, SOUTH FORK	111.32	0	0	0	19	19	MI				. . . . .
EEL RIVER, MIDDLE FORK	111.70	0	0	0	64	64	MI				. . . . .
EEL RIVER, NORTH FORK	111.50	0	0	0	41	41	MI				. . . . .

R0033406

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D H S L
EEL RIVER, SOUTH FORK	111.30	0	85	0	0	85	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
ELDER CREEK	111.33	22	0	0	0	22	MI				. . . . .
ELK RIVER	110.00	0	17	0	0	17	MI				. . . . .
ESSEX GULCH	109.10	0	2	0	0	2	MI				. . . . .
ETNA CREEK	105.42	9	0	0	0	9	MI	Yes	DATA DO NOT JUSTIFY LISTING AT THIS TIME		. . . . .
FRENCH CREEK	105.42	4	6	0	0	10	MI	Yes	DATA DO NOT JUSTIFY LISTING AT THIS TIME		. . . . .
FULLER CREEK	113.84	0	9	0	0	9	MI				. . . . .
GARCIA RIVER	113.70	0	39	0	0	39	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
GARCIA RIVER, NORTH FORK	113.70	0	7	0	0	7	MI				. . . . .
GRASS VALLEY CREEK	106.31	0	14	0	0	14	MI	Yes	DATA INDICATE WATER QUALITY CLASSIFICATION IS INTERMEDIATE. DOES NOT REQUIRE LISTING AT THIS TIME		. . . . .
GRAY CREEK	108.10	0	4	0	0	4	MI				. . . . .
GREEN VALLEY CREEK	114.11	0	5	0	0	5	MI				. . . . .
GREENWOOD CREEK	113.61	0	15	0	0	15	MI				. . . . .
GROUSE CREEK	106.21	0	22	0	0	22	MI				. . . . .

R0033407

EXHIBIT 1

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 I	3	3	1
GUALALA RIVER	113.80	0	35	0	0	35	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		.	.	.	.	.	.	.
HARDSCRABBLE CREEK	103.30	0	0	0	5	5	MI				.	.	.	.	.	.	.
HARDY CREEK	113.12	0	0	0	4	4	MI				.	.	.	.	.	.	.
HAYFORK CREEK	106.24	0	0	0	13	13	MI	Yes	INSUFFICIENT DATA TO JUSTIFY LISTING AT THIS TIME		.	.	.	.	.	.	.
HIGH PRAIRIE CREEK	105.11	0	4	0	0	4	MI				.	.	.	.	.	.	.
HOADLEY GULCH	106.31	0	0	0	4	4	MI				.	.	.	.	.	.	.
HOLLOW TREE CREEK	111.32	0	19	0	0	19	MI				.	.	.	.	.	.	.
HOPPAW CREEK	105.11	0	5	0	0	5	MI				.	.	.	.	.	.	.
HOSPITAL CREEK	106.11	0	0	0	3	3	MI				.	.	.	.	.	.	.
HUNTER CREEK	105.11	0	5	0	0	5	MI				.	.	.	.	.	.	.
ILLINOIS RIVER, EAST FORK	102.20	0	0	0	9	9	MI				.	.	.	.	.	.	.
INDIAN CREEK	105.32	0	0	0	13	13	MI				.	.	.	.	.	.	.
INDIAN CREEK	106.31	0	0	0	12	12	MI				.	.	.	.	.	.	.
INMAN CREEK	113.70	0	5	0	0	5	MI				.	.	.	.	.	.	.
JACOBY CREEK	110.00	8	2	0	0	10	MI				.	.	.	.	.	.	.

REGION 1

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Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
JANES CREEK	110.00	0	3	0	0	3	MI				. . . . .
JEWETT CREEK	112.30	0	0	0	1	1	MI				. . . . .
JOE CREEK	102.30	0	0	0	3	3	MI				. . . . .
JOLLY GIANT CREEK	110.00	0	0	0	1	1	MI				. . . . .
JUAN CREEK	113.12	0	5	0	0	5	MI				. . . . .
JUG HANDLE CREEK	113.20	0	0	0	5	5	MI				. . . . .
JULIAS CREEK	113.11	0	0	0	1	1	MI				. . . . .
KIDDER CREEK	105.42	0	16	0	0	16	MI	Yes	DATA INDICATE QUALITY IS INTERMEDIATE. DOES NOT REQUIRE LISTING AT THIS TIME		. . . . .
KLAMATH RIVER	105.00	0	126	0	0	126	MI	Yes	SEDIMENTATION AND ELEVATED WATER TEMPERATURES HAVE IMPACTED FISHERY RESOURCES		. . . . .
KLAMATH RIVER, LOWER	105.10	0	68	0	0	68	MI				. . . . .
KLAMATH RIVER, MIDDLE	105.30	0	16	0	0	16	MI				. . . . .
LAGUNA DE SANTA ROSA	114.21	0	0	26	0	26	MI	Yes	LOW DISSOLVED OXYGEN AND HIGH AMMONIA LEVEL DUE TO NPS DISCHARGES HAVE IMPAIRED FISH AND WILDLIFE HABITAT		. X . . X . X
LARABEE CREEK	111.13	0	0	0	21	21	MI				. . . . .

R0033409

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
LEGGETT CREEK	111.32	0	0	0	1	1	MI				. . . . .
LINDSAY CREEK	109.10	0	7	0	0	7	MI				. . . . .
LITTLE GRASS VALLEY CREEK	106.31	0	6	0	0	6	MI				. . . . .
LITTLE JUAN CREEK	113.12	0	0	0	3	3	MI				. . . . .
LITTLE RIVER	108.20	0	0	0	17	17	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
LOST RIVER	105.93	0	26	0	0	26	MI	Yes	DATA INDICATE THAT WATER QUALITY CLASSIFICATION IS INTERMEDIATE. LISTING NOT REQUIRED AT THIS TIME		. . . . .
LUFFENHOLTZ CREEK	108.10	0	0	0	1	1	MI				. . . . .
MAD RIVER	109.00	0	90	0	0	90	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES. LISTING NOT JUSTIFIED AT THIS TIME		. . . . .
MAPLE CREEK	108.10	0	0	0	16	16	MI				. . . . .
MARK WEST CREEK	114.23	0	18	0	0	18	MI				. . . . .
MATTOLE RIVER	112.30	0	56	0	0	56	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
MCGARVEY CREEK	105.11	0	6	0	0	6	MI				. . . . .
MILL CREEK	103.13	0	0	0	12	12	MI				. . . . .

R0033410

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
MOFFETT CREEK	105.42	0	21	0	0	21	MI				. . . . .
MORRISON CREEK	103.11	0	0	0	3	3	MI				. . . . .
MULE CREEK	106.40	0	0	0	4	4	MI				. . . . .
MYNOT CREEK	105.11	0	0	0	3	3	MI				. . . . .
NAVARRO RIVER	113.50	0	25	0	0	25	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
NEW RIVER	106.14	25	0	0	0	25	MI				. . . . .
NOISY CREEK	107.30	0	0	0	10	10	MI				. . . . .
NOYO RIVER	113.20	0	35	0	0	35	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
NOYO RIVER, LITTLE NORTH FORK	113.20	0	6	0	0	6	MI				. . . . .
OMAGAR CREEK	105.11	0	0	0	3	3	MI				. . . . .
OUTLET CREEK	111.61	0	0	0	30	30	MI				. . . . .
PANTHER CREEK	107.20	0	4	0	0	4	MI				. . . . .
PATRICK CREEK	109.10	0	2	0	0	2	MI				. . . . .
PELLETREAU CREEK	106.22	0	0	0	7	7	MI				. . . . .
PHILPOT CREEK	106.25	0	0	0	5	5	MI				. . . . .

R0033411

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EXHIBIT 1

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 06/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
PINER CREEK	114.22	1	3	0	0	4	MI				. . . . .
POISON GULCH	106.15	0	0	0	2	2	MI				. . . . .
POST CREEK	106.23	0	0	0	5	5	MI				. . . . .
POTATO PATCH CREEK	105.11	0	0	0	6	6	MI				. . . . .
RATTLESNAKE CREEK	106.23	0	0	0	9	9	MI				. . . . .
REDWOOD CREEK	107.00	0	63	0	0	63	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
REDWOOD CREEK (NOYO TRIB.)	113.20	0	4	0	0	4	MI				. . . . .
ROCKPILE CREEK	113.82	0	25	0	0	25	MI				. . . . .
ROSELAND CREEK	114.21	0	5	0	0	5	MI				. . . . .
RUSH CREEK	106.31	0	0	0	14	14	MI				. . . . .
RUSSIAN RIVER	114.10	105	0	0	0	105	MI	Yes	WATER DIVERSIONS, POINT AND NON-POINT SOURCE DISCHARGES HAVE IMPACTED BENEFICIAL USES. LISTING NOT REQUIRED		. . . . .
RUSSIAN RIVER, EAST FORK	114.32	11	0	0	0	11	MI				. . . . .
RUSSIAN RIVER, LOWER	114.11	30	0	0	0	30	MI				. . . . .

REGION 1

NOV 12

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R0033412

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 0 M S L
											3 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9
SALMON RIVER	105.20	46	0	0	0	46	MI	Yes	SEDIMENTATION AND ELEVATED WATER TEMPERATURES HAVE IMPACTED FISHERY RESOURCES		. . . . .
SALT RIVER	111.11	0	0	0	8	8	MI				. . . . .
SANTA ROSA CREEK	114.22	5	11	0	0	16	MI				. . . . .
SCOTT RIVER	105.40	0	68	0	0	68	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
SHASTA RIVER	105.50	0	52	0	0	52	MI	Yes	WATER DIVERSIONS AND NON-POINT SOURCE DISCHARGES HAVE IMPACTED FISHERY RESOURCES		. . . . .
SMITH RIVER	103.00	50	0	0	0	50	MI	Yes	NON-POINT SOURCE DISCHARGES THREATEN BENEFICIAL USES. QUALITY IS GOOD. LISTING NOT JUSTIFIED		. . . . .
STEMPLE CREEK	115.40	0	0	17	0	17	MI	Yes	SEDIMENTATION, LOW DISSOLVED OXYGEN AND HIGH AMMONIA LEVELS FROM NPS DISCHARGES HAVE IMPAIRED FISH AND WILDLIFE HABITAT		. X . . X . X
SUMMIT CREEK	106.25	0	0	0	3	3	MI				. . . . .
SUN VALLEY CREEK	110.00	0	1	0	0	1	MI				. . . . .
SUPPLY CREEK	106.11	0	0	0	8	8	MI				. . . . .
TECTAN CREEK	105.11	0	10	0	0	10	MI				. . . . .
TEN MILE RIVER	113.13	0	10	0	0	10	MI				. . . . .

R0033413

REGION 1

VOL 12

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D N S L
TISH TANG CREEK	106.11	0	0	0	10	10	MI				. . . . .
TOMKI CREEK	111.62	0	18	0	0	18	MI	Yes	DATA INDICATE THAT THE WATER QUALITY CLASSIFICATION IS INTERMEDIATE. LISTING NOT REQUIRED AT THIS TIME		. . . . .
TRAMWAY GULCH	113.50	0	2	0	0	2	MI				. . . . .
TRINITY RIVER	106.00	60	110	0	0	170	MI	Yes	FLOW DIVERSIONS AND SEDIMENTATION HAVE IMPACTED BENEFICIAL USES		. . . . .
TRINITY RIVER, EAST FORK, SOUTH FORK	106.23	0	0	0	8	8	MI				. . . . .
TRINITY RIVER, LOWER	106.11	0	30	0	0	30	MI				. . . . .
TRINITY RIVER, SOUTH FORK	106.20	0	0	0	80	80	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
TURNAR CREEK	105.11	0	11	0	0	11	MI				. . . . .
USAL CREEK	113.11	0	6	0	0	6	MI				. . . . .
VAN DUZEN RIVER	111.20	0	63	0	0	63	MI	Yes	SEDIMENTATION FROM NATURAL AND HUMAN SOURCES HAS IMPACTED BENEFICIAL USES		. . . . .
WEAVER CREEK	106.32	13	0	0	0	13	MI				. . . . .
WILSON CREEK	103.50	0	8	0	0	8	MI				. . . . .
WINCHESTER CREEK	108.20	0	0	0	1	1	MI				. . . . .

R0033414

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Region 1

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
WINCHUCK RIVER	101.00	0	0	0	8	8	MI				

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REGION 1

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CC-CC-09

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Ocean

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
NORTH (KLAMATH RIVER BASIN)		44	0	0	0	44	MI	Yes	POINT AND NON-POINT SOURCE DISCHARGES THREATEN BENEFICIAL USES		.	.	.	.	.	.	.	.	.
NORTH COAST BASIN (OCEAN, SAMOA PEN.)		0	0	1	0	1		Yes	Dioxin	Point	X	X	.	X	X	.	.	.	.
SOUTH (NORTH COASTAL BASIN)		295	0	0	0	295	MI	Yes	POINT AND NON-POINT SOURCE DISCHARGES THREATEN BENEFICIAL USES		.	.	.	.	.	.	.	.	.

R0033416

Region 1

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D M S L
											3 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1
BIG ELK LAKE	105.22	0	0	0	15	15	AC				. . . . .
BUCK LAKE	105.31	0	0	0	5	5	AC				. . . . .
CANYON CREEK LAKES	106.15	0	0	0	30	30	AC				. . . . .
CLEAR LAKE RESERVOIR	105.93	0	0	0	24805	24805	AC	Yes	INSUFFICIENT DATA TO JUSTIFY LISTING AT THIS TIME		. . . . .
COPCO LAKE	105.38	0	0	0	998	998	AC				. . . . .
CUDDIHY LAKES (SW)	105.22	0	0	0	7	7	AC				. . . . .
DEVILS PUNCHBOWL	105.31	0	0	0	15	15	AC				. . . . .
EWING RESERVOIR	106.25	0	0	0	32	32	AC				. . . . .
GRANITE LAKE	106.40	0	0	0	18	18	AC				. . . . .
INDIAN TOM LAKE	105.91	0	0	0	480	480	AC				. . . . .
IRON GATE RESERVOIR	105.37	0	0	0	1020	1020	AC				. . . . .
JUANITA LAKE	105.81	55	0	0	0	55	AC				. . . . .
KLAMATH LAKE SUMP	105.91	0	0	0	16600	16600	AC				. . . . .
LAKE MENDOCINO	114.32	1960	0	0	0	1960	AC	Yes	DATA INDICATES WATER QUALITY CLASSIFICATION IS GOOD		. . . . .
LAKE PILLSBURY	111.63	0	0	0	2280	2280	AC				. . . . .

R0033417

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VOL 12

RADHOK 1

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
LAKE RALPHINE	114.22	26	0	0	0	26	AC				.	.	.	.	.	.	.	.	.
LAKE SHASTINA	105.50	1850	0	0	0	1850	AC				.	.	.	.	.	.	.	.	.
LAKE SONOMA	114.24	3600	0	0	0	3600	AC				.	.	.	.	.	.	.	.	.
LEWISTON LAKE	106.40	610	0	0	0	610	AC				.	.	.	.	.	.	.	.	.
LITTLE SOUTH FORK	105.24	0	0	0	10	10	AC				.	.	.	.	.	.	.	.	.
LONG GULCH LAKE	105.24	0	0	0	8	8	AC				.	.	.	.	.	.	.	.	.
LOST LAKE (2)	105.22	0	0	0	8	8	AC				.	.	.	.	.	.	.	.	.
LOWER WRIGHT LAKE	105.41	0	0	0	22	22	AC				.	.	.	.	.	.	.	.	.
MEISS LAKE	105.81	4000	0	0	0	4000	AC				.	.	.	.	.	.	.	.	.
PICAYUNE LAKE	106.40	0	0	0	15	15	AC				.	.	.	.	.	.	.	.	.
RUTH LAKE	109.40	1178	0	0	0	1178	AC				.	.	.	.	.	.	.	.	.
SPRING LAKE	114.22	0	0	0	154	154	AC				.	.	.	.	.	.	.	.	.
STODDARD LAKE	106.40	0	0	0	32	32	AC				.	.	.	.	.	.	.	.	.
SUGAR PINE LAKE	106.40	0	0	0	7	7	AC				.	.	.	.	.	.	.	.	.
TRINITY LAKE	106.40	16400	0	0	0	16400	AC				.	.	.	.	.	.	.	.	.
TULE LAKE SUMP	105.92	0	0	0	12416	12416	AC	Yes	INSUFFICIENT DATA TO JUSTIFY LISTING AT THIS TIME		.	.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1
VAN ARSDALE RESERVOIR	111.63	0	0	0	163	163	AC				.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 0 H S L
ALEXANDER VALLEY AREA		22	0	1	0	23	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
ANDERSON VALLEY		4	0	1	0	5	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
ANNAPOLIS OHLSON RANCH		9	0	1	0	10	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
BIG LAGOON AREA		0	0	0	5	5	SOMI				. . . . .
BIG RIVER VALLEY		4	0	1	0	5	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
BODEGA BAY AREA		4	0	1	0	5	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
BRANSCOMB TOWN AREA		0	0	0	5	5	SOMI				. . . . .
BRAY TOWN AREA		0	0	0	5	5	SOMI				. . . . .
BUTTE VALLEY		0	0	0	480	480	SOMI				. . . . .
CLOVERDALE AREA		8	0	1	0	9	SOMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
COTTONEVA CREEK VALLEY		0	0	0	5	5	SOMI				. . . . .
DINSMORES TOWN AREA		0	0	0	5	5	SOMI				. . . . .
EDEN VALLEY		0	0	0	5	5	SOMI				. . . . .

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COOC

Region 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 N	3 S	3 L	3	3	3	1	9
EEL RIVER VALLEY		119	0	1	0	120	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
EUREKA PLAIN		59	0	1	0	60	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
FAIRCHILD SWAMP VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
FORT BRAGG TERRACE AREA		23	0	1	0	24	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS AND FAILING SEPTIC SYSTEMS		.	.	.	.	.	.	.	.	.
GARBERVILLE TOWN AREA		4	0	1	0	5	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
GARCIA RIVER AREA		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
GRAVELLY VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
GUALALA RIVER VALLEY		4	0	1	0	5	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
HAPPY CAMP TOWN AREA		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
HAYFORK VALLEY		0	0	0	6	6	SQMI				.	.	.	.	.	.	.	.	.
HEALDSBURG AREA		26	0	1	0	27	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
HETTENSHAW VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.

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EXHIBIT 4

Region 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1	9
HONEYDEW TOWN AREA		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
HOOPA VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
HYAMPOM VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
KENWOOD VALLEY		0	0	0	6	6	SQMI				.	.	.	.	.	.	.	.	.
KLAMATH RIVER VALLEY		0	0	0	720	720	SQMI				.	.	.	.	.	.	.	.	.
KNIGHTS VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
LARABEE VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
LAYTONVILLE VALLEY		0	0	0	12	12	SQMI				.	.	.	.	.	.	.	.	.
LEGGETT AREA		1	0	1	0	2	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
LITTLE LAKE VALLEY		16	0	1	0	17	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.
LITTLE VALLEY		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
LOWER KLAMATH RIVER VALLEY		0	0	0	12	12	SQMI				.	.	.	.	.	.	.	.	.
LOWER LAYTONVILLE		0	0	0	5	5	SQMI				.	.	.	.	.	.	.	.	.
LOWER RUSSIAN RIVER VALLEY		8	0	1	0	9	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.

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EXHIBIT 1

Region 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D M S L
MAD RIVER VALLEY		59	0	1	0	60	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
MATTOLE RIVER VALLEY		0	0	0	5	5	SQMI				. . . . .
MCDOWELL VALLEY		0	0	0	3	3	SQMI				. . . . .
MODOC PLATEAU PVA		0	0	0	3000	3000	SQMI	Yes			. . . . .
MODOC PLATEAU RVA		999	0	1	0	1000	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
NAVARRO RIVER VALLEY		0	0	0	5	5	SQMI				. . . . .
PEPPERWOOD TOWN AREA		0	0	0	5	5	SQMI				. . . . .
POTTER VALLEY		0	0	0	13	13	SQMI				. . . . .
PRAIRIE CREEK AREA		0	0	0	40	40	SQMI				. . . . .
RED ROCK VALLEY		0	0	0	5	5	SQMI				. . . . .
REDWOOD CREEK VALLEY		0	0	0	5	5	SQMI				. . . . .
RINCON VALLEY		0	0	0	4	4	SQMI				. . . . .
ROUND VALLEY		0	0	0	23	23	SQMI				. . . . .
SANEL VALLEY		0	0	0	11	11	SQMI				. . . . .

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REGION 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
SANTA ROSA PLAINS		91	0	5	0	96	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS AND FAILING SEPTIC SYSTEMS		. . . . .
SCOTT RIVER VALLEY		0	0	0	80	80	SQMI				. . . . .
SEIAD VALLEY		4	0	1	0	5	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
SHASTA VALLEY		339	0	1	0	340	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
SHERWOOD VALLEY		0	0	0	5	5	SQMI				. . . . .
SMITH RIVER PLAIN		0	50	20	0	70	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS AND AGRICULTURAL CHEMICALS		. . . . .
TEN MILE RIVER VALLEY		0	0	0	5	5	SQMI				. . . . .
UKIAH VALLEY		15	0	1	0	16	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
WEAVERVILLE AREA		1	0	1	0	2	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		. . . . .
WEOTT TOWN AREA		0	0	0	5	5	SQMI				. . . . .
WILLIAMS VALLEY		0	0	0	5	5	SQMI				. . . . .

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Region 1

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	9
WINDSOR AREA		1	0	1	0	2	SQMI	Yes	WATER WELLS ARE IMPAIRED BY LEAKING UNDERGROUND TANKS		.	.	.	.	.	.	.	.	.

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REGION 1

Region 1

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
ALBION RIVER DELTA	113.40	0	0	0	128	128	AC				. . . . .
ALDER CREEK ESTUARY	113.63	0	0	0	9	9	AC				. . . . .
BEAR HARBOR ESTUARY	113.11	0	0	0	2	2	AC				. . . . .
BIG LAGOON	108.10	0	0	0	1220	1220	AC				. . . . .
BIG RIVER DELTA	113.30	0	0	0	215	215	AC				. . . . .
BIG SALMON CREEK ESTUARY	113.40	0	0	0	9	9	AC				. . . . .
BODEGA HARBOR WETLAND	115.20	416	0	0	0	416	AC				. . . . .
BRUSH CREEK ESTUARY	113.64	0	0	0	2	2	AC				. . . . .
CASPER CREEK ESTUARY	113.20	0	0	0	13	13	AC				. . . . .
CLARK'S SLOUGH	110.00	0	1	0	0	1	AC				. . . . .
CLEON LAKE WETLAND	113.20	0	0	0	32	32	AC				. . . . .
COTTONEVA CREEK ESTUARY	113.12	0	0	0	14	14	AC				. . . . .
CRESCENT CITY MARINE	103.11	0	0	0	100	100	AC				. . . . .
DEAD LAKE WETLAND	103.11	0	0	0	50	50	AC				. . . . .
DRY LAGOON	108.10	0	0	0	80	80	AC				. . . . .

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Region 1

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D	3 0 M	3 0 S	3 0	3 0	3 1	3 1 L
EEL RIVER DELTA	111.11	0	0	0	6350	6350	AC				.	.	.	.	.	.	.
ELK CREEK ESTUARY	113.62	0	0	0	17	17	AC				.	.	.	.	.	.	.
ESTERO AMERICANO	115.30	322	0	370	0	692	AC	Yes	SEDIMENTATION, LOW DISSOLVED OXYGEN AND HIGH AMMONIA LEVELS FROM NPS DISCHARGES HAVE IMPAIRED FISH AND WILDLIFE HABITAT		.	X	.	.	X	.	X
ESTERO DE SAN ANTONIO	115.40	64	0	255	0	319	AC	Yes	SEDIMENTATION, LOW DISSOLVED OXYGEN AND HIGH AMMONIA LEVELS FROM NPS DISCHARGES HAVE IMPAIRED FISH AND WILDLIFE HABITAT		.	X	.	.	X	.	X
EUREKA SLOUGH	110.00	0	0	0	4	4	AC				.	.	.	.	.	.	.
FRESHWATER LAGOON	108.10	245	0	0	0	245	AC				.	.	.	.	.	.	.
GARCIA RIVER DELTA	113.70	0	0	0	264	264	AC				.	.	.	.	.	.	.
GREENWOOD CREEK ESTUARY	113.61	0	0	0	14	14	AC				.	.	.	.	.	.	.
GUALALA RIVER DELTA		0	0	0	20	20	AC				.	.	.	.	.	.	.
HARDY CREEK ESTUARY	113.12	0	0	0	6	6	AC				.	.	.	.	.	.	.
HATMAWAY CREEK ESTUARY	113.70	0	0	0	80	80	AC				.	.	.	.	.	.	.
HUMBOLDT BAY NWR	110.00	0	0	0	115	115	AC				.	.	.	.	.	.	.
HUNTERS LAGOON	113.64	0	0	0	86	86	AC				.	.	.	.	.	.	.

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Region 1

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
INGLENOOK CREEK ESTUARY	113.20	0	0	0	5	5	AC				. . . . .
INGLENOOK FEN	113.20	0	0	0	2	2	AC				. . . . .
JACKASS CREEK ESTUARY	113.11	0	0	0	3	3	AC				. . . . .
KLAMATH RIVER DELTA	105.11	0	0	0	400	400	AC				. . . . .
LAGUNA CREEK MARSH	113.64	0	0	0	20	20	AC				. . . . .
LAKE EARL	103.11	2521	0	0	0	2521	AC				. . . . .
LAKE EARL WETLAND	103.11	0	0	0	2290	2290	AC				. . . . .
LAKE TALAWA	103.11	0	0	0	270	270	AC				. . . . .
LITTLE RIVER ESTUARY	108.20	0	0	0	2	2	AC				. . . . .
MAD RIVER ESTUARY	109.10	0	0	0	100	100	AC				. . . . .
MAD RIVER SLOUGH	100.00	0	0	0	450	450	AC				. . . . .
MATTOLE RIVER ESTUARY	112.30	0	0	0	175	175	AC				. . . . .
NAVARRO RIVER DELTA	113.50	0	0	0	20	20	AC				. . . . .
NOYO RIVER ESTUARY	113.20	0	0	0	82	82	AC				. . . . .
PUDDING CREEK	113.20	0	0	0	58	58	AC				. . . . .

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COPY

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EXHIBIT 1

Region 1

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 I D M S L
ESTUARY											
REDWOOD CREEK DELTA	107.10	0	0	0	5	5	AC				. . . . .
RUSSIAN RIVER DELTA	114.11	100	0	0	0	100	AC				. . . . .
SALMON CREEK LAGOON	115.10	0	0	0	40	40	AC				. . . . .
SANDHILL LAKE ESTUARY	113.20	0	0	0	25	25	AC				. . . . .
SMITH RIVER DELTA	113.11	0	0	0	415	415	AC				. . . . .
STONE LAGOON	108.10	0	0	0	521	521	AC				. . . . .
TEN MILE RIVER DELTA	113.13	0	0	0	109	109	AC				. . . . .
USAL CREEK ESTUARY	113.11	0	0	0	10	10	AC				. . . . .

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ANCHOR 1

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Region 1

Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D H S L
ARCATA BAY	110.00	0	8500	0	0	8500	AC	Yes	POINT AND NON-POINT SOURCE DISCHARGES HAVE IMPACTED BENEFICIAL USES. QUALITY OF BAY IS INTERMEDIATE, NOT IMPAIRED.		. . . . .
BODEGA BAY	115.00	5000	0	0	0	5000	AC	Yes	POINT AND NON-POINT SOURCE DISCHARGES THREATEN BENEFICIAL USES		. . . . .
BODEGA HARBOR	115.20	340	0	0	0	340	AC				. . . . .
CRESCENT CITY HARBOR	103.11	384	0	0	0	384	AC				. . . . .
HUMBOLDT BAY	110.00	0	8000	0	0	8000	AC	Yes	POINT AND NON-POINT SOURCE DISCHARGES HAVE IMPACTED BENEFICIAL USES. QUALITY IS INTERMEDIATE, NOT IMPAIRED		. . . . .

R0033430

COOCO

VOL 12

MEMOR 1

Region 1

Areas of Special Biological Significance

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
BODEGA MARINE REFUGE	115.20	200	0	0	0	200	AC				. . . . .
DEL MAR LANDING RESERVE	113.85	77	0	0	0	77	AC				. . . . .
GERSTLE COVE	113.85	2	0	0	0	2	AC				. . . . .
KELP BEDS SAUNDERS REEF	113.70	618	0	0	0	618	AC				. . . . .
KELP BEDS TRINIDAD	108.10	1581	0	0	0	1581	AC				. . . . .
KINGS RANGE NATIONAL CONSERVATION AREA	112.30	3680	0	0	0	3680	AC				. . . . .
PYGMY FOREST ASBS	108.10	259	0	0	0	259	AC				. . . . .
REDWOOD NATIONAL PARK	117.10	4160	0	0	0	4160	AC				. . . . .

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Region 2

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
ALAMEDA CREEK	204.30	0	0	27	0	27	MI	Yes	Threat of recreational impacts Fisheries habitat degradation	Non-Point	X X . . X . X
ALAMITOS CREEK	205.40	0	0	14	7	21	MI	Yes	Recreational impacts High concentrations of mercury in fish	Non-Point	X X . . X . X
ARROYO DE LA LAGUNA	204.30	0	0	5	0	5	MI	Yes	Total Dissolved Solid, Chlorides violate objectives	Non-Point	. X . . X . X
CORTE MADERA CREEK	206.20	0	0	0	14	14					. . . . .
COYOTE CREEK (REG 2)	205.30	26	34	0	0	60	MI	Yes	Threat of drinking water impairment Threat of recreational impacts Threat of objectives violated	Non-Point	X . . . . .
GUADALUPE CREEK	205.40	0	0	6	0	6	MI	Yes	Elevated fish tissue levels	Non-Point	X X . . X . X
GUADALUPE RIVER	205.40	0	0	12	0	12	MI	Yes	Elevated fish tissue levels Fish population decline	Non-Point	X X . . X . X
LAGUNITAS CREEK	201.13	0	0	22	0	22	MI	Yes	Sedimentation	Non-Point	. X . . X . X
LOS GATOS CREEK (REG 2)	205.40	0	0	0	20	20	MI	Yes	Sedimentation Urban nonpoint pollution	Non-Point	. . . . .
NAPA RIVER	206.50	0	15	40	0	55	MI	Yes	Eutrophication Sedimentation Degradation of fisheries habitat	Non-Point	. X . . X . X
PESCADERO CREEK (REG 2)	202.40	21	0	0	0	21	MI	Yes	Sedimentation	Non-Point	. . . . .

R0033432

Region 2

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
PETALUMA RIVER	206.30	0	5	20	0	25	MI	Yes	Eutrophication Sedimentation Fisheries habitat degradation	Non-Point	. X . . X . X
PILARCITOS CREEK	202.32	11	0	0	0	11		Yes			. . . . .
REDWOOD CREEK (REG 2)	201.30	13	0	0	0	13	MI	Yes			. . . . .
SAN ANTONIO CREEK (REG 2)	206.30	0	0	0	17	17	MI	Yes	Eutrophication	Non-Point	. . . . .
SAN FRANCISQUITO CREEK	205.50	0	0	0	10	10	MI				. . . . .
SAN GREGORIO CREEK	202.30	10	0	0	0	10	MI	Yes	Threat of sedimentation	Non-Point	. . . . .
SAN LEANDRO CREEK	204.20	0	12	0	0	12					. . . . .
SAN LORENZO CREEK	204.20	0	0	0	17	17					. . . . .
SONOMA CREEK	206.40	0	9	14	0	23	MI	Yes	Eutrophication Exceedance of coliform standard	Non-Point	. X . . X . X
SUISUN CREEK	207.22	0	0	0	23	23					. . . . .
WALKER CREEK (REG 2)	201.12	0	0	25	0	25	MI	Yes	Nonpoint source pollution - dairies	Non-Point	. X . . X . X
WALNUT CREEK	207.32	0	0	0	12	12					. . . . .

R0033433

COPY

ANCHOR 2

VOL 12

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 2

Ocean

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 P	3 M	3 S	3 L	3	3	3	1	0	0	0	1	1	.3	4	4	4	6	9	1
PACIFIC OCEAN COAST		112	0	0	0	112																								

REGION 2

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R0033434

Region 2

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
ALMADEN RES	205.40	0	62	0	0	62	AC	Yes		Non-Point	X	.	.	.	.	.	.	.	.
ALPINE LAKE	201.13	219	0	0	0	219	AC	Yes			.	.	.	.	.	.	.	.	.
ANDERSON RES	205.30	0	1600	0	0	1600	AC	Yes		Non-Point	X	.	.	.	.	X	.	.	.
BEAR GULCH RES	205.50	25	0	0	0	25		Yes			.	.	.	.	.	.	.	.	.
BELL CANYON		68	0	0	0	68	AC	Yes		Non-Point	.	.	.	.	.	.	.	.	.
BERKELEY AQUATIC PARK LAGOON	203.00	0	65	0	0	65		Yes	Recreational impacts Eutrophication	Non-Point	.	.	.	.	.	.	.	.	.
BON TEMPE LAKE	201.13	140	0	0	0	140		Yes			.	.	.	.	.	.	X	.	.
BRIONES RES	206.60	730	0	0	0	730		Yes			.	.	.	.	.	.	.	.	.
CALAVERAS RES	204.30	1450	0	0	0	1450		Yes			.	.	.	.	.	.	.	.	.
CALERO RES	205.40	0	0	350	0	350	AC	Yes	Mercury exceeds FDA in fish	Non-Point	X	X	.	.	X	X	X		
CHABOT LAKE (ALAMEDA)	204.20	315	0	0	0	315		Yes			.	.	.	.	.	.	.	.	.
CHABOT LAKE (SOLANO)	206.50	0	0	0	50	50	AC	Yes		Non-Point	.	.	.	.	.	X	.	.	.
COYOTE RES	205.30	0	640	0	0	640	AC	Yes	Elevated shellfish tissue levels	Non-Point	X	.	.	.	.	X	.	.	.
CRYSTAL SPRINGS, LOWER	204.40	1492	0	0	0	1492		Yes			.	.	.	.	.	.	.	.	.
CRYSTAL SPRINGS,	204.40	682	0	0	0	682		Yes			.	.	.	.	.	.	.	.	.

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Region 2

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 D	3 0 3 4 M	3 0 4 4 S	3 0 4 4 L	3 1 4 9	3 1	3 1
UPPER																	
CULL CANYON RES	204.20	0	19	0	0	19					.	.	.	.	.	X	.
DALWICK LAKE	206.50	0	0	0	35	35					.	.	.	.	.	X	.
DON CASTRO RES	204.20	0	19	0	0	19					.	.	.	.	.	X	.
ELIZABETH LAKE (REG 2)	205.20	0	63	0	0	63	AC		Periodic elevated coliform	Non-Point	.	.	.	.	.	X	.
FELT LAKE	205.50	0	38	0	0	38		Yes	Eutrophication		.	.	.	.	.	X	.
FREMONT LAGOON	205.20	0	0	0	3	3					.	.	.	.	.	X	.
GUADALUPE RES	205.40	0	0	80	0	80	AC	Yes	Elevated fish tissue levels	Non-Point	X	X	.	.	X	X	X
HENNESSEY LAKE	206.50	850	0	0	0	850		Yes	Eutrophication	Non-Point	.	.	.	.	.	X	.
HERMAN LAKE	207.21	0	0	110	0	110	AC	Yes	Elevated fish tissue levels	Non-Point	X	X	.	.	X	X	X
HORSESHOE LAKE	204.20	0	0	0	1	1					.	.	.	.	.	X	.
KENT LAKE	201.13	265	0	0	0	265		Yes			.	.	.	.	.	X	.
LAFAYETTE LAKE	207.32	500	0	0	0	500		Yes			.	.	.	.	.	X	.
LAKE DEL VALLE	204.30	1060	0	0	0	1060		Yes			.	.	.	.	.	X	.
LEXINGTON LAKE	205.40	450	0	0	0	450		Yes	Threat of elevated fish tissue levels	Non-Point	.	.	.	.	.	.	.
MERRITT LAKE	204.20	0	160	0	0	160		Yes	Eutrophication	Non-Point	.	.	.	.	.	X	.

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Region 2

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 0 M	3 0 $	3 0 L	3 0	3 1	3 1	3 9
MILLIKEN RES	206.50	50	0	0	0	50		Yes			.	.	.	.	.	X	.
NICASIO RES	201.13	844	0	0	0	844		Yes			.	.	.	.	.	X	.
PHOENIX LAKE (REG 2)	203.20	18	0	0	0	18		Yes			.	.	.	.	.	X	.
PILARCITOS LAKE	202.22	109	0	0	0	109		Yes			.	.	.	.	.	.	.
RECTOR RES	206.50	90	0	0	0	90		Yes			.	.	.	.	.	.	.
SAN ANDREAS LAKE	204.40	550	0	0	0	550		Yes			.	.	.	.	.	.	.
SAN ANTONIO RES	204.30	825	0	0	0	825		Yes			.	.	.	.	.	.	.
SAN LEANDRO RES	204.20	788	0	0	0	788		Yes			.	.	.	.	.	.	.
SAN PABLO RES	206.60	854	0	0	0	854		Yes			.	.	.	.	.	X	.
SCOTTSDALE LAKE	206.20	0	0	0	15	15		Yes			.	.	.	.	.	X	.
SEARSVILLE LAKE	205.50	0	109	0	0	109					.	.	.	.	.	.	.
SOULA JULE RES	201.13	63	0	0	0	63		Yes			.	.	.	.	.	.	.
STAFFORD LAKE	206.20	245	0	0	0	245		Yes	Eutrophication	Non-Point	.	.	.	.	.	X	.
STEVENS CREEK	205.50	95	0	0	0	95		Yes			.	.	.	.	.	.	.
TEMESCAL LAKE	203.30	0	10	0	0	10		Yes			.	.	.	.	.	X	.
VASONA LAKE	205.40	0	0	0	58	58		Yes			.	.	.	.	.	X	.

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REGION 2

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 2

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
ARROYO DEL HAMBRE		0	0	0	2	2		Yes			. . . . .
CASTRO VALLEY		0	0	0	4	4	SQMI				. . . . .
CLAYTON VALLEY		0	30	0	0	30					. . . . .
EAST BAY PLAIN		0	0	0	0	0	SQMI				. . . . .
HALF MOON BAY TERRANCE		0	0	0	25	25					. . . . .
ISLAIS VALLEY		0	0	0	3	3					. . . . .
KENWOOD VALLEY		0	0	0	0	0	SQMI				. . . . .
LIVERMORE VALLEY		0	100	0	0	100	SQMI	Yes	Drinking water impairment Threat of drinking water impairment fuel leaks/VOC pollution	Point	. . . . .
MERCED VALLEY		0	0	0	8	8		Yes	Drinking water impairment Threat of drinking water impairment fuel leaks/VOC pollution	Point & Non-Point	. . . . .
NAPA VALLEY		0	0	0	230	230	SQMI	Yes		Point & Non-Point	. . . . .
NAPA-SONOMA VOL NI		0	0	0	150	150					. . . . .
NILES CONE		76	0	20	0	96	SQMI	Yes	Drinking water impairment Threat of drinking water impairment Fuel leaks/VOC pollution	Point & Non-Point	. . . . .
NOVATO VALLEY		0	0	0	35	35					. . . . .

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Region 2

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3 3	3 4	3 4	3 4	3 9
PESCADERO VALLEY		0	0	0	8	8					.	.	.	.	.	.	.	.	.
PETALUMA VALLEY		41	0	0	0	41	SQMI	Yes		Non-Point	.	.	.	.	.	.	.	.	.
PITTSBURG PLAIN		0	0	30	0	30	SQMI	Yes	Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.	.	.
ROSS VALLEY		0	0	0	6	6					.	.	.	.	.	.	.	.	.
SAN FRANCISCO SAND		0	0	0	24	24					.	.	.	.	.	.	.	.	.
SAN GREGORIO VALLEY		0	0	0	10	10					.	.	.	.	.	.	.	.	.
SAN PEDRO VALLEY		0	0	0	2	2					.	.	.	.	.	.	.	.	.
SAN RAFAEL VALLEY		0	0	0	3	3					.	.	.	.	.	.	.	.	.
SAN RAMON VALLEY		0	30	0	0	30	SQMI				.	.	.	.	.	.	.	.	.
SAND POINT AREA		0	0	0	2	2	SQMI				.	.	.	.	.	.	.	.	.
SANTA CLARA VALLEY		330	0	20	0	350	SQMI	Yes	Drinking water impairment Threat of drinking water impairment fuel leaks/VOC pollution	Point & Non-Point	.	.	.	.	.	.	.	.	.
SEBASTOPOL-MERCED		0	0	0	150	150	SQMI				.	.	.	.	.	.	.	.	.
SONOMA VALLEY		0	0	0	50	50	SQMI	Yes			.	.	.	.	.	.	.	.	.
SOUTH BAY		0	0	0	1	1	SQMI				.	.	.	.	.	.	.	.	.
SUISUN FAIRFIELD VALLEY		0	0	0	260	260					.	.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 2

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 D	3 0 M	3 0 S	3 1 L	3 4	4 4	4 6	9 9
SUISUN VALLEY		20	0	0	0	20		Yes			.	.	.	.	.	.	.	.
VISITATION VALLEY		0	0	0	3	3					.	.	.	.	.	.	.	.
YGNACIO VALLEY		0	30	0	0	30	SQMI				.	.	.	.	.	.	.	.

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Region 2

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3
											1	0	0	0	0	1	1
											.	3	4	4	4	4	9
											1						
BAIR ISLAND		0	0	0	960	960		Yes			.	.	.	.	.	.	.
BOLINAS LAGOON	201.30	0	850	0	0	850					.	.	.	.	.	.	.
COON ISLAND		0	0	0	250	250					.	.	.	.	.	.	.
CORTE MADERA ER		0	0	0	85	85					.	.	.	.	.	.	.
CORTE MADERA MARSH		0	0	0	200	200					.	.	.	.	.	.	.
DAY ISLAND		0	0	0	75	75					.	.	.	.	.	.	.
DRAKES ESTERO	201.20	0	2560	0	0	2560					.	.	.	.	.	.	.
FAGEN SLOUGH		0	0	0	330	330					.	.	.	.	.	.	.
GALLINAS CREEK MARSH		0	0	0	850	850					.	.	.	.	.	.	.
LIMANTOUR ESTERO	201.20	0	1	0	0	1					.	.	.	.	.	.	.
N RICHMOND MARSH		0	0	0	400	400					.	.	.	.	.	.	.
NAPA MARSHES		0	0	0	10000	10000					.	.	.	.	.	.	.
NOVATO CREEK MARSH		0	0	0	130	130					.	.	.	.	.	.	.
PESCADERO MARSH		0	0	0	520	520					.	.	.	.	.	.	.
PETALUMA RIVER MARSH		0	0	0	3800	3800					.	.	.	.	.	.	.
PILLAR MARSH		0	0	0	30	30					.	.	.	.	.	.	.

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REGION 2

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Region 2

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 H	3 S	3 L	3	3	3	1
POINT EDITH WETLANDS		0	0	0	380	380					.	.	.	.	.	.	.	.
POMPONIO CREEK LAGOON		0	0	0	1	1					.	.	.	.	.	.	.	.
PRINCETON MARSH		0	0	0	30	30					.	.	.	.	.	.	.	.
PT REYES PENNINSULA		0	0	0	2333	2333					.	.	.	.	.	.	.	.
REDWOOD SHORES ER		0	0	0	100	100					.	.	.	.	.	.	.	.
RODEO LAGOON		0	0	0	38	38					.	.	.	.	.	.	.	.
SACRAMENTO SAN JOAQUIN DELTA	207.10		B/D			3400		Yes	Fish population decline Elevated fish and shellfish tissue level Aquatic habitat degradation		X	X	.	.	X	.	X	B/D
SAN GREGORIO CREEK LAGOON		0	0	0	6	6					.	.	.	.	.	.	.	.
SAN PABLO BAY WETLANDS	206.10	0	0	0	35000	35000				Point & Non-Point	.	.	.	.	.	.	.	.
SAN PEDRO HILL MARSH		0	0	0	50	50					.	.	.	.	.	.	.	.
SAN RAFAEL CREEK MARSH		0	0	0	200	200					.	.	.	.	.	.	.	.
SANDPIPER WETLANDS		0	0	0	13	13					.	.	.	.	.	.	.	.
SOUTH HAMPTON BAY WETLANDS		0	0	0	300	300					.	.	.	.	.	.	.	.

REGION 2

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VOL 12

CO--CO

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 2

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	9	B/D
SUISUN MARSH	207.23			B/D		57000		Yes	Aquatic & wildlife habitat impaired	Point & Non-Point	X	X		X		X				B/D
TOMALES BAY WETLANDS	201.11	0	0	0	1905	1905					.	.	.	.	.	.	.	.	.	
TUNITAS CREEK LAGOON		0	0	0	11	11					.	.	.	.	.	.	.	.	.	
WALKER CREEK MARSH		0	0	0	15	15					.	.	.	.	.	.	.	.	.	
WHITE SLOUGH		0	0	0	40	40					.	.	.	.	.	.	.	.	.	

R0033443

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 2

Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	0	0	0	1	1	.	3	4	4	6	4	9	1	1	1	1	1	1	1
CARQUINEZ STRAIT	207.10			B/D		6560		Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X																		B/D
PEYTON SLOUGH	207.10	0	0	1	0	1		Yes	Metals exceed shallow water effluent limits.	Point	X	X	.	X	X	.	.																		B/D
[illegible] BAY	203.13			B/D		2560		Yes	Eutrophication Elevated coliform Urban runoff	Point & Non-Point	X	X	.	.	X	.	X																		B/D
SAN FRANCISCO BAY, CENTRAL	203.12			B/D		67700	SQMI	Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X																		B/D
SAN FRANCISCO BAY, LOWER	204.10			B/D		79900		Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X																		B/D
SAN FRANCISCO BAY, SOUTH	205.10	0	0	24500	0	24500		Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	X	X	.	X																		B/D
SAN PABLO BAY	206.10			B/D		71300		Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X																		B/D
SUISUN BAY	207.10			B/D		25000		Yes	Fish population decline Elevated fish tissue levels Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X																		B/D
TOMALES BAY	201.11	0	0	7820	0	7820		Yes	Coliform, Shellfish harvest closure.	Non-Point	X	X	.	.	X	.	X																		

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Region 2

Areas of Special Biological Significance

Water Body Name	Hydro. Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D N S L
BIRD ROCK		72	0	0	0	72		Yes			. . . . .
DOUBLE POINT		86	0	0	0	86		Yes			. . . . .
DUXBURY REEF RSRV		1626	0	0	0	1626		Yes			. . . . .
FARALLON ISLAND		2000	0	0	0	2000		Yes		Non-Point	. . . . .
JAMES FITZGERALD RESERVE	202.21	1006	0	0	0	1006		Yes	Elevated shellfish tissue levels		. . . . .
POINT REYES		1359	0	0	0	1359		Yes			. . . . .

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Region 3

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	1	1
ANTONELLIS POND	304.12	0	12	0	0	12	AC	No	elevated bateria levels	Non-Point	.	.	.	.	.	.	.	.
CORCORAN LAGOON	304.13	12	0	0	0	12	AC	No	Minor exceedance of bacteria criteria	Non-Point	.	.	.	.	.	.	.	.
ESPINOSA SLOUGH	309.10	0	0	320	0	320	AC	Yes	Return Ag flows carrying pesticides. Objectives violated Elevated fish tissue levels	Non-Point	X	X	.	.	X	.	X	.
GRAVES WETLAND	314.10	0	0	0	30	30	AC	No	Bordered by 50% urban, 50% ag. land		.	.	.	.	.	.	.	.
MARINA PONDS	309.10	0	0	0	5	5	AC	No			.	.	.	.	.	.	.	.
MEARY'S LAGOON	304.12	0	35	0	0	35	AC	No			.	.	.	.	.	.	.	.
TEMBLADERO SLOUGH	309.10	0	0	1000	0	1000	AC	Yes	Potential water quality limited segment Elevated pesticides in fish tissue Ag/Urban runoff entering slough	Non-Point	X	X	.	.	X	.	X	.
TEQUISQUITA SLOUGH	305.40	300	0	0	0	300	AC	No			.	.	.	.	.	.	.	.
YOUNGER'S LAGOON	304.12	0	0	0	10	10	AC	No	Limited information available		.	.	.	.	.	.	.	.

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Region 3

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1
AGUA CALIENTE CREEK	314.51	0	0	0	16	16	MI	No	Limited information available		.	.	.	.	.	.	.	.
ALAMO CREEK	312.30	0	0	0	10	10	MI	No	Limited information available		.	.	.	.	.	.	.	.
ALAMO PINTADO CREEK	314.40	0	0	0	12	12	MI	No	Limited information available		.	.	.	.	.	.	.	.
ALBA CREEK	304.13	0	0	1	0	1	MI	Yes	Sedimentation Low flows	Non-Point	.	X	.	.	X	.	X	.
AMAYA CREEK	304.13	0	3	0	0	3	MI	No	Log jams and landslides	Point & Non-Point	.	.	.	.	.	.	.	.
AMO NUEVO CREEK	304.11	5	0	0	0	5	MI	No	Limited Information Available		.	.	.	.	.	.	.	.
APTOS CREEK	304.13	0	7	1	0	8	MI	Yes	Fish population decline Sedimentation Elevated bacteria levels	Non-Point	.	X	.	.	X	.	X	.
ARROYO BURRO CREEK	315.32	0	0	5	0	5	MI	No	Threat of recreational impacts Bacteria in creek water may affect bacti levels of shellfish in SB channel	Non-Point	.	X	.	.	X	.	X	.
ARROYO DE LA CRUZ CREEK	310.12	0	10	0	0	10	MI	No	Limited Information Available		.	.	.	.	.	.	.	.
ARROYO GRANDE CREEK	310.31	0	0	0	19	19	MI	No	Limited Information Available		.	.	.	.	.	.	.	.
ARROYO SECO RIVER	309.60	40	0	0	0	40	MI	No	Info Available thru Mont. Co. Flood Con.		.	.	.	.	.	.	.	.
ATASCADERO CREEK	310.18	0	0	0	10	10	MI	No	Limited Information Available		.	.	.	.	.	.	.	.
ATASCADERO CREEK (SB)	315.31	0	0	0	5	5	MI	Yes	Limited information available		.	.	.	.	.	.	.	.

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D M S L
BALDWIN CREEK	304.11	4	0	0	0	4	MI	No	Limited information available		. . . . .
BATES CREEK	304.13	0	3	0	0	3	MI	No	Sedimentation Natural log jams, blockages to fisg mig. Silted dam prevents fish migration	Point & Non-Point	. . . . .
BEAN CREEK	304.12	0	13	0	0	13	MI	No	Fish population decline Sedimentation Residential septic systems	Point & Non-Point	. . . . .
BEAR CREEK	304.12	0	12	0	0	12	MI	No	Sedimentation Recreational impacts Fecal Coliform	Non-Point	. . . . .
BENNETT CREEK	304.13	0	2	0	0	2	MI	No	Quarry Operations on Creek	Point	. . . . .
BIG CREEK	304.11	7	0	0	0	7	MI	No	Limited Information Available		. . . . .
BIG SUR RIVER	308.00	0	21	0	0	21	MI	Yes	Elevated bacteria levels	Point & Non-Point	. . . . .
BIXBY CREEK	308.00	0	0	0	6	6	MI	No	Flows year round		. . . . .
BLACKBURN GULCH	304.13	0	2	0	0	2	MI	No	Limited Information Available		. . . . .
BODFISH CREEK	305.20	6	0	0	0	6	MI	No	Limited Information Available		. . . . .
BOULDER CREEK	304.12	0	7	0	0	7	MI	No	Sedimentation Recreational impacts Fecal coliform levels	Non-Point	. . . . .
BRANCIFORTE CREEK	304.12	0	10	0	0	10	MI	No	Sedimentation	Non-Point	. . . . .

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Region 3

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
BROWNS CREEK	305.10	0	5	0	0	5	MI	No	Sedimentation	Non-Point	. . . . .
BULL CREEK	304.12	0	2	0	0	2	MI	No	Limited Information Available		. . . . .
BURNETT CREEK	310.12	0	0	0	9	9	MI	No	Limited Information Available		. . . . .
BURNS CREEK	304.13	0	0	3	0	3	MI	Yes	Sedimentation Fish habitat impaired Sedimentation	Non-Point	. X . . X . X
CACHAGUA CREEK	307.00	13	0	0	0	13	MI	No	Limited information available		. . . . .
CARBONERA CREEK	304.12	0	0	13	0	13	MI	Yes	Sedimentation Fish population decline Elevated bacteria levels	Point & Non-Point	. X . . X . X
CARMEL RIVER	307.00	0	35	0	0	35	MI	Yes	Sedimentation Slightly raised bacteria levels Threat of drinking water impairment	Non-Point	. . . . .
CARPINTERIA CREEK	315.34	0	6	0	0	6	MI	No	Limited Information Available		. . . . .
CAYUCOS CREEK	310.16	6	0	0	0	6	MI	No	Limited Information Available		. . . . .
CHALONE CREEK	309.70	0	0	15	0	15	MI	Yes	Info available from Mont. Co. Flood Con.		. X . . X . X
CHORRO CREEK	310.22	0	3	10	0	13	MI	No	CMC dicharge Inactive mines/Sedimentation Threat of drinking water impairment	Point & Non-Point	X X . . X . X
CLEAR CREEK	304.13	0	2	0	0	2	MI	No	Sedimentation Threat of drinking water impairment	Non-Point	. . . . .

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Region 3

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D N S L
CLIPPER GULCH	305.10	0	1	0	0	1	MI	No	Sedimentation	Non-Point	. . . . .
COOKHOUSE GULCH	305.10	1	0	0	0	1	MI	No	Limited Information Available		. . . . .
CORRALITOS CREEK	305.10	0	10	0	0	10	MI	No	Sedimentation	Non-Point	. . . . .
CUYAMA RIVER	312.30	0	91	0	0	91	MI	Yes	Elevated levels of NO3, SO4, TDS in river below Twitchell Res. Limited information available	Non-Point	. . . . .
DAIRY CREEK	310.22	0	4	0	0	4	MI	No	Mines near head waters Suspected natural Cr. in sediments	Non-Point	X . . . . .
DAVIS CREEK	314.10	0	0	0	4	4	MI	No			. . . . .
DEER CREEK	304.12	0	3	0	0	3	MI	No	Sedimentation Periodic elevated nutrient/bacteria lev.	Non-Point	. . . . .
DIABLO GULCH CREEK	305.10	0	0	2	0	2	MI	Yes	Sedimentation Low flows	Non-Point	. X . . X . X
DOYLE GULCH CREEK	304.13	3	0	0	0	3	MI	No	Limited Information Available		. . . . .
EL JARO CREEK	310..24	3	0	0	0	3	MI	No	Limited Information Available		. . . . .
ESTRELLA RIVER	317.00	0	55	0	0	55	MI	No	Limited Information Available		. . . . .
EUREKA GULCH	305.10	0	2	0	0	2	MI	No	Sedimentation Main sedimentation source to Corralitos	Non-Point	. . . . .
FALL CREEK	304.12	3	0	0	0	3	MI	No	Limited Information Available		. . . . .

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Region 3

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 D	3 0 3 4 M	3 0 4 4 S	3 0 4 4 L	3 1 4 9
FRITCH CREEK	304.13	1	0	0	0	1	MI	No	Limited Information Available		.	.	.	.	.
GAMECOCK CREEK	305.10	0	2	0	0	2	MI	No	Sedimentation	Point & Non-Point	.	.	.	.	.
GARRAPATA CREEK	308.00	0	0	0	7	7	MI	No	Limited information available		.	.	.	.	.
GAZOS CREEK	304.11	8	0	0	0	8	MI	No	Limited information available		.	.	.	.	.
GLEN ANNE CREEK	315.10	0	0	0	2	2	MI	No	Limited Information Available		.	.	.	.	.
GOLD GULCH CREEK	304.12	0	0	2	0	2	MI	Yes	Sedimentation Low flows	Point & Non-Point	.	X	.	.	X	.	X
GRANITE CREEK	304.12	0	3	0	0	3	MI	No	Limited Information Available		.	.	.	.	.
GREEN OAKS CREEK	304.11	0	0	0	3	3	MI	No	Limited information available		.	.	.	.	.
GROVER GULCH	304.14	0	0	3	0	3	MI	Yes	Sedimentation Log jams and other natural blockages hamper fish migration.	Non-Point	.	X	.	.	X	.	X
HARE CREEK	304.12	0	2	0	0	2	MI	No	Sedimentation Periodic elevated nutrient/bacti. levels	Non-Point	.	.	.	.	.
HESTER CREEK	304.13	0	4	0	0	4	MI	No	Limited Information Available	Non-Point	.	.	.	.	.
HINCKLEY CREEK	304.13	0	4	0	0	4	MI	No	Threat of fish population decline Threat of sedimentation Threat of objectives violated	Non-Point	.	.	.	.	.
HUASNA RIVER	312.30	25	0	0	0	25	MI	Yes	Limited information available		.	.	.	.	.

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D N S L
INDIAN CREEK	314.51	10	0	0	0	10	MI	No	Limited Information Available		. . . . .
JALAMA CREEK	314.10	0	0	0	11	11	MI	No	Year round flow		. . . . .
JAMISON CREEK	304.12	0	2	0	0	2	MI	No	Sedimentation Periodic elevated nutrient/bacti levels	Non-Point	. . . . .
KINGS CREEK	304.13	0	8	0	0	8	MI	No	Sedimentation Low flows	Non-Point	. . . . .
LAGUNA CREEK	304.11	0	7	0	0	7	MI	No	Sedimentation Threat of drinking water impairment	Non-Point	. . . . .
LAS TABLAS CREEK	309.81	0	0	5	0	5	MI	Yes	Potential Water Quality Limited Segment Toxic discharge from Buena Vista mine Drinking water impairment	Point & Non-Point	X X . . X . X
LAS TABLAS CREEK, NORTH FORK	309..81	0	4	1	0	5	MI	Yes	Drinking water impairment Threat of fish kills Threat of fish population decline	Point & Non-Point	X X . . X . X
LAS TABLAS CREEK, SOUTH FORK	309.81	0	3	1	0	4	MI	Yes	Drinking water impairment Threat of fish kills Threat of fish population decline	Point & Non-Point	X X . . X . X
LAURAL CREEK	304.13	0	3	0	0	3	MI	No	Sedimentation Threat of fish population decline Threat of sedimentation	Non-Point	. . . . .
LIDDELL CREEK	304.11	0	3	0	0	3	MI	No	Sedimentation Threat of drinking water impairment	Non-Point	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
LIMEKILN CREEK	308.00	7	0	0	0	7	MI	No	Limited information available	Point	. . . . .
LITTLE CREEK	304.11	3	0	0	0	3	MI	No	Limited Information Available		. . . . .
LITTLE SUR RIVER	308.00	12	0	0	0	12	MI	No	Limited Information Available		. . . . .
LLAGAS CREEK	305.30	0	21	0	0	21	MI	No	Threat of drinking water impairment Recreational impacts Fecal Coliform levels	Point & Non-Point	. . . . .
LOCKHART GULCH CREEK	304.12	0	1	2	0	3	MI	Yes	Sedimentation Low flows	Non-Point	. X . . X . X
LOGAN CREEK	304.12	0	0	1	0	1	MI	Yes	Sedimentation Periodic elevated nutrients/bacti levels	Non-Point	. X . . X . X
LOMPICO CREEK	304.12	0	0	4	0	4	MI	Yes	Sedimentation Drinking water impairment Elevated bacteria levels	Non-Point	. X . . X . X
LOMPOC CANYON	310..24	0	0	0	2	2	MI	No	Limited Information Available		. . . . .
LOS OSOS CREEK	310.22	0	6	2	0	8	MI	Yes	Sedimentation Drains agricultural lands, flows into Morro Bay	Non-Point	. X . . X . X
LOVE CANYON CREEK	304.12	0	4	0	0	4	MI	No	Sedimentation Low flows	Non-Point	. . . . .
MACKENZE CREEK	304.13	2	0	0	0	2	MI	No	Limited Information Available		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 0 M S L	3 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9
MAJORS CREEK	304.11	0	5	0	0	5	MI	No	Sedimentation Threat of drinking water impairment	Non-Point	. . . . .	
MALOSKY CREEK	304.13	1	0	0	0	1	MI	No	Limited Information Available		. . . . .	
MARSHALL CREEK	304.12	0	0	2	0	2	MI	Yes	Sedimentation Low flows	Non-Point	. X . . X . X	
MASON CREEK	304.13	1	0	0	0	1	MI	No	Limited Information Available		. . . . .	
MILL CREEK	304.11	5	0	0	0	5	MI	No	Limited Information Available		. . . . .	
MILL CREEK (SLR)	304.12	1	0	0	0	1	MI	No	Limited Information Available		. . . . .	
MINERS CREEK	304.13	0	0	2	0	2	MI	Yes	Sedimentation	Non-Point	. X . . X . X	
MISSION CREEK	315.32	0	0	7	0	7	MI	Yes	Coliform	Non-Point	X X . . X . X	
MONO CREEK	314.51	21	0	0	0	21	MI	No	Limited Information Available		. . . . .	
MOORES GULCH	304.13	0	3	0	0	3	MI	No	Fish population decline Sedimentation	Non-Point	. . . . .	
MORMAN GULCH	305.10	0	1	0	0	1	MI	No	Limited information available		. . . . .	
MORRO CREEK	310.21	0	11	0	1	11	MI	No	Abandoned mines Suspect natural Cr in sediment	Non-Point	X	
MOUNTAIN CHARLIE GULCH	304.12	0	4	0	0	4	MI	No	Sedimentation Low flows	Non-Point	. . . . .	
NACIMIENTO RIVER	309.81	0	0	0	45	45	MI	No	Limited information available		. . . . .	

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Region 3

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D N S L
NEWELL CREEK	304.12	2	4	0	0	6	MI	No	Limited Information Available	Non-Point	. . . . .
OAK CANYON CREEK	310.24	0	0	0	2	2	MI	No	Limited information available		. . . . .
OLD CREEK	310..17	5	0	0	0	5	MI	No	Limited information available		. . . . .
OLD SALINAS RIVER	309.10	0	0	5	0	5	MI	Yes	Potential Water Quality Limited Segment Elevated fish tissue levels Threat of drinking water impairment	Non-Point	X X . . X . X
PACHECO CREEK	305.40	20	0	0	0	20	MI	No	Limited information available		. . . . .
PAJARO RIVER	305.10	0	40	0	0	40	MI	Yes	Pot. probs from pesticides in Ag. runoff Potential recreational impacts	Point & Non-Point	X . . . . .
PALO COLORADO CANYON	308.00	0	0	0	2	2	MI	No	Limited Information Available		. . . . .
PANCHO RICO CREEK	309.70	0	0	15	0	15	MI	Yes	Info available from Mont Co. Flood Cont.	Non-Point	. X . . X . X
PESCADERO CREEK	305.50	9	0	0	0	9	MI	No	Limited Information Available		. . . . .
PICO CREEK	310.13	0	2	0	0	2	MI	No	Threat of drinking water impairment Abandoned mine on south fork	Non-Point	. . . . .
PICO CREEK, NORTH FORK	310.13	8	0	0	0	8	MI	No	Limited Information Available		. . . . .
PICO CREEK, SOUTH FORK	310.13	7	0	0	0	7	MI	No	Limited Information Available		. . . . .
PISMO CREEK	310.26	6	0	0	0	6	MI	No	Limited Information Available		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 (3 T, 3 D, 3 N, 3 S, 4 L, 4 L, 4 L, 6 L, 9 L)
RAMSEY GULCH	305.10	0	2	0	0	2	MI	No	Sedimentation Threat of fish kills	Non-Point	. . . . .
RATTLESNAKE GULCH	305.10	0	1	0	0	1	MI	No	Sedimentation	Non-Point	. . . . .
REDWOOD CREEK	305.10	0	0	2	0	2	MI	Yes	Natural barriers to fish migration Low flows Sedimentation	Non-Point	. X . . X . X
RIDER GULCH CREEK	305.10	0	0	2	0	2	MI	Yes	Low flows Sedimentation Threat of fish population decline	Non-Point	. X . . X . X
RINCON CREEK	315.34	0	9	0	0	9	MI	No	Sedimentation	Non-Point	. . . . .
RUINS CREEK	304.13	0	0	3	0	3	MI	Yes	Low flows Sedimentation	Non-Point	. X . . X . X
SALINAS RIVER	309.10	120	30	30	0	180	MI	Yes	Potential Water Quality Limited Segment Ag return flows carrying toxic organics Elevated shellfish tissue levels	Point & Non-Point	X X X . X . X
SALISIPUDES CREEK	310.24	0	5	0	0	5	MI	No	Limited Information Available		. . . . .
SALMON CREEK	308.00	0	0	0	3	3	MI	Yes	Limited information available		. . . . .
SAN ANTONIO CREEK	313.00	0	30	0	0	30	MI	No	Limited Information Available		. . . . .
SAN ANTONIO RIVER	309.81	0	60	0	0	60	MI	Yes	Limited information available Threat of elevated cadmium levels		. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
SAN BENITO RIVER	305.00	0	80	0	0	80	MI	Yes	Mining activity at upstream locations (Hernandez Reservoir) Limited information available	Non-Point	. . . . .
SAN BERNARDO CREEK	310.22	0	5	0	0	5	MI	No	Abandoned mines at headwater	Non-Point	X . . . . .
SAN CLEMENTE CREEK	307.00	8	0	0	0	8	MI	No	Limited information available		. . . . .
SAN CORPOFORO CREEK	310.11	12	0	0	0	12	MI	No	Limited Information Available		. . . . .
SAN DIEGO CREEK	311.00	5	0	0	0	5	MI	No	Limited information available		. . . . .
SAN JOSE CREEK	307.00	8	0	0	0	8	MI	No	Limited Information Available		. . . . .
SAN LORENZO CREEK	309.70	0	0	39	0	39	MI	Yes	Info Available from Mont. Co. Flood Cont		. X . . X . X
SAN LORENZO RIVER	304.12	0	20	5	0	25	MI	Yes	Drinking water impairment Fish population decline Sedimentation/Elevated bacteria levels	Non-Point	X X . . X . X
SAN LUIS OBISPO CREEK	310.24	5	0	10	0	15	MI	Yes	Threat of drinking water impairment Fish pop. decline/spawning impairment Sedimentation	Point & Non-Point	X X . . X . X
SAN LUISITO CREEK	310.22	0	5	0	0	5	MI	No	Mines at headwaters Suspect natural Cr in sediments	Non-Point	X . . . . .
SAN MARCOS CREEK	309.81	11	0	0	0	11	MI	No	Limited information available		. . . . .
SAN MIGUELITO CREEK	314.10	0	0	0	5	5	MI	No	Spring fed, runs year round		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
SAN SIMEON CREEK	310.13	0	7	0	0	7	MI	No	Mines on creek headwaters Suspect natural mercury in sediments Threat of drinking water impairment	Non-Point	X . . . . .
SAN VICENTE CREEK	304.11	0	10	0	0	10	MI	No	Threat of sedimentation	Non-Point	. . . . .
SANTA CRUZ CREEK	314.51	9	0	0	0	9	MI	No	Limited Information Available		. . . . .
SANTA LUCIA CREEK	309..60	10	0	0	0	10	MI	No	Limited information available		. . . . .
SANTA MARIA RIVER	312.10	0	20	0	0	20	MI	No	Limited information available		. . . . .
SANTA MONICA CREEK	315.34	0	4	0	0	4	MI	No	Pesticides in stream sediments	Non-Point	. . . . .
SANTA RITA CREEK	309.81	12	0	0	0	12	MI	No	Limited Information Available		. . . . .
SANTA ROSA CREEK	314.20	0	12	0	0	12	MI	No	Abandoned mining operations Suspect natural Ni, Cr, Hg in sed/water Threat of toxic bioassay results	Non-Point	X . . . . .
SANTA YNEZ RIVER	314.00	0	59	11	0	70	MI	Yes	Excessive TDS/Conductivity Low flows have reduced fish survival Coliform levels may impair REC-1	Non-Point	. X . . X . X
SCOTT CREEK	304.11	10	0	0	0	10	MI	No	Limited Information Available		. . . . .
SHINGLE MILL CREEK	304.12	0	0	2	0	2	MI	Yes	Sedimentation Low flows	Non-Point	. X . . X . X
SHINGLE MILL GULCH	305.10	0	2	0	0	2	MI	No	Sedimentation Low flows	Non-Point	. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 0 M S L
SISQUOC RIVER	312.20	0	45	0	0	45	MI	No	Sedimentation Objectives violated Seasonal flow	Non-Point	. . . . .
SMITH CREEK	304.13	1	0	0	0	1	MI	No	Limited Information Available		. . . . .
SOQUEL CREEK	304.13	0	5	0	0	5	MI	Yes	Threat of drinking water impairment Sedimentation Threat of spawning impairment	Non-Point	. . . . .
SOQUEL CREEK, EAST BRANCH	304.13	0	12	0	0	12	MI	No	Sedimentation	Non-Point	. . . . .
SOQUEL CREEK, WEST BRANCH	304.13	0	6	0	0	6	MI	No	fish population declines Sedimentation	Non-Point	. . . . .
SOUTH FALL CREEK	304.13	2	0	0	0	2	MI	No	Limited Information Available		. . . . .
STEINER CREEK	310.13	6	0	0	0	6	MI	No	Limited Information Available		. . . . .
TASSAJARA CREEK	309..60	10	0	0	0	10	MI	No	Limited information available		. . . . .
TECOLOTE CREEK	315.10	2	0	0	0	2	MI	No	Limited Information Available		. . . . .
TIE GULCH	304.13	1	0	0	0	1	MI	No	Limited Information Available		. . . . .
TRES PINOS CREEK	305.30	0	0	0	32	32	MI	No	Limited information available		. . . . .
TULARCITOS CREEK	307.00	15	0	0	0	15	MI	No	Limited information available		. . . . .
TWO BAR CREEK	304.12	0	4	0	0	4	MI	No	Sedimentation Periodic elevated nutrient/bacti levels	Non-Point	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
UVAS CREEK	305.20	0	17	0	0	17	MI	No	Possible urban runoff problems	Non-Point	. . . . .
VALENCIA CREEK	304.13	0	0	6	0	6	MI	Yes	Fish population decline Sedimentation Spawning impairment	Non-Point	. X . . X . X
WADDELL CREEK (MAIN STEM)	304.10	0	3	0	0	3	MI	No	Threat of drinking water impairment Threat of fish kills Potential impacts from WWTP discharge	Point & Non-Point	. . . . .
WADDELL CREEK, EAST BRANCH	304.10	0	0	3	0	3	MI	Yes	Drinking water impairment Fish habitat impairment Elevated nutrient levels	Point & Non-Point	. X . . X . X
WADDELL CREEK, WEST BRANCH	304.10	5	0	0	0	5	MI	No			. . . . .
WILLOW CREEK	308.00	0	0	0	5	5	MI	No	Year round flow		. . . . .
ZAYANTE CREEK	304.12	0	8	0	0	8	MI	No	Sedimentation High turbidity, increased nutrient load Fecal Coliform	Non-Point	. . . . .

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Region 3

Ocean

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
ANO NUEVO COAST	304.00	26	0	0	0	26	MI	Yes	Point Ano Nuevo to Soquel Point		. . . . .
ANO NUEVO ISLAND	304.20	1	0	0	0	1	MI	Yes	ASBS		. . . . .
BIG SUR COAST	308.00	86	0	0	0	86	MI	Yes	ASBS areas contained within coastal area Pt. Pinos to Pt. Piedras Blancas		. . . . .
DIABLO COAST	310.25	17	0	0	0	17	MI	Yes	Diablo Canyon power plant discharge	Point	X . . . . .
ESTERO BAY COAST	310.00	23	0	0	0	23	MI	Yes	Point Estero to Poitn Buchon (Morro Bay)		. . . . .
JULIA PFEIFFER BURNS UNDERWATER PARK	308.00	10	0	0	0	10	MI	Yes	ASBS		. . . . .
PACIFIC GROVE MARINE GARDENS	309.05	7	0	0	0	7	MI	Yes	ASBS		. . . . .
PESCADERO COAST	304.00	17	0	0	0	17	MI	Yes	Pescadero Point to Point Ano Nuevo		. . . . .
PISMO COAST	310.00	26	0	0	0	26	MI	Yes	Point San Luis to Point Sal		. . . . .
POINT LOBOS ECOLOGICAL RESERVE	308.00	8	0	0	0	8	MI	Yes	ASBS		. . . . .
SALMON CREEK (BIG SUR COAST)	308.00	5	0	0	0	5	MI	Yes	ASBS		. . . . .
SAN MIGUEL ISLAND	316.10	26	0	0	0	26	MI	Yes	ASBS		X . . . . .
SAN SIMEON COAST	310.13	31	0	0	0	31	MI	Yes			. . . . .
SANTA BARBARA NORTH	313.00	56	0	0	0	56	MI	Yes	Point Arguello to Coal Oil Point		. . . . .

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Ocean

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 R	3 M	3 S	3 L	3	3	1
COAST																		
SANTA BARBARA SOUTH COAST	315.00	0	25	0	0	25	MI	Yes	Elevated bacteria levels in shellfish Storm water runoff - suspect quality Threat of elevated fish tissue levels	Point & Non-Point	X	.	.	.	.	.	.	.
SANTA CRUZ ISLAND	316.10	76	0	0	0	76	MI	Yes	ASBS		.	.	.	.	.	.	.	.
SANTA ROSA ISLAND	316.10	56	0	0	0	56	MI	Yes	ASBS		.	.	.	.	.	.	.	.
VANDENBURG COAST	314.10	25	0	0	0	25	MI	Yes			.	.	.	.	.	.	.	.

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Region 3

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 0 . 3 1 D	3 0 4 M	3 0 4 S	3 1 4 L	3 1 9
ABBOTT LAKE (THE LAKES)	309.60	0	0	0	8	8	AC	No			.	.	.	.	X
ATASCADERO LAKE	309.81	0	30	0	0	30	AC	No	Eutrophic	Non-Point	.	.	.	.	X
CACHUMA RESERVOIR	314.52	3108	0	0	0	3108	AC	Yes	Sedimentation	Non-Point	.	.	.	.	X
CHESBRO RESERVOIR	305.20	0	265	0	0	265	AC	Yes	Limited Information Available		.	.	.	.	X
DEL MONTE LAKE	309.50	0	0	0	6	6	AC	No	Limited information available		.	.	.	.	X
DREW LAKE	305.10	0	64	0	0	64	AC	No			.	.	.	.	X
DUNE LAKES	312.10	0	0	0	860	860	AC	No			.	.	.	.	X
EL ESTERO LAKE	309.50	0	17	0	0	17	AC	Yes	Threat of elevated nutrients.		.	.	.	.	X
FREEDOM LAKE	305.10	0	0	0	12	12	AC	No			.	.	.	.	X
GIBRALTAR RESERVOIR	314.51	335	0	0	0	335	AC	No	Sedimentation Hg mine tailings in lake TSM data showed no impact	Point & Non-Point	.	.	.	.	X
HERNANDEZ RESERVOIR	305.50	0	0	590	0	590	AC	Yes	Potential water quality limited segment Suspect natural Hg sources Hg detected in fish tissue	Non-Point	X	X	.	.	X X X
JAMESON RESERVOIR	314.51	142	0	0	0	142	AC	No	Domestic water supply		.	.	.	.	X
KELLEY LAKE	305.10	0	128	0	0	128	AC	No			.	.	.	.	X

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1
LAGUNA LAKE	310.24	0	213	0	0	213	AC	Yes	Limited information available Past mining activity in watershed Eutrophic/Urban runoff	Non-Point	.	.	.	.	.	X	.	.
LOCH LOMAND	304.12	250	0	0	0	250	AC	No	Domestic water supply		.	.	.	.	.	X	.	.
LOPEZ RESERVOIR	310.31	0	940	0	0	940	AC	No			.	.	.	.	.	X	.	.
LOS PADRES RESERVOIR	307.00	0	1024	0	0	1024	AC	No	Sedimentation	Non-Point	.	.	.	.	.	X	.	.
MORAN LAKE	304.13	0	0	0	3	3	AC	No			.	.	.	.	.	X	.	.
NACIMIENTO RESERVOIR	309.82	0	0	5370	0	5370	AC	Yes	Water quality limited segment Elevated fish tissue levels Sediment impaired, not water in Res.	Non-Point	X	X	.	.	X	X	X	.
OSO FLACO LAKE	312.10	0	110	0	0	110	AC	Yes	Candidate for the EPA 304(l) long list Trace amounts of heavy metals, herbicide fertilizer, and pesticides in Ag runoff	Non-Point	.	.	.	.	.	X	.	.
PACHECO RESERVOIR	305.40	13	0	0	0	13	AC	No			.	.	.	.	.	X	.	.
PALM BEACH POND	305.10	0	12	0	0	12	AC	Yes	Limited information available		.	.	.	.	.	X	.	.
PINTO LAKE	305.10	0	160	0	0	160	AC	No	Elevated bacteria levels	Non-Point	.	.	.	.	.	X	.	.
ROBERTS/LAGUNA GRANDE LAKE	309.50	0	136	0	0	136	AC	Yes	Beneficial uses not impaired Siltation of lake. Urban runoff/coliform	Non-Point	.	.	.	.	.	X	.	.
SAN ANTONIO RESERVOIR	309.83	0	5720	0	0	5720	AC	Yes	Cd in fish tissue samples	Non-Point	X	.	.	.	.	X	.	.

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 N	3 S	3 L	3	3	3	1
SAN CLEMENTE DAM	307.00	192	0	0	0	192	AC	No	Domestic water supply		.	.	.	.	.	.	X	.
SANTA MARGARITA RESERVOIR	309.81	796	0	0	0	796	AC	No			.	.	.	.	.	.	X	.
SCHWAN LAKE	304.12	0	0	24	0	24	AC	Yes	Excessive plant growth Urban runoff Fish kills	Non-Point	X	X	.	.	X	X	X	
SODA LAKE	311.00	0	12800	0	0	12800	AC	No			.	.	.	.	.	.	X	.
TWITCHELL RES	312.30	0	0	0	3670	3670	AC	No			.	.	.	.	.	.	X	.
TYMAN LAKE	305.10	0	64	0	0	64	AC	No			.	.	.	.	.	.	X	.
UVAS RES	305.20	0	300	0	0	300	AC	No			.	.	.	.	.	.	X	.
WHALE ROCK RES	310.17	0	0	0	594	594	AC	No			.	.	.	.	.	.	X	.
WHITE ROCK LAKE	307.00	0	0	0	15	15	AC	No			.	.	.	.	.	.	X	.

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Region 3

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1
ANO NUEVO AREA	304.20	0	2	0	0	2	sqmi	No	Limited Information Available		.	.	.	.	.	.	.	.
ARROYO DE LA CRUZ VALLEY		0	0	0	3	3	sqmi	No			.	.	.	.	.	.	.	.
ARROYO GR -NIPOMA		0	0	0	40	40	sqmi	No			.	.	.	.	.	.	.	.
BIG SPRINGS AREA		0	0	0	8	8	sqmi	No			.	.	.	.	.	.	.	.
BITTER WATER VALLE		0	0	0	7	7	SQMI	No			.	.	.	.	.	.	.	.
CAREAGA SAND HIGHLANDS	314.30	0	15	0	0	15	sqmi	No			.	.	.	.	.	.	.	.
CARMEL VALLEY	307.00	0	10	0	0	10	sqmi	No	Elevated NO3 in shallow wells Fe & Mn concentration exceed DOHS sta.	Non-Point	.	.	.	.	.	.	.	.
CARPINTERIA BASIN	315.34	0	12	0	0	12	sqmi	No	High TDS concentrations (mineralization)	Non-Point	.	.	.	.	.	.	.	.
CARRIZO PLAIN		0	0	0	270	270	sqmi	No			.	.	.	.	.	.	.	.
CAYUCOS VALLEY		0	0	0	2	2	sqmi	No			.	.	.	.	.	.	.	.
CHOLAME VALLEY		0	0	0	20	20	sqmi	No			.	.	.	.	.	.	.	.
CHORRO VALLEY		0	0	0	7	7	sqmi	No			.	.	.	.	.	.	.	.
CORRAL DE TEIRRA		0	0	0	20	20	sqmi	No			.	.	.	.	.	.	.	.
CUYUMA VALLEY		0	0	0	230	230	sqmi	No			.	.	.	.	.	.	.	.
DRY LAKE VALLEY		0	0	0	4	4	sqmi	No			.	.	.	.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1
GILROY-HOLLISTER		0	70	0	280	350	sqmi	No	Threat of nitrates Potential impacts from underground tanks Limited info available at this time.		.	.	.	.	.	.	.	.
GOLETA BASIN	315 31	0	16	0	0	16	sqmi	No	TDS,CL, SO4, exceeded at transfer stat.	Point	.	.	.	.	.	.	.	.
HERNANDEZ VALLEY		0	0	0	2	2	sqmi	No			.	.	.	.	.	.	.	.
HUASNA VALLEY		0	0	0	6	6	sqmi	No			.	.	.	.	.	.	.	.
LANGLEY AREA	309.20	0	27	0	0	27	sqmi	Yes	High TDS near Crazyhorse Landfill	Point	.	.	.	.	.	.	.	.
LOCKWOOD VALLEY (REG 3)		0	0	0	90	90	sqmi	No			.	.	.	.	.	.	.	.
LOS OSOS VALLEY		0	20	0	0	20	sqmi	No			.	.	.	.	.	.	.	.
MONTECITO AREA		0	0	0	3	3	sqmi	No			.	.	.	.	.	.	.	.
MORRO VALLEY		0	0	0	5	5	sqmi	No			.	.	.	.	.	.	.	.
OLD VALLEY		0	0	0	3	3	sqmi	No			.	.	.	.	.	.	.	.
PAJARO VALLEY	305.10	0	120	0	0	120	sqmi	Yes	Severe overdrafting and Nitrate problems Objectives violated Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.	.
PASO ROBLES BASIN		0	860	0	0	860	sqmi	Yes	Boron, Flouride, TDS concent. are high widespread H2S gases in H20	Point & Non-Point	.	.	.	.	.	.	.	.
PEACH TREE VALLEY		0	0	0	18	18	sqmi	No			.	.	.	.	.	.	.	.

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Ground Water

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PISMO CREEK VALLEY		0	0	0	10	10	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
POZO VALLEY		0	0	0	9	9	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QUIEN SABE VALLEY		0	0	0	7	7	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
RAFEAL VALLEY		0	0	0	4	4	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
RINCONADA VALLEY		0	0	0	7	7	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SALINAS VALLEY, 180' & 400' AQUIFER	309.10	0	124	0	0	124	sqmi	Yes	Saltwater intrusion at 180' and 400' Threat of drinking water impairment Threat of objectives violated	Point & Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SALINAS VALLEY, EASTSIDE AQUIFER	309.20	0	124	0	0	124	sqmi	Yes	High nitrate concentrations Objectives violated Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SALINAS VALLEY, UPPER FOREBAY	309.30	0	167	0	0	167	sqmi	Yes	Nitrate levels exceed drinking standards Threat of drinking water impairment Threat of objectives violated	Point & Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SALINAS VALLEY, UPPER VALLEY AQUIFER	309.40	0	0	205	0	205	sqmi	Yes	Nitrate concentrations (Ag and Septic) ASBS impairment Threat of drinking water impairment	Point & Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN BENITO RIVER VALLEY		0	0	0	10	10	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN CARPOFORO VALLEY		0	0	0	2	2	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAN LUIS OBISPO		0	0	0	15	15	sqmi	No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Region 3

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D N S L
VALLEY											
SAN SIMEON VALLEY		0	0	0	2	2	sqmi	No			. . . . .
SANTA ANA VALLEY		0	0	0	4	4	sqmi	No			. . . . .
SANTA BARBARA		0	0	0	15	15	sqmi	No			. . . . .
SANTA CRUZ PURISIM		0	0	0	65	65	sqmi	No			. . . . .
SANTA MARIA VALLEY	312.10	0	80	120	0	200	sqmi	Yes	Portions a potential UOL segment Overdrafting	Point & Non-Point	. . . . .
SANTA ROSA VALLEY		0	0	0	5	5	sqmi	No			. . . . .
SANTA YNEZ VALLEY		0	230	30	0	260	sqmi	Yes	Lompoc Plain a potential UOL segment	Point & Non-Point	. . . . .
SCOTTS VALLEY	304.11	0	0	8	0	8	sqmi	Yes	Drinking water impairment Excessive nitrate concentrations Industrial solvents contamination	Point & Non-Point	. . . . .
SEASIDE AREA	309.50	0	30	0	0	30	sqmi	Yes	Threat of drinking water impairment 180' aquifer has salt water Extracting from 400' aquifer	Point & Non-Point	. . . . .
SOQUEL VALLEY		0	0	0	7	7	sqmi	No			. . . . .
TORO VALLEY		0	0	0	2	2	sqmi	No			. . . . .
TRES PINOS CREEK VALLEY		0	0	0	4	4	sqmi	No			. . . . .

R0033469

EXHIBIT 3

VOL 12

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 3

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1
UPPER SANTA ANA VALLEY (REG 3)		0	0	0	3	3	sqmi	No			.	.	.	.	.	.	.	.
VILLA VALLEY		0	0	0	4	4	sqmi	No			.	.	.	.	.	.	.	.
WEST SANTA CRUZ TE		0	0	0	6	6	sqmi	No			.	.	.	.	.	.	.	.

REGION 3

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Region 3

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 D	3 0 3 4 N	3 0 4 4 S	3 0 4 4 L	3 1 4 9
ARROYO DE CORRAL	310.12	0	0	0	40	40	AC	No			.	.	.	.	.
ARROYO DE LA CRUZ ESTUARY	310.12	40	0	0	0	40	AC	No			.	.	.	.	.
ARROYO LAGUNA	310.12	0	0	0	3	3	AC	No			.	.	.	.	.
BALDWIN CREEK ESTUARY	304.11	0	0	0	10	10	AC	No			.	.	.	.	.
BENNETT SLOUGH/ESTUARY	305.10	0	0	0	20	20	AC	No			.	.	.	.	.
BIG SUR RIVER EST	308.00	4	0	0	0	4	AC	Yes			.	.	.	.	.
CANADA HONDA CREEK ESTUARY	315.10	0	0	0	1	1	AC	No			.	.	.	.	.
CARMEL RIVER ESTUARY	307.00	0	42	0	0	42	AC	Yes	Insufficient data.		.	.	.	.	.
CARPINTERIA MARSH (EL ESTERO MARSH)	315.34	0	0	215	0	215	AC	Yes	Threat to wildlife populations. Potential Water Quality Limited Segment Elevated shellfish tissue levels	Non-Point	X	X	.	.	X . X
CASCADE CREEK LAGOON/ESTUARY	304.20	0	0	0	9	9	AC	No			.	.	.	.	.
DEVEREAUX LAGOON	315.31	0	0	0	45	45	AC	No			.	.	.	.	.
ELKHORN SLOUGH	306.00	0	0	2100	0	2100	AC	Yes	Potential Water Quality Limited Segment Supports Ag return flows. Elevated shellfish tissue levels	Non-Point	X	X	.	.	X . X

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Region 3

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 N	3 S	3 L	3	3	3	1
GAZOS CREEK LAGOON/ESTUARY	304.20	0	0	0	2	2	AC	No			.	.	.	.	.	.	.	.
GOLETA SLOUGH/ESTUARY	315.31	0	0	400	0	400	AC	Yes	Non-point runoff from urban development Elevated shellfish tissue levels Elevated bacteria levels (DHS,Patwells)	Non-Point	X	X	.	.	X	.	X	.
GREEN OAKS CREEK LAGOON/ESTUARY	304.20	0	0	0	31	31	AC	No			.	.	.	.	.	.	.	.
JALAMA CREEK ESTUARY	315.10	0	0	0	2	2	AC	No			.	.	.	.	.	.	.	.
LAGUNA CREEK EST	304.10	0	0	0	25	25	AC	No			.	.	.	.	.	.	.	.
LITTLE PICO CREEK ESTUARY	310.13	3	0	0	0	3	AC	No			.	.	.	.	.	.	.	.
LITTLE SUR RIVER ESTUARY	308.00	7	0	0	0	7	AC	No			.	.	.	.	.	.	.	.
LUCERNE LAKE ESTUARY	304.11	0	0	0	80	80	AC	No			.	.	.	.	.	.	.	.
MCCLUSKY SLOUGH	305.10	0	0	0	250	250	AC	No			.	.	.	.	.	.	.	.
MORO COJO SLOUGH	309.10	0	0	150	0	150	AC	Yes	Receives direct discharge from Ag drains	Non-Point	X	X	.	.	X	.	X	.
OCEANO LAGOON	310.31	0	105	0	0	105	AC	Yes	Agricultural runoff Limited data available	Non-Point	.	.	.	.	.	.	.	.
OLD SALINAS RIVER EST	309.10	0	0	50	0	50	AC	Yes	Pesticide residues in fish and shellfish	Non-Point	X	X	.	.	X	.	X	.

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Region 3

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 (3 0 3 4 0 0 0 4 0 0 1 4 1 1 9 1) D H S L
PARSONS SLOUGH	305.10	0	0	0	1	1	AC	No			X . . . . .
PICO CREEK ESTUARY	310.13	5	0	0	0	5	AC	No	Suspect natural lead in sediments		X . . . . .
PISMO CREEK ESTUARY	310.26	0	0	0	30	30	AC	No			. . . . .
PISMO MARSH	310.31	0	0	0	90	90	AC	No			. . . . .
SALINAS LAGOON	309.10	0	100	50	0	150	AC	Yes	Agricultural runoff from lower Salinas carrying toxic organics	Non-Point	X X . . X . X
SAN ANTONIO CREEK ESTUARY	313.00	0	0	0	7	7	AC	No			. . . . .
SAN JOSE CREEK ESTUARY	307.00	0	0	0	10	10	AC	No			. . . . .
SAN LORENZO RIVER ESTUARY	304.12	0	0	2	0	2	AC	Yes	Elevated bacteria levels	Non-Point	. X . . X . X
SAN LUIS OBISPO CREEK ESTUARY	310.26	0	23	0	0	23	AC	No	Threat of fish population decline Threat of spawning impairment	Point & Non-Point	. . . . .
SAN SIMEON CREEK ESTUARY	310.13	0	0	0	40	40	AC	No			. . . . .
SANTA MARIA RIVER ESTUARY	312.10	0	0	0	145	145	AC	No			. . . . .
SANTA ROSA CREEK ESTUARY	310.13	0	0	0	40	40	AC	No			. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 3

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
SANTA YNEZ RIVER ESTUARY	314.00	0	400	0	0	400	AC	No	Threat of fish population decline Threat of spawning impairment	Non-Point	. . . . .
SCOTT CREEK LAGOON	304.11	30	0	0	0	30	AC	No			. . . . .
SOQUEL LAGOON	304.13	0	0	2	0	2	AC	Yes	Bacteria and nutrient levels	Non-Point	. X . . X . X
WADDELL CREEK ESTUARY	304.11	0	0	0	11	11	AC	No			. . . . .
WATSONVILLE SLOUGH / PAJARO SLOUGH	305.10	0	0	150	0	150	AC	Yes	Potential water quality limited segment Ag/Urban runoff entering slough Elevated fish tissue levels	Non-Point	X X . . X . X
WILDER CR EST	304.12	0	0	0	18	18	AC	No			. . . . .
WOODS LAGOON	304.12	0	0	0	6	6	AC	No			. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 3

Agricultural Drains

Water Body Name	Hydro. Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
BLANCO DRAIN	309.10	0	0	8	0	8	MI	Yes	Agricultural drain. High Chloride and Nitrogen concentration Pest. in fish tissue violate FDA std.	Non-Point	X	X	.	.	X	.	X		
SALINAS RECLAMATION CANAL	309.20	0	0	20	0	20	MI	Yes	Potential water quality limited segment Suspect toxic organics in Ag. runoff Elevated fish tissue levels	Non-Point	X	X	.	.	X	.	X		

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Region 3

Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
CARMEL BAY	307.00	5120	0	0	0	5120	AC	Yes	Municipal outfall. ASBS Area Minimal concs of metal and ag-products	Point & Non-Point	. . . . .
MONTEREY BAY NORTH	309.50	67840	0	0	0	67840	AC	Yes	Soquel Point to Salinas River Mouth Municipal outfalls Urban runoff	Point & Non-Point	X . . . . .
MONTEREY BAY SOUTH	309.50	76200	0	640	0	67840	AC	Yes	Salinas River Mouth to Point Pinos Municipal outfalls, Urban runoff (Monterey Harbor has high lead conc.)	Point & Non-Point	X X . . X . X
MONTEREY HARBOR	309.50	0	0	74	0	74	AC	Yes	Potential water quality limited segment Shellfish objectives violated (lead) Elevated shellfish tissue levels	Point & Non-Point	X X . . X . X
MORRO BAY	310.22	0	0	3200	0	3200	AC	Yes	Potential Water Quality Limited Segment Elevated bacteria levels in shellfish Sediment impacting salt marsh habitat	Point & Non-Point	X X . . X . X
MOSS LANDING HARBOR	306.00	0	0	400	0	400	AC	Yes	Potential Water Quality Limited Segment Elevated shellfish tissue levels	Non-Point	X X . . X . X
SAN LUIS HARBOR	310.22	0	0	0	1	1	AC	Yes			. . . . .
SANTA BARBARA HARBOR	315.32	0	78	0	0	78	AC	Yes	Elevated shellfish tissue levels	Point & Non-Point	. . . . .
SANTA CRUZ HARBOR	304.12	0	0	0	38	38	AC	Yes	Elevated shellfish tissue levels	Non-Point	X . . . . .

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Region 4

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
BALLONA CREEK	405.13	0	6	0	0	6	MI	Yes	Heavy metals and organics suspected	Non-Point	X . . . . .
CALLEGUAS CREEK	403.11	0	0	22	0	22	MI	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Threat of drinking water impairment	Non-Point	X X . . X . X
COYOTE CREEK	405.15	0	13	0	0	13	MI	Yes	Suspected heavy metals and high coliform and nutrients.	Non-Point	. . . . .
DOMINGUEZ CHANNEL	405.12	0	15	0	0	15	MI	Yes	Suspected heavy metals and organics	Non-Point	X . . . . .
LOS ANGELES RIVER (LOWER)	405.15	0	28	0	0	28	MI	Yes	Suspected heavy metals and pesticides	Non-Point	X . . . . .
LOS ANGELES RIVER (UPPER)	405.21	42	27	0	0	69	MI	No			. . . . .
MALIBU CREEK	404.21	0	9	0	0	9	MI	Yes	Suspected heavy metals	Non-Point	. . . . .
MATILIJA CREEK	402.20	15	0	0	0	15	MI	No			. . . . .
PIRU CREEK	403.42	59	0	0	0	59	MI	No			. . . . .
REVOLON SLOUGH	402.10	0	0	9	0	9	MI	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Threat of drinking water impairment	Non-Point	X X . . X . X
RIO HONDO	405.41	0	20	0	0	20	MI	Yes	Suspected heavy metals and conv. pollutant parameters. Low flow	Non-Point	X . . . . .
SAN ANTONIO CREEK	402.20	10	0	0	0	10	MI	No			. . . . .

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Region 4

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
SAN GABRIEL RIVER (LOWER)	405.15	0	17	0	0	17	MI	Yes	Threat of elevated fish tissue levels Threat of toxic bioassay results Threat of drinking water impairment	Point & Non-Point	X . . . . .
SAN GABRIEL RIVER (UPPER)	405.41	0	42	0	0	42	MI	No		Point & Non-Point	. . . . .
SANTA ANA CREEK	402.20	10	0	0	0	10	MI	No			. . . . .
SANTA CLARA RIVER	403.00	0	75	0	0	75	MI	No	Suspected heavy metals and pesticides	Non-Point	. . . . .
SANTA PAULA CREEK	403.20	24	0	0	0	24	MI	No			. . . . .
SESPE CREEK	403.30	59	0	0	0	59	MI	No			. . . . .
VENTURA RIVER (LOWER)	402.10	8	7	0	0	15	MI	Yes	Suspected sedimentation, pesticides, eutrophication, fish kills, turbidity, pesticides, oil discharges	Point & Non-Point	X . . . . .
VENTURA RIVER (UPPER)	402.20	18	0	0	0	18	MI	No			. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 (1)	3 (D)	3 (H)	3 (S)	3 (L)	3	3
BIG SANTA ANITA RESERVOIR	405.33	17	0	0	0	17	AC	No			.	.	.	.	.	.	.
BOUQUET RESERVOIR	403.52	628	0	0	0	628	AC	No			.	.	.	.	.	.	.
CASITAS LAKE	402.20	0	2720	0	0	2720	AC	No	Suspected elevated pesticides	Non-Point	.	.	.	.	.	X	.
CASTAIC LAKE	403.51	2630	0	0	0	2630	AC	No			.	.	.	.	.	.	.
COGSWELL RESERVOIR	405.43	160	0	0	0	160	AC	No			.	.	.	.	.	.	.
CRYSTAL LAKE	405.43	0	5	0	0	5	AC	No			.	.	.	.	.	X	.
DRY CANYON RESERVOIR	403.51	58	0	0	0	58	AC	No			.	.	.	.	.	.	.
ELEANOR LAKE	404.26	0	184	0	0	184	AC	No			.	.	.	.	.	.	.
ELIZABETH LAKE	403.51	0	0	90	0	90	AC	Yes	Eutrophication	Non-Point	.	X	.	.	X	X	X
HARBOR PARK LAKE	405.12	0	0	50	0	50	AC	Yes	Health advisory in effect-chlordane> FDA Elevated fish tissue levels Eutrophication	Non-Point	X	X	.	.	X	X	X
HUGHES LAKE	403.51	0	0	40	0	40	AC	Yes	Eutrophication	Non-Point	.	X	.	.	X	X	X
LEGG LAKE	405.41	0	70	0	0	70	AC	No			X	.	.	.	.	.	.
LINCOLN PARK LAKE	405.15	0	0	0	5	5	AC	No			.	.	.	.	.	X	.
LIVE OAK RESERVOIR	405.40	77	0	0	0	77	AC	No			.	.	.	.	.	.	.

R0033479

Region 4

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 D	3 0 3 4 M	3 0 4 4 S	3 0 4 4 S	3 1 4 9 L
MALIBU LAKE CLUB LAKE	404.24	0	55	0	0	55	AC	No	Suspected eutrophication, sedimentation	Non-Point	.	.	.	.	X .
MATILIJA RESERVOIR	402.20	0	124	0	0	124	AC	No	Sedimentation Eutrophication	Non-Point	.	.	.	.	X .
MORRIS RESERVOIR	405.43	420	0	0	0	420	AC	No			.	.	.	.	X .
PACOIMA RESERVOIR	405.22	0	0	0	68	68	AC	No			.	.	.	.	.
PIRU LAKE	403.40	0	1240	0	0	1240	AC	No	Suspected elevated total dissolved solids.	Non-Point	.	.	.	.	X .
POLLIWOG PARK POND	405.12	0	0	0	2	2	AC	No			.	.	.	.	X .
PUDDINGSTONE RESERVOIR	405.52	0	0	490	0	490	AC	Yes	Pesticides,PCB's (TSN) Elevated fish tissue levels Recreational impacts	Non-Point	X	X	.	.	X X X
PYRAMID RESERVOIR	403.43	1360	0	0	0	1360	AC	No			.	.	.	.	.
SAN ANTONIO RESERVOIR	481.23	139	0	0	0	139	AC	No			.	.	.	.	.
SAN DIMAS RESERVOIR	405.44	16	0	0	0	16	AC	No			.	.	.	.	.
SAN GABRIEL RESERVOIR	405.43	500	0	0	0	500	AC	No			.	.	.	.	.
SAMPIT RESERVOIR	405.41	9	0	0	0	9	AC	No			.	.	.	.	.
SHERWOOD LAKE	404.26	184	0	0	0	184	AC	No			.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1
SILVER LAKE	405.15	0	0	0	78	78	AC	No			.	.	.	.	.	.	.	.
TUJUNGA RESERVOIR	405.23	84	0	0	0	84	AC	No			.	.	.	.	.	X	.	.
UPPER VAN NORMAN RESERVOIR	405.21	448	0	0	0	448	AC	No			.	.	.	.	.	.	.	.
WESTLAKE LAKE	404.25	0	0	0	156	156	AC	No			.	.	.	.	.	X	.	.

R0033481

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
ARROYO SANTA ROSA VALLEY	403.63	0	0	9	0	9	SQMI	Yes	Threat of drinking water impairment Threat of objectives violated	Point & Non-Point	. . . . .
COASTAL PLAIN - L.A.	405.10	450	0	50	0	500	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
CONEJO VALLEY	403.64	0	0	0	4	4	SQMI	No			. . . . .
HIDDEN VALLEY	404.26	0	0	0	3	3	SQMI	No			. . . . .
HUNGRY VALLEY	403.43	0	0	0	4	4	SQMI	No			. . . . .
LOCKWOOD VALLEY	403.44	0	0	0	20	20	SQMI	No			. . . . .
LOS POSAS VALLEY	403.61	0	0	0	79	79	SQMI	No			. . . . .
LOWER SANTA CLARA RIVER VALLEY (VENTURA CO.)		0	146	100	0	246	SQMI	Yes	Objectives violated Threat of drinking water impairment	Point & Non-Point	. . . . .
LOWER VENTURA RIVER VALLEY	402.10	0	5	0	0	5	SQMI	No			. . . . .
MALIBU AREA	404.00	0	0	1	0	1	SQMI	Yes	Objectives violated	Non-Point	. . . . .
OJAI VALLEY	402.32	0	0	0	13	13	SQMI	No			. . . . .
PLEASANT VALLEY	403.12	0	47	0	0	47	SQMI	No			. . . . .
RUSSELL VALLEY	404.25	0	0	0	6	6	SQMI	No			. . . . .
SAN FERNANDO VALLEY	405.20	90	32	50	20	192	SQMI	Yes	Drinking water impairment	Point & Non-Point	. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 10 M S L
SAN GABRIEL VALLEY	405.40	0	0	70	100	170	SQMI	Yes	Drinking water impairment	Point & Non-Point	. . . . .
SIMI VALLEY	403.67	0	0	25	0	25	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
THOUSAND OAKS AREA	403.68	0	0	0	5	5	SQMI	No			. . . . .
TIERRA REJADA VALLEY	403.65	0	0	0	1	1	SQMI	No			. . . . .
UPPER OJAI VALLEY	402.31	0	0	0	3	3	SQMI	No			. . . . .
UPPER SANTA ANA VALLEY	402.20	30	0	0	0	30	SQMI	No			. . . . .
UPPER SANTA CLARA RIVER VALLEY (L.A. COUNTY)	403.51	0	28	2	60	90	SQMI	Yes	Objectives violated Threat of drinking water impairment	Non-Point	. . . . .
UPPER VENTURA RIVER VALLEY	402.20	0	5	0	0	5	SQMI	No			. . . . .

R0033483

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 6 6 4 9 / 1 0 M S L
BALLONA WETLANDS	405.13	0	0	150	0	150	AC	Yes	Habitat destruction Metals	Non-Point	. X . . X . X
COLORADO LAGOON	405.12	0	0	13	0	13	AC	Yes	High coliform counts (DHS) Pesticides & Lead > E95 & HIS (SMW) Elevated shellfish tissue levels	Non-Point	X X . . X . X
MALIBU LAGOON	406.31	0	29	0	0	29	AC	Yes	Suspected heavy metals, periodic beach closures	Point & Non-Point	. . . . .
MCGRATH LAKE ESTUARY	403.11	0	40	0	0	40	AC	No	Suspected pesticides	Non-Point	. . . . .
MUGU LAGOON	403.11	0	0	1500	0	1500	AC	Yes	Pesticides Elevated shellfish tissue levels Elevated fish tissue levels	Non-Point	X X . . X . X
SAN GABRIEL RIVER (TIDAL PRISM)	405.15	0	0	3	0	3	MI	Yes	Elevated fish tissue levels	Point & Non-Point	X X . . X . X
SANTA CLARA RIVER ESTUARY	403.00	0	0	0	60	60	AC	No			. . . . .
VENTURA RIVER ESTUARY	402.10	0	0	0	10	10	AC	Yes			. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 4

Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1 .
ALAMITOS BAY	405.12	0	285	0	0	285	AC	No	Suspected heavy metals, periodic bacterial contamination	Point & Non-Point	.	.	.	.	.	.	.	.
CHANNEL ISLANDS HARBOR	403.11	0	220	0	0	220	AC	No	Suspected heavy metals	Non-Point	.	.	.	.	.	.	.	.
KING HARBOR	405.12	40	50	0	0	90	AC	No			.	.	.	.	.	.	.	.
LONG BEACH HARBOR (INNER)	405.12	0	0	840	0	840	AC	Yes	Health advisory in effect, PCB's > MAS Elevated shellfish tissue levels	Non-Point	X	X	.	.	X	.	X	.
LOS ANGELES HARBOR (INNER)	405.12	0	0	1260	0	1260	AC	Yes	Pesticides, metals & PCB's (SMW) Health advisory in effect. Elevated shellfish tissue levels	Point & Non-Point	X	X	.	.	X	.	X	.
MARINA DEL REY HARBOR	405.13	0	0	354	0	354	AC	Yes	Metals, pesticides Coliform exceedences Elevated shellfish tissue levels	Non-Point	X	X	.	.	X	.	X	.
PORT HUENEME (HARBOR)	403.11	0	121	0	0	121	AC	No	Suspected PCBs, heavy metals	Non-Point	X	.	.	.	.	.	.	.
SAN PEDRO BAY	405.12	10200	500	0	0	10700	AC	No	Suspected heavy metals	Point & Non-Point	.	.	.	.	.	.	.	.
SANTA MONICA BAY (VENTURA CO.LINE TO POINT FERMIN)	405.13	0	0	256000	0	256000	AC	Yes	Objectives violated Elevated fish tissue levels	Point & Non-Point	X	X	.	.	X	.	X	.
VENTURA HARBOR	403.11	223	200	0	0	423	AC	No	Suspected heavy metals	Point & Non-Point	.	.	.	.	.	.	.	.

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Region 4

Areas of Special Biological Significance

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 I	3 D	3 M	3 S	3 L	3	3	1
ANACAPA ISLAND	406.10	21280	0	0	0	21280	AC	No			.	.	.	.	.	.	.	.
NEARSHORE - POINT MUGU TO LATIGO POINT		11710	0	0	0	11710	AC	No			.	.	.	.	.	.	.	.
SAN CLEMENTE ISLAND	406.50	80512	0	0	0	80512	AC	No			.	.	.	.	.	.	.	.
SAN NICOLAS ISLAND AND BEGG ROCK	406.20	102528	0	0	0	102528	AC	No			.	.	.	.	.	.	.	.
SANTA BARBARA ISLAND	406.30	14000	0	0	0	14000	AC	No			.	.	.	.	.	.	.	.
SANTA CATALINA ISLAND (AREAS 1-4)	406.40	17936	0	0	0	17936	AC	No			.	.	.	.	.	.	.	.

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Region 5

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
ASH CREEK WMA											. . . . .
BERENDA SLOUGH	545.20	0	0	0	215	215					. . . . .
BUTTE SINK FWMA		0	0	0	435	435					. . . . .
CINDER FLATS WA		0	0	0	100	100					. . . . .
COLUSA NWR		0	0	0	2569	2569					. . . . .
GRASSLANDS MARSHES	541.20	0	0	8224	0	8224		Yes	Aquatic life impairment Wildlife impairment Selenium, TDS	Non-Point	X X . . X . X
GRAY LODGE WA		0	0	0	4500	4500					. . . . .
KERN NWR		0	0	0	3200	3200					. . . . .
KESTERSON NWR		0	0	0	2500	2500					. . . . .
LAS BANOS WA		0	0	0	2400	2400					. . . . .
LOWER SHERMAN ISLAND		0	0	0	1700	1700					. . . . .
MENDOTA NWR		0	0	0	6500	6500					. . . . .
MERCED NWR		0	0	0	1532	1532					. . . . .
MODOC NWR		0	0	0	345	345					. . . . .
MUD SLOUGH	541.20	0	0	14	0	14		Yes	Selenium, TDS Fisheries habitat degradation	Non-Point	X X . . X . X

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Region 5

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1
NEW MORMON SLOUGH	544.00	0	0	1	0	1	AC		Elevated fish tissue levels Health advisory for Hg	Non-Point	.	X	.	.	X	.	X	.
OLD MORMON SLOUGH	544.00	0	0	1	0	1	AC		Elevated fish tissue levels Health advisory for Hg	Non-Point	.	X	.	.	X	.	X	.
PELEVAN NWR		0	0	0	3106	3106					.	.	.	.	.	.	.	.
RECLAMATION SLOUGH	520.10	0	1	0	0	1		Yes	Elevated fish tissue levels	Non-Point	X	.	.	.	.	.	.	.
SACRAMENTO NWR		0	0	0	6150	6150					.	.	.	.	.	.	.	.
SACRAMENTO SLOUGH		0	0	1	0	1	AC	Yes	Elevated fish tissue levels	Non-Point	X	X	.	.	X	.	X	.
SALT SLOUGH	541.20	0	0	15	0	15	AC	Yes	Aquatic life impairments Selenium, TDS, pesticides		X	X	.	.	X	.	X	.
SAN LUIS NWR		0	0	0	2666	2666					.	.	.	.	.	.	.	.
SUTTER NWR		0	0	0	2497	2497					.	.	.	.	.	.	.	.
VOLTA WA		0	0	0	2600	2600					.	.	.	.	.	.	.	.

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D N S L
AMERICAN RIVER	519.21	242	0	23	0	265		Yes	Toxic bioassay results Threat of elevated fish tissue levels Fisheries habitat degradation	Non-Point	X X . . X . X
ANTELOPE CREEK (SACRAMENTO)	509.63	0	0	0	10	10					. . . . .
ARCADE CREEK	519.21	0	0	0	1	1					. . . . .
ATKINS CREEK	508.10	0	0	0	2	2	MI				. . . . .
BAILEY CREEK	507.10	0	0	0	8	8	MI				. . . . .
BATTLE CREEK	507.10	0	66	0	0	66			Inadequate flows, high temperature Fisheries habitat degradation	Non-Point	. . . . .
BEAR CREEK	507.22	0	6	0	0	6	MI		Threat to fisheries habitat Inadequate flows	Non-Point	. . . . .
BEAR CREEK (SAN JOAQN)	531.20	0	0	0	66	66					. . . . .
BEAR RIVER (FEATHER)	515.10	0	77	0	0	77			Inadequate flows, high temperature Fisheries habitat degradation	Non-Point	. . . . .
BEAR RIVER (MOKELUMNE)	532.60	0	0	0	20	20					. . . . .
BIG CHICO CREEK	509.10	64	0	0	0	64					. . . . .
BURNEY CREEK	526.32	0	15	0	0	15	MI		Threat to fisheries habitat Inadequate flows	Non-Point	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 0 3 . 1 D	3 3 3 3 3 3 3 1 0 0 0 0 1 1 4 4 4 4 9 1 M S L
BUTTE CREEK	520.00	0	87	0	0	87			Inadequate flows, no fish screens Fisheries habitat degradation	Non-Point	.	. . . . .
CACHE CREEK	511.30	0	124	0	0	124		Yes	Threat of elevated fish tissue levels Threat to fisheries habitat Inadequate flows	Non-Point	X	. . . . .
CALAVERAS RIVER	533.00	0	80	0	0	80			Fisheries habitat degradation Inadequate flows	Non-Point	.	. . . . .
CANTUA CREEK	551.10	0	10	0	0	10		Yes	Threat to aquatic life Agricultural wastewater	Non-Point	.	. . . . .
CHERRY CREEK	536.51	0	1	0	0	1	MI		Threat to fisheries habitat Inadequate flows	Non-Point	.	. . . . .
CHICO CREEK	509.10	0	1	0	0	1	MI		Threat to fisheries habitat Inadequate flows	Non-Point	.	. . . . .
CHOWCHILLA RIVER	539.10	64	1	0	0	65			Threat to aquatic habitat Inadequate flows Loss of fish and wildlife habitat	Non-Point	.	. . . . .
CHURN CREEK	508.10	0	13	0	0	13					.	. . . . .
CLAVEY RIVER	536.40	35	0	0	0	35					.	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 0 M S L
CLEAR CREEK	524.60	42	15	0	0	57			Threat to aquatic habitat Inadequate flows Gravel mining	Non-Point	. . . . .
COLUSA DRAIN	520.21	0	0	70	0	70		Yes	Toxic bioassay results Pesticides Agricultural wastewater	Non-Point	X X . . X . X
COSUMNES RIVER	531.00	0	0	0	80	80					. . . . .
COTTONWOOD CREEK	508.20	0	143	0	0	143			Fisheries habitat degradation Gravel mining Agricultural wastewater	Non-Point	. . . . .
COW CREEK	508.10	21	28	0	0	49			Fisheries habitat degradation Insufficient data to confirm Aquatic life impairment	Non-Point	. . . . .
CRYSTAL CREEK	524.63	0	0	0	1	1	MI		Insufficient data	Non-Point	. . . . .
DEER CREEK (SACRAMENTO)	504.20	61	10	0	0	71			Fisheries habitat degradation Inadequate flows Poor fish passage	Non-Point	. . . . .
DEER CREEK (TULARE)	555.20	0	58	0	0	58			Threat of fish population decline	Non-Point	. . . . .
DELTA (S.J. AT ANTIOCH)	543.00	0	0	1	0	1	MI	Yes	Dioxin discharge	Point	X X . X X . . . B/D
DELTA WATERWAYS	[illegible]		0/0			700		Yes	Health advisories for Hg Fisheries habitat impairment Elevated Dioxin, pesticides	Non-Point	X X . . X . X B/D

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D N S L
DIGGER CREEK	507.12	0	3	0	0	3	MI		Threat to fisheries habitat Inadequate flows	Non-Point	. . . . .
DINKEY CREEK	552.33	23	0	0	0	23					. . . . .
DOLLY CREEK		0	0	1	0	1	MI	Yes	Aquatic impairment Human health impairment Mine drainage	Non-Point	. X . . X . X
DOWNIE RIVER	517.33	20	0	0	0	20					. . . . .
DRY CREEK (SACRAMENTO)	519.21	0	37	0	0	37					X . . . . .
DUNN CREEK	543.00	0	0	9	0	9		Yes	Elevated fish tissue levels Fish population decline Drinking water impairment	Non-Point	X X X . X . X
ELDER CREEK @ GERBER	504.20	62	0	0	0	62					. . . . .
ETICUERA CREEK		0	1	0	0	1	MI		Threat to aquatic life Heavy metals Insufficient data	Non-Point	. . . . .
FALL RIVER (FEATHER)	518.32	25	0	0	0	25					. . . . .
FALL RIVER (PIT)	526.40	0	24	1	0	25			Fisheries habitat degradation Inadequate flows Over grazing	Non-Point	. X . . X . X

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
FEATHER RIVER, LOWER	519.22	0	0	12	0	12		Yes	Elevated fish tissue levels Toxic bioassay results Fisheries habitat impairment	Non-Point	X X . . X . X
FEATHER RIVER, M FK	518.30	0	113	0	0	113			Recreational impacts	Non-Point	. . . . .
FEATHER RIVER, N FK	518.40	31	66	0	0	97		Yes	Elevated fish tissue levels Fisheries habitat impairment Inadequate flows, sedimentation	Non-Point	X . . . . .
FEATHER RIVER, N FK, E BRANCH	578.50	0	17	0	0	17			Fish population decline	Non-Point	. . . . .
FEATHER RIVER, S FK	518.20	40	0	0	0	40					. . . . .
FRENCH RAVINE	516.32	0	0	1	0	1		Yes	Bacteria objectives violated	Non-Point	. X . . X . X
FRESNO RIVER	545.00	0	75	0	0	75			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
GARZAS CREEK	542.20	16	0	0	0	16					. . . . .
GRINDSTONE CREEK	522.23	0	32	0	0	32			Elevated metals concerns Insufficient data	Non-Point	X . . . . .
HARLEY GULCH	513.51	0	0	8	0	8		Yes	Objectives violated Threat of fish population decline Threat of elevated fish tissue levels	Non-Point	X X X . X . X
HAT CREEK	526.34	0	15	0	0	15	MI		Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists (1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L)
HORSE CREEK	526.20	0	0	2	0	2		Yes	Fish kills Fish population decline Objectives violated	Non-Point	X X . . X . X
HUMBUG CREEK	517.32	0	0	9	0	9		Yes	Fish population decline Heavy metals Mine drainage	Non-Point	X X . . X . X
HUNTING CREEK		0	1	0	0	1	MI	Yes	Limited sampling Elevated metals	Non-Point	. . . . .
INDIAN CREEK	518.54	0	50	0	0	50		Yes	Sedimentation Threat to aquatic habitat	Non-Point	. . . . .
JAMES CREEK	512.24	0	0	6	0	6		Yes	Fish population decline Elevated fish tissue levels Mine drainage	Non-Point	X X . . X . X
KANAKA CREEK	517.42	0	0	1	0	1		Yes	Drinking water impairment Threat of fish population decline Mine drainage	Non-Point	X X . . X . X
KAWEAH RIVER (LOWER)	553.40	0	39	0	0	39			Loss of fish and wildlife habitat Inadequate flows	Non-Point	. . . . .
KAWEAH RIVER (UPPER)	553.40	0	38	0	0	38			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
KERN RIVER (LOWER)	554.40	0	74	0	0	74			Fisheries habitat degradation Inadequate flows		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
KERN RIVER (UPPER)	554.40	0	90	0	0	90			Fisheries habitat degradation Inadequate flows		. . . . .
KINGS RIVER (LOWER)	551.90	65	0	30	0	95		Yes	Elevated fish tissue levels Objectives violated TDS	Non-Point	X X . . X . X
KINGS RIVER (MAIN FORK)	551.90	0	81	0	0	81		Yes	Sedimentation Degraded fish habitat Inadequate flows	Non-Point	. . . . .
KINGS RIVER (UPPER N. FORK)	551.90	0	38	0	0	38			Degraded fish habitat Inadequate flows	Non-Point	. . . . .
LATERAL #5	535.50	0	0	5	0	5		Yes	Toxic bioassay results Threat of fish population decline	Non-Point	. X . . X . X
LINDA CREEK	519.21	0	1	0	0	1		Yes	Threat of PCBs Aquatic life impairment	Non-Point	X . . . . .
LITTLE BACKBONE CREEK	506.20	2	0	1	0	3		Yes	Fish kills Fish population decline Objectives violated	Non-Point	X X . X X . X
LITTLE CLIPPER CREEK	516.34	0	1	0	0	1		Yes	Threat of fish population decline Threat of elevated fish tissue levels	Non-Point	X . . . . .
LITTLE COW CREEK	507.33	16	15	2	0	33		Yes	Fish population decline Mine drainage	Non-Point	X X . . X . X
LITTLE GRIZZLY CREEK	518.54	0	0	10	0	10		Yes	Fish population decline Mine drainage	Non-Point	X X . X X . X

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
LITTLE PANOCHE CREEK		0	1	0	0	1	MI		Limited information No impairments to beneficial uses	Non-Point	. . . . .
LITTLE WOLF CREEK	516.32	0	1	0	0	1		Yes	Threat of fish population decline Objectives violated	Non-Point	. . . . .
LONE TREE CREEK	531.40	0	0	15	0	15		Yes	Fish population decline Dairies	Non-Point	. X . . X . X
LOS GATOS CREEK (REG 5)	559.20	0	41	0	0	41		Yes	Threat of drinking water impairment	Non-Point	. . . . .
MARIPOSA CREEK	538.00	0	0	0	12	12					. . . . .
MARSH CREEK	543.00	0	0	24	0	24		Yes	Objectives violated Fish population decline Elevated fish tissue levels	Non-Point	X X X . X . X
MCCLOUD RIVER	505.24	59	1	0	0	60		Yes	Elevated fish tissue levels	Non-Point	X . . . . .
MERCED RIVER, LOWER	535.00	30	0	60	0	90		Yes	Elevated fish tissue levels Toxic bioassay results Fish habitat impairments	Non-Point	X X . . X . X
MERCED RIVER, UPPER	537.00	30	60	0	0	90					. . . . .
MIDDLE RIVER	544.00	0	0	30	0	30			Health advisories for Hg Fisheries habitat degradation Elevated tissue levels		X X . . X . X
MILL CREEK (1)	552.40	9	1	0	0	10			Limited sampling	Non-Point	. . . . .

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Region 5

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
MILL CREEK (2)	509.42	0	60	0	0	60			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
MOKELUMNE RIVER, LOWER	531.20	0	0	20	0	20		Yes	Threat of fish population decline Mine drainage, low flows Fish kills and habitat degradation	Non-Point	X X . . X . X
MOKELUMNE RIVER, UPPER	532.60	83	1	0	56	140			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
NATOMAS EAST MAIN DRAIN	519.22	0	0	12	0	12		Yes	Elevated fish tissue levels Toxic bioassay results Aquatic life impairments	Non-Point	X X . . X . X
OLD RIVER	544.00	0	0	48	0	48		Yes	Fisheries habitat degradation Elevated tissue levels	Non-Point	X X . . X . X
ORESTIMBA CREEK	541.10	0	0	3	0	3		Yes	Toxic bioassay results Threat of fish kills	Non-Point	. X . . X . X
OWENS CREEK	535.70	0	0	0	55	55					. . . . .
PANOCHE CREEK		0	0	1	0	1	MI	Yes	Sedimentation Selenium Aquatic life impairment	Non-Point	. X . . X . X
PIT RIVER	506.00	160	40	0	0	200			Fisheries habitat degradation Inadequate flows Metals	Non-Point	. . . . .
PORT OF STOCKTON	544.00	0	0	1	0	1	MI	Yes	Elevated fish tissue levels Aquatic life impairment	Non-Point	. X . . X . X

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
POSO CREEK	555.50	0	76	0	0	76				Non-Point	. . . . .
PUTAH CREEK	511.10	88	1	0	0	89			Fisheries habitat degradation Inadequate flows	Non-Point	X . . . . .
RED BANK CREEK	504.23	0	0	0	23	23					. . . . .
RISING RIVER	526.34	5	0	0	0	5					. . . . .
ROARING RIVER	552.34	17	0	0	0	17					. . . . .
RUBICON RIVER	514.40	65	0	0	0	65					. . . . .
SACRAMENTO R.(SHASTA DAM TO RED BLUFF)	508.10	0	12	60	0	72		Yes	Elevated fish tissue levels Fisheries habitat degradation Fish kills, warm water, Dioxin	Non-Point	X X . X X . X
SACRAMENTO RIVER (ABOVE SHASTA LAKE)	511.20	20	20	0	0	40					. . . . .
SACRAMENTO RIVER (RED BLUFF TO DELTA)	500.00	80	75	60	0	215		Yes	Toxic bioassay results Degraded fisheries habitat Low flows, warm water	Non-Point	X X . . X . X
SAN CARLOS CREEK	542.20	0	0	1	0	1		Yes	Drinking water impairment Threat of fish population decline	Non-Point	X X X . X . X
SAN JOAQUIN RIVER	544.00	155	75	100	0	330		Yes	Fish population decline Elevated fish tissue levels Toxic bioassay results	Non-Point	X X . . X . X
SPANISH CREEK	518.52	5	20	0	0	25					. . . . .

EXHIBIT 5

R0033498

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
SPRING CREEK	524.40	3	0	5	0	8		Yes	Fish kills Fish population decline Toxic bioassay results	Non-Point	X X . X X . X
ST JOHNS RIVER	558.10	0	0	0	25	25		Yes			. . . . .
STANISLAUS RIVER (LOWER)	535.30	0	0	48	0	48		Yes	Elevated fish tissue levels Toxic bioassay results Threat of fish population decline	Non-Point	X X . . X . X
STANISLAUS RIVER (UPPER)	534.00	90	23	0	0	113			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
STONY CREEK	522.30	109	0	0	0	109					. . . . .
SULFUR CREEK	513.51	0	0	7	0	7		Yes	Drinking water impairment Fish population decline Objectives violated	Non-Point	X X X . X . X
SUTTER BYPASS	520.30	0	24	0	0	24		Yes	Elevated fish tissue levels	Non-Point	X . . . . .
TEMPLE CREEK	531.40	0	0	10	0	10		Yes	Fish population decline Elevated salt, NH3 Dairies	Non-Point	. X . . X . X
THOMES CREEK	523.10	61	0	0	0	61					. . . . .
TOMI CREEK	526.20	2	0	1	0	3		Yes	Fish population decline Objectives violated Mine drainage	Non-Point	X X . . X . X
TULE RIVER (LOWER)	558.20	59	0	0	0	59					. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

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Region 5

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
TULE RIVER (PIT)	526.41	10	0	0	0	10					. . . . .
TULE RIVER (UPPER)	558.20	0	32	0	0	32			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
TUOLUMNE RIVER (LOWER)	535.50	0	0	50	0	50		Yes	Elevated fish tissue levels Toxic bioassay results Fish habitat degradation, low flows	Non-Point	X X . . X . X
TUOLUMNE RIVER (UPPER)	536.30	90	9	0	0	99			Fisheries habitat degradation Inadequate flows High temperatures	Non-Point	. . . . .
WEST SQUAW CREEK	505.10	6	0	2	0	8		Yes	Fish kills Fish population decline Objectives violated	Non-Point	X X . X X . X
WHITE RIVER	555.30	0	0	0	55	55					. . . . .
WILLOW CREEK (MADERA COUNTY)	540.21	0	24	0	0	24		Yes	Threat of recreational impacts	Non-Point	. . . . .
WILLOW CREEK (WHISKEYTOWN)	524.63	12	0	3	0	15		Yes	Fish population decline Heavy metals, acid Mine drainage	Non-Point	X X . . X . X
YUBA RIVER, LOWER	515.30	14	19	0	0	33		Yes	Elevated fish tissue levels Fisheries habitat degradation Low flows, warm water	Non-Point	X . . . . .
YUBA RIVER, MIDDLE	517.40	47	16	0	0	63					. . . . .

R0033500

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 5

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
YUBA RIVER, N FK	517.50	57	1	0	0	58			Fisheries habitat degradation Inadequate flows	Non-Point	. . . . .
YUBA RIVER, S FK	517.30	36	27	0	0	63					. . . . .

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
ALMANOR LAKE	518.41	0	28070	0	0	28070					. . . . . X .
ALOHA LAKE	514.35	0	0	0	630	630					. . . . .
AMADOR LAKE	532.40	0	385	0	0	385					. . . . . X .
ANGORA LAKES (SM)	517.34	0	0	0	18	18					. . . . .
ANTIOCH MUNICIPAL LAKE	543.00	0	55	0	0	55					. . . . . X .
AZURE LAKE	534.10	0	0	0	32	32					. . . . .
BARE ISLAND LAKE	540.40	0	0	0	2	2					. . . . .
BASS LAKE (MADERA CO)	540.22	0	1165	0	0	1165					. . . . . X .
BAYLEY LAKE	526.52	328	0	0	0	328					. . . . .
BEACH LAKE	510.00	0	0	295	0	295		Yes	Elevated fish tissue levels Threat of fish population decline Threat of objectives violated	Non-Point	X X . . X X X
BERRYESSA LAKE	512.21	0	0	20700	0	20700		Yes	Elevated fish tissue levels Threat of fish population decline Threat of objectives violated	Non-Point	X X . . X X X
BETHANY RES	543.00	0	140	0	0	140					. . . . . X .
BIG BEAR LAKE (REG 5)	540.40	0	0	0	11	11					. . . . . X .

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Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
BIG FIVE LAKES	554.20	0	0	0	7	7					.	.	.	.	.	.	.	.	.
BIG LAKE	526.41	0	973	0	0	973					.	.	.	.	.	.	X	.	.
BIG SAGE RES	526.54	5267	0	0	0	5267					.	.	.	.	.	.	X	.	.
BINGAMAN LAKE	536.60	0	0	0	12	12					.	.	.	.	.	.	.	.	.
BLACK BUTTE RES	522.12	0	4560	0	0	4560					X	.	.	.	.	.	X	.	.
BLACK LAKE	518.44	0	0	0	10	10					.	.	.	.	.	.	.	.	.
BLAIR RES (NEV CO)	517.41	0	0	0	4	4					.	.	.	.	.	.	X	.	.
BLUE LAKE	526.53	0	163	0	0	163					.	.	.	.	.	.	.	.	.
BLUE LAKE, LOWER	513.51	0	75	0	0	75					.	.	.	.	.	.	.	.	.
BOHN LAKE, LOWER	512.30	0	50	0	0	50					.	.	.	.	.	.	.	.	.
BOWMAN LAKE	517.33	0	0	0	825	825					.	.	.	.	.	.	.	.	.
BOX LAKE	526.33	0	0	0	20	20					.	.	.	.	.	.	.	.	.
BRITTON LAKE	526.31	0	1293	0	0	1293					.	.	.	.	.	.	X	.	.
BUCKS LAKE	518.42	0	1852	0	0	1852					.	.	.	.	.	.	X	.	.
BULLARDS BAR RES	517.51	0	4810	0	0	4810					.	.	.	.	.	.	X	.	.

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Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D M S L
											3 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1
CANANCHE RES	531.20	0	7700	0	0	7700		Yes	Fish kills Threat of fish population decline Fisheries habitat degradation	Non-Point	X . . . . X .
CAMP FAR WEST RES	516.31	0	2680	0	0	2680					. . . . . X .
CASCADE LAKES	517.34	0	0	0	85	85					. . . . .
CHERRY LAKE	536.50	1765	0	0	0	1765					. . . . .
CHIEF LAKES	540.60	0	0	0	220	220					. . . . .
CHIQUITO LAKE	540.40	0	12	0	0	12					. . . . .
CLEAR LAKE	513.52	0	0	43000	0	43000		Yes	Elevated fish tissue levels Eutrophication Recreational and fish impacts	Non-Point	X X . . X X X
COMBIE LAKE	516.33	0	360	0	0	360					. . . . .
CONCOW RES	518.60	0	280	0	0	280					. . . . . X .
CONTRA LOMA LAKE	543.00	0	81	0	0	81					. . . . . X .
COURTRIGHT LAKE	552.33	0	0	0	1440	1440					. . . . .
COW MEADOW LAKE	536.51	0	0	0	17	17					. . . . .
CRESTA LAKE	518.42	95	0	0	0	95					. . . . . X .
CRYSTAL LAKE (REG 5)	553.41	0	0	0	12	12					. . . . .

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 1 0 M S L
DALLAS-WARNER LAKE	542.30	0	0	0	3800	3800					. . . . . X .
DAVIS CREEK RES	513.32	0	0	290	0	290		Yes	Elevated fish tissue levels	Non-Point	X X . . X X X
DAVIS LAKE	518.34	0	0	0	4026	4026			Limited information		. . . . . X .
DEER CREEK LAKE	517.20	0	56	0	0	56					. . . . . X .
DEERHART LAKE	518.45	0	0	0	7	7					. . . . .
DON PEDRO RES	536.32	0	12960	0	0	12960			Threat of elevated fish tissue levels	Non-Point	X . . . . X .
DONNELL LAKE	534.41	0	0	0	430	430					. . . . .
DOROTHY LAKE (REG 5)	536.60	0	0	0	481	481					. . . . .
DORRIS RES	526.52	1060	0	0	0	1060					. . . . .
DUCK LAKE	534.50	0	0	0	10	10					. . . . .
EAST LAKE (TULARE CO)	522.33	0	0	0	25	25					. . . . . X .
EAST PARK RES	522.33	0	1818	0	0	1818		Yes	Limited sampling Mercury exceeds NIS criteria in edible portion of fish	Non-Point	X . . . . X .
EDISON LAKE	540.40	0	0	0	1880	1880					. . . . .
EGG LAKE	526.42	594	0	0	0	594					. . . . .
ELEANOR LAKE (REG 5)	536.53	0	0	0	948	948					. . . . .

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
ELLIS LAKE	515.40	4	0	0	0	4					. . . . . X .
EMERALD LAKE	523.22	0	0	0	3	3					. . . . .
EMIGRANT LAKE	514.36	0	0	0	16	16					. . . . .
ENGLEBRIGHT LAKE	517.14	0	815	0	0	815					. . . . . X .
EVERGREEN LAKE	536.20	0	0	0	5	5					. . . . .
FEATHER LAKE	526.35	0	0	0	8	8					. . . . .
FLORENCE LAKE	540.40	0	0	0	962	962					. . . . .
FOLSOM RES	514.23	0	11450	0	0	11450					X . . . . X .
FORDYCE LAKE	517.34	730	0	0	0	730					. . . . .
FORNI LAKE	514.44	0	0	0	6	6					. . . . .
FRANCIS LAKE	517.14	0	105	0	0	105					. . . . .
FRENCH LAKE	517.33	0	0	0	337	337					. . . . .
FRENCH MEADOWS LAKE	514.42	1418	0	0	0	1418					. . . . . X .
FRENCHMAN LAKE	518.36	1470	0	0	0	1470					. . . . .
FROG LAKE	532.60	0	0	0	6	6					. . . . .
GLEN LAKE	518.44	0	0	0	2	2					. . . . .

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Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 0 M S L
GOLD LAKE	518.42	0	0	0	14	14					. . . . .
GOOSE LAKE (REG 5X)	518.33	0	0	0	30	30					. . . . .
GOOSE LAKE (REG 5Y)	527.20	0	124160	0	0	124160					. . . . .
GRANITE LAKE (REG 5)	536.20	0	0	0	7	7					. . . . .
GROUSE LAKE	514.33	0	0	0	6	6					. . . . .
HEATHER LAKE	553.41	0	0	0	10	10					. . . . .
HELL HOLE LAKE	514.45	1250	0	0	0	1250					. . . . .
HENDERSON LAKE	532.40	0	31	0	0	31					. . . . .
HETCH HETCHY RES	536.60	1960	0	0	0	1960					. . . . .
HIDDEN LAKES	518.44	0	0	0	1	1					. . . . .
HIGHLAND CREEK	513.54	146	0	0	0	146					. . . . .
HOCKETT LAKES (C)	553.42	0	0	0	7	7					. . . . .
HORSESHOE LAKE (H)(1)	552.34	0	0	0	12	12					. . . . .
HUME LAKE (EAST SIDE)	552.34	0	85	0	0	85					. . . . . X .
HUNTINGTON LAKE	540.52	0	0	0	1435	1435					. . . . .

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Report Date : 06/16/90

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 I D M S L
ICE HOUSE LAKE	514.33	678	0	0	0	678					. . . . .
ICEBURG LAKE	540.60	0	0	0	35	35					. . . . .
INDIAN VALLEY (REG 5X)	513.40	4000	0	0	0	4000					. . . . . X .
IRON CANYON	526.15	510	0	0	0	510					. . . . .
IRON CANYON RES	526.15	0	0	0	432	432					. . . . .
ISABELLA LAKE	554.21	0	11400	0	0	11400			Sedimentation Threat of fish population decline Threat of recreational impacts	Non-Point	. . . . . X .
JACKS LAKE	526.44	64	0	0	0	64					. . . . . X .
JACKSON MEADOWS	517.43	1030	0	0	0	1030					. . . . . X .
JEFF DAVIS LAKE	532.60	0	0	0	62	62					. . . . .
JENKINSON LAKE	532.25	0	0	0	640	640					. . . . .
KAWEAH LAKE	553.44	0	1940	0	0	1940			Elevated fish tissue levels Sedimentation Threat of recreational impacts	Non-Point	X . . . . X .
KERCKHOFF LAKE	540.11	0	160	0	0	160					. . . . .
KESWICK RES	526.40	0	450	200	0	650		Yes	Fish population decline Recreational impacts Objectives violated	Non-Point	X X . . X . X

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Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 1 0 M	3 0 S	3 0 L	3 0	3 1	3 4	3 4	3 4	3 9
LEOPOLD LAKE	536.51	0	0	0	8	8					.	.	.	.	.	.	.	.	.
LITTLE BEAR LAKE	526.35	0	0	0	5	5					.	.	.	.	.	.	.	.	.
LITTLE GRASS VALLEY LAKE	518.24	0	1423	0	0	1423					.	.	.	.	.	.	X	.	
LITTLE LAKE	552.33	0	9	0	12	12					.	.	.	.	.	.	.	.	.
LITTLE SPANISH LAKE	552.33	0	0	0	5	5					.	.	.	.	.	.	.	.	.
LOIS LAKE	514.45	0	0	0	25	25					.	.	.	.	.	.	.	.	.
LONG LAKE (2) (PLACER)	514.55	0	0	0	10	10					.	.	.	.	.	.	.	.	.
LONG LAKE (3) (PLUMAS)	518.33	0	0	0	141	141					.	.	.	.	.	.	.	.	.
LOS BANOS RES	535.50	470	0	0	0	470					.	.	.	.	.	.	.	.	.
LOST CREEK LAKE	518.23	118	0	0	0	118					.	.	.	.	.	.	.	.	.
LOST LAKE (1) (TUOLUMNE)	534.41	0	0	0	8	8					.	.	.	.	.	.	.	.	.
LOST LAKE (FRESNO)	540.22	0	0	0	30	30					.	.	.	.	.	.	X	.	
LOWER BEAR RES	532.60	746	0	0	0	746					.	.	.	.	.	.	.	.	.
LOWER ROCK LAKE	517.33	0	0	0	7	7					.	.	.	.	.	.	.	.	.

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Report Date : 04/16/90

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
MACUMBER LAKE	507.12	0	85	0	0	85					. . . . .
MAGEE LAKE	526.34	0	0	0	5	5					. . . . .
MAMMOTH POOL	540.40	1100	0	0	0	1100					. . . . .
MANZANITA LAKE	540.34	26	0	0	0	26					. . . . .
MARSH CREEK RES	543.00	0	0	375	0	375		Yes	Elevated fish tissue levels	Non-Point	. X . . X X X
MARY LAKE (REG 5)	536.60	0	0	0	74	74					. . . . .
MCCLOUD LAKE	505.23	0	520	0	0	520					. . . . .
MCCLURE RES	537.22	0	7110	0	0	7110			Threat of elevated fish tissue levels Threat of fish population decline	Non-Point	X . . . . .
MCKINSTRY LAKE	517.34	0	0	0	10	10					. . . . .
MCSWAIN LAKE	537.10	312	0	0	0	312					. . . . .
MELONES RES	534.22	1843	0	0	0	1843					. . . . .
MENDOTA POOL	535.71	0	0	0	500	500					. . . . . X .
MERLE COLLINS LAKE	517.13	975	0	0	0	975					. . . . .
MERRIAM LAKE	540.40	0	0	0	20	20					. . . . .
MILLERTON LAKE	540.23	4900	0	0	0	4900					. . . . . X .
MINERS RANCH LAKE	515.40	0	52	0	0	52					. . . . .

R0033510

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 W	3 S	3 L	3	3	3	1 .	1 9
MIRROR LAKE	540.51	0	0	0	6	6					.	.	.	.	.	.	.	.	.
MOSQUITO LAKE, LOWER	532.60	0	4	0	0	4					.	.	.	.	.	.	.	.	.
MOUNTAIN MEADOW LAKE	518.45	5746	0	0	0	5746					.	.	.	.	.	.	.	.	.
MUD LAKES (E)	552.33	0	0	0	4	4					.	.	.	.	.	.	.	.	.
NATOMA LAKE	514.21	540	0	0	0	540					.	.	.	.	.	.	.	.	.
NEIL LAKE	540.18	0	0	0	2	2					.	.	.	.	.	.	.	.	.
NELLIE LAKE	540.51	0	0	0	12	12					.	.	.	.	.	.	.	.	.
NEW HOGAN LAKE	533.10	0	0	0	4410	4410					.	.	.	.	.	.	.	.	.
NOBEL LAKE	531.10	0	0	0	5	5					.	.	.	.	.	.	.	.	.
NYDIVER LAKES (M)	540.60	0	0	0	8	8					.	.	.	.	.	.	.	.	.
O'NEILL FOREBAY	541.20	0	2250	0	0	2250					.	.	.	.	.	.	X	.	.
OROVILLE LAKE	518.12	0	15808	0	0	15808					.	.	.	.	.	.	X	.	.
PARADISE RES	521.30	0	165	0	0	165					.	.	.	.	.	.	X	.	.
PARDEE RES	532.60	0	2138	0	0	2138		Yes	Threat of elevated fish tissue levels Threat of fish population decline Limited sampling	Non-Point	X	.	.	.	.	.	X	.	.
PETER PANDE	540.60	80	0	0	0	80					.	.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 P	3 N	3 S	3 L	3	3	3	1
PHOENIX LAKE (REG 5)	517.34	0	0	0	16	16					.	.	.	.	.	X	.	
PINE FLAT RES	552.32	0	5970	0	0	5970			Threat of recreational impacts	Non-Point	.	.	.	.	.	X	.	
RAINBOW LAKE	524.35	0	113	0	0	113					.	.	.	.	.	.	.	
RELIEF RES	534.41	0	288	0	0	288					.	.	.	.	.	.	.	
ROBERTS RES	526.61	0	640	0	0	640					.	.	.	.	.	X	.	
ROCK CREEK LAKE (REG 5X)	514.51	0	55	0	0	55					.	.	.	.	.	.	.	
ROCK CREEK LAKE (REG 5Y)	518.42	0	80	0	0	80					.	.	.	.	.	.	.	
ROCKBOUND LAKE	514.45	0	0	0	108	108					.	.	.	.	.	.	.	
ROLLINS RES	516.34	0	825	0	0	825			Threat of elevated fish tissue levels Limited sampling	Non-Point	X	.	.	.	.	X	.	
ROOSEVELT LAKE	536.60	0	0	0	60	60					.	.	.	.	.	.	.	
ROPI LAKE	514.35	0	0	0	20	20					.	.	.	.	.	.	.	
S P LAKES (SE)	514.54	0	0	0	15	15					.	.	.	.	.	.	.	
SADDLE LAKE	518.42	0	0	0	9	9					.	.	.	.	.	.	.	
SALT SPRINGS LAKE	532.60	0	0	0	963	963					.	.	.	.	.	.	.	
SAN LUIS RES	542.32	12700	0	0	0	12700					.	.	.	.	.	X	.	

R0033512

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
SAN LUIS WASTEWAY	535.10	0	50	0	0	50					. . . . .
SARDINE LAKE	517.54	0	0	0	62	62					. . . . .
SAUCER LAKE	518.43	0	0	0	7	7					. . . . .
SCOTTS FLAT RES	517.20	0	720	0	0	720					. . . . . X .
SEQUOIA LAKE	552.34	0	95	0	0	95			Threat of recreational impacts Threat of eutrophication	Non-Point	. . . . .
SHADOW LAKE	526.35	0	0	0	12	12					. . . . .
SHASTA LAKE	506.1		29480	20	0	29500		Yes	Fish kills Threat of fish population decline	Non-Point	X X . . X X X
SHAVER LAKE	540.25	0	0	0	2177	2177					. . . . . X .
SHRINER LAKE	532.60	0	0	0	3	3					. . . . .
SISKIYOU LAKE	525.22	430	0	0	0	430					. . . . . X .
SLY CREEK RES	518.23	0	562	0	0	562					. . . . . X .
SMITH LAKE	518.34	0	0	0	80	80					. . . . .
SNAG LAKE (BUTTE CO)	518.60	0	98	0	0	98					. . . . . X .
SNAG LAKE (SIERRA CO)	518.33	0	20	0	0	20					. . . . . X .
SNAKE LAKE	518.52	0	100	0	0	100					. . . . . X .

R0033513

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 R	3 S	3 L	3	3	3	1	1	4	4	4	9
SOLANO LAKE	511.20	0	125	0	0	125					.	.	.	.	.	.	X	.					
SPAULDING LAKE	517.34	674	0	0	0	674					.	.	.	.	.	.	.	.					
SPIDER LAKE	514.44	0	0	0	42	42					.	.	.	.	.	.	.	.					
STAR LAKE	518.44	0	0	0	90	90					.	.	.	.	.	.	.	.					
STAR LAKES (N) (LOWER)	537.40	0	0	0	2	2					.	.	.	.	.	.	.	.					
STERLING LAKE	517.34	0	0	0	112	112					.	.	.	.	.	.	.	.					
STONY GORGE RES	522.22	0	1274	0	0	1274					X	.	.	.	.	X	.						
STRAWBERRY LAKE	540.51	0	0	0	6	6					.	.	.	.	.	.	.	.					
SUCCESS LAKE	555.12	0	2400	0	0	2400			Sedimentation Threat of recreational impacts	Non-Point	.	.	.	.	.	X	.						
SUMMIT LAKE (1) (ALPINE)	536.20	0	0	0	7	7					.	.	.	.	.	.	.	.					
SUMMIT LAKE (2) (FRESNO)	534.50	0	0	0	13	13					.	.	.	.	.	.	.	.					
SWAMP LAKES (W)	552.34	0	0	0	12	12					.	.	.	.	.	.	.	.					
SWAN LAKE	526.35	0	0	0	11	11					.	.	.	.	.	.	.	.					
THERMALITO AFTERBAY	515.40	0	4550	0	0	4550					.	.	.	.	.	X	.						

R0033514

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Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
THERMALITO FOREBAY	515.40	0	330	0	0	330					.	.	.	.	.	.	.	.	.
THOMPSON LAKE	518.42	0	0	0	5	5					.	.	.	.	.	.	.	.	.
THREE LAKES (NW)	518.42	0	0	0	16	16					.	.	.	.	.	.	.	.	.
THURSTON LAKE	513.51	0	500	0	0	500					.	.	.	.	.	.	X	.	.
TULARE LAKE	558.30	0	0	0	60000	60000					.	.	.	.	.	.	X	.	.
TULE LAKE	526.43	0	320	0	0	320					.	.	.	.	.	.	.	.	.
TULLOCH LAKE	534.22	1260	0	0	0	1260					.	.	.	.	.	.	X	.	.
TWIN LAKES (N)	540.40	0	0	0	10	10					.	.	.	.	.	.	.	.	.
TWIN LAKES (S)	540.40	0	0	0	10	10					.	.	.	.	.	.	.	.	.
UNION RESERVOIR	534.50	0	0	0	147	147					.	.	.	.	.	.	.	.	.
UNION VALLEY	514.34	2860	0	0	0	2860					.	.	.	.	.	.	.	.	.
VEE LAKE	540.40	0	0	0	50	50					.	.	.	.	.	.	.	.	.
VERNON LAKE	536.60	0	0	0	45	45					.	.	.	.	.	.	.	.	.
VOGELSANG LAKE	537.60	0	0	0	15	15					.	.	.	.	.	.	.	.	.
WACA LAKE	514.35	0	0	0	5	5					.	.	.	.	.	.	.	.	.
WANOO LAKES (NW)	540.40	0	0	0	10	10					.	.	.	.	.	.	.	.	.

R0033515

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 5

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 P	3 M	3 S	3 L	3	3	3	1
											.	.	.	.	.	.	.	.
WALTON LAKES	540.40	0	0	0	2	2					.	.	.	.	.	.	.	.
WEST VALLEY LAKE	526.53	0	970	0	0	970					.	.	.	.	.	.	X	.
WISHON LAKE	552.33	0	0	0	1025	1025					.	.	.	.	.	.	.	.
WISKEYTOWN RES	524.61	3151	0	100	0	3251		Yes	Recreational impacts Coliform bacteria	Non-Point	.	X	.	.	X	.	X	.
WRIGHT LAKES (NW)	554.24	0	0	0	5	5					.	.	.	.	.	.	.	.
WRIGHTS LAKE	514.33	65	0	0	0	65					.	.	.	.	.	.	X	.
YUBA RESERVOIR	516.32	0	0	0	8	8					.	.	.	.	.	.	.	.

R0033516

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 5

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 I D M S L
ALTURAS BASIN	5-2	0	0	0	0	0					. . . . .
AMERICAN VALLEY	5-10	7	0	0	0	7					. . . . .
ASH VALLEY	5-54	0	0	0	10	10					. . . . .
BEAR VALLEY (SB)	5-64	0	0	0	13	13					. . . . .
BEAR VALLEY (TL)	5-81	0	0	0	3	3					. . . . .
BERRYESSA VALLEY	5-20	0	0	0	4	4					. . . . .
BIG VALLEY	5-4	0	120	40	0	160					. . . . .
BRITE VALLEY	5-80	4	0	0	0	4					. . . . .
BUCKER SWAMP VALLEY	5-42	0	0	0	3	3					. . . . .
BURNEY CREEK VALLEY	5-48	0	0	0	4	4					. . . . .
BURNS VALLEY	5-17	2	0	0	0	2					. . . . .
BUTTE CREEK VALLEY	5-51	0	0	0	4	4					. . . . .
CASTAIC LAKE VALLEY	5-29	2	0	0	0	2					. . . . .
CAYTON VALLEY	5-45	0	0	0	3	3					. . . . .
CEDAR GROVE AREA	5-72	0	0	0	6	6					. . . . .
CHOWCHILLA B PORT	5-22	0	0	0	230	230					. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
CHROME TOWN AREA	5-61	0	0	0	5	5					. . . . .
CLEAR LAKE CACHE FN	5-66	0	0	0	36	36					. . . . .
CLEAR LAKE PV	5-67	0	0	0	34	34					. . . . .
CLOVER VALLEY	5-58	0	0	0	23	23					. . . . .
COLLAYOMI VALLEY	5-19	7	0	0	0	7					. . . . .
COYOTE VALLEY	5-18	0	6	0	0	6					. . . . .
CUDDY CANYON VALLY	5-82	0	0	0	3	3					. . . . .
CUDDY RANCH AREA	5-83	0	0	0	6	6					. . . . .
CUDDY VALLEY	5-84	0	0	0	4	4					. . . . .
CUMMINGS VALLEY	5-27	13	0	0	0	13					. . . . .
DELTA MENDOTA PORT	5-22	0	0	0	365	365					. . . . .
DIXIE VALLEY	5-53	0	0	0	7	7					. . . . .
DRY BURNEY CREEK VALLEY	5-49	0	0	0	5	5					. . . . .
E SAN JOAQUIN PORT	5-22	0	0	0	1140	1140					. . . . .
EGG LAKE VALLEY	5-41	0	0	0	7	7					. . . . .
ELKCREEK AREA	5-62	0	0	0	6	6					. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Feature Lists
FALL RIVER VALLEY	5-5	100	20	0	0	120					
FANDANGO VALLEY	5-39	0	0	0	26	26					
GOOSE LAKE VALLEY	5-1	55	20	0	0	75					
GOOSE VALLEY	5-47	0	0	0	8	8					
GRAY VALLEY	5-52	0	0	0	10	10					
GRISSLY VALLEY	5-59	0	0	0	17	17					
HIGH VALLEY	5-16	3	0	0	0	3					
HOT SPRINGS VALLEY	5-40	0	0	0	11	11					
HUMBUG VALLEY	5-60	14	0	0	0	14					
INDIAN VALLEY (REG 5Y)	5-9	20	0	0	0	20					
INNS VALLEY	5-79	0	0	0	8	8					
JESS VALLEY	5-3	9	0	0	0	9					
KAWEAH BASIN PORT	5-22	0	0	0	690	690		Yes			
KELSEYVILLE VALLEY	5-15	25	5	0	0	30					
KERN CNTY B PORT	5-22	0	0	0	2770	2770					
KERN RIVER VALLEY	5-25	70	0	0	0	70					

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Ground Water

Water Body Name	Hydrg Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1
KINGS BASIN PORT	5-22	0	0	0	1220	1220		Yes			.	.	.	.	.	.	.	.
LAKE ALMANOR VALLY	5-7	7	0	0	0	7					.	.	.	.	.	.	.	.
LAKE BRITTON AREA	5-46	0	0	0	23	23					.	.	.	.	.	.	.	.
LAST CHANCE CREEK VALLEY	5-57	0	0	0	5	5					.	.	.	.	.	.	.	.
LITTLE INDIAN VALLEY	5-65	0	0	0	3	3					.	.	.	.	.	.	.	.
LONG VALLEY 1	5-31	0	0	0	3	3					.	.	.	.	.	.	.	.
LONG VALLEY 2	5-44	0	0	0	5	5					.	.	.	.	.	.	.	.
LOS BANOS CREEK VALLY	5-70	0	0	0	8	8					.	.	.	.	.	.	.	.
LOWER LAKE VALLEY	5-30	0	4	1	0	5					.	.	.	.	.	.	.	.
MADERA BASIN PORT	5-22	0	0	0	620	620					.	.	.	.	.	.	.	.
MANACHE MEADOWS AREA	5-76	0	0	0	6	6					.	.	.	.	.	.	.	.
MCCLOUD AREA	5-35	0	0	0	106	106					.	.	.	.	.	.	.	.
MERCED BASIN PORT	5-22	0	0	0	690	690					.	.	.	.	.	.	.	.
MILL POTERA AREA	5-85	0	0	0	5	5					.	.	.	.	.	.	.	.
MODESTO BASIN PORT	5-22	0	0	0	340	340					.	.	.	.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
MODOC PLATEAU PVA (REG 5)	5-33	0	0	0	650	650					. . . . .
MODOC PLATEAU RVA (REG 5)	5-32	0	0	0	375	375					. . . . .
MOHAWK VALLEY	5-11	6	0	2	0	8					. . . . .
MOUNT SHASTA AREA	5-34	0	0	0	295	295					. . . . .
MTN MEADOWS VALLEY	5-8	10	0	0	0	10					. . . . .
N FORK BATTLE CREEK VALLEY	5-50	0	0	0	14	14					. . . . .
PANOCHE VALLEY	5-23	50	0	0	0	50					. . . . .
PIT RIVER & ALT, S FK	5-2.01	115	25	0	0	140					. . . . .
PLEASANT VALLEY PORT	5-22	0	0	0	260	260					. . . . .
PONDOSA TOWN AREA	5-38	0	0	0	15	15					. . . . .
POPE VALLEY	5-68	0	0	0	15	15					. . . . .
REDDING BASIN	5-6	410	100	0	0	510					. . . . .
ROCKHOUSE MEADOW VALLEY	5-78	0	0	0	5	5					. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 H	3 S	3 L	3	3	3	1
ROCKY PRAIRE VALLEY	5-43	0	0	0	5	5					.	.	.	.	.	.	.	.
ROUND VALLEY (REG 5)	5-36	15	0	0	0	15					.	.	.	.	.	.	.	.
SACATOR CANYON VALLEY	5-77	0	0	0	6	6					.	.	.	.	.	.	.	.
SACRAMENTO VALLEY 1	5-55	0	0	0	810	810					.	.	.	.	.	.	.	.
SACRAMENTO VALLEY 2	5-21	4400	500	100	0	5000		Yes	Drinking water impairment Objectives violated		.	.	.	.	.	.	.	.
SAN JOAQUIN VALLEY	5-22	7900	500	100	0	8500		Yes	Drinking water impairment Objectives violated		.	.	.	.	.	.	.	.
SCOTT VALLEY	5-14	4	0	0	0	4					.	.	.	.	.	.	.	.
SIERRA VALLEY	5-12	100	40	0	0	140					.	.	.	.	.	.	.	.
SPRINGVILLE AREA	5-74	0	0	0	188	188					.	.	.	.	.	.	.	.
SQUAW VALLEY (FRESNO COUNTY)	5-24	8	0	0	0	8					.	.	.	.	.	.	.	.
STONYFORD TOWN AREA	5-63	0	0	0	7	7					.	.	.	.	.	.	.	.
TEHACHAPI VALLEY, WEST	5-28	37	0	0	0	37					.	.	.	.	.	.	.	.
TEMPLETON MTN AREA	5-75	0	0	0	138	138					.	.	.	.	.	.	.	.
THREE RIVERS AREA	5-73	0	0	0	5	5					.	.	.	.	.	.	.	.

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Region 5

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
TOAD WELL AREA	5-37	0	0	0	7	7					. . . . .
TRACY BASIN PORT	5-22	0	0	0	570	570					. . . . .
TULARE LAKE PORT	5-22	0	0	0	910	910		Yes			. . . . .
TULE BASIN PORT	5-22	0	0	0	660	660		Yes			. . . . .
TURLOCK BASIN PORT	5-22	0	0	0	545	545					. . . . .
UPPER LAKE VALLEY	5-13	10	5	0	0	15					. . . . .
VALLECITOS CREEK VALLEY	5-71	0	0	0	20	20					. . . . .
WALKER BSN CREEK VALLEY	5-26	16	0	0	0	16					. . . . .
WARM SPRINGS VALLEY	5-2.02	85	15	0	0	100					. . . . .
WESTSIDE BASIN PORT	5-22	0	0	0	1010	1010		Yes			. . . . .
YELLOW CREEK VALLY	5-56	0	0	0	5	5					. . . . .
YOSEMITE VALLEY	5-69	0	0	0	10	10					. . . . .

R0033523

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Region 6

Report Date : 04/16/90

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D N S L
ADOBE MU, MINOR STREAMS	602.00	1	0	0	0	1					. . . . .
ADOBE MU, SPRINGS	602.00	1	0	0	0	1					. . . . .
ALKALI LAKES AREA WETLANDS	641.00	0	1	0	0	1			Grazing impacts Water diversions Natural high salinity	Non-Point	X . . . . .
AMARGOSA MU, SPRINGS	609.00	1	0	0	0	1					. . . . .
AMARGOSA MU, STREAMS	609.00	1	0	0	0	1					. . . . .
AMARGOSA RIVER WETLANDS	609.00	0	1	0	0	1			Natural high salinity Grazing impacts	Non-Point	X . . . . .
AMEDEE HOT SPRINGS	637.20	0	0	1	0	1		Yes	Objectives violated Geothermal springs (see Honey Lake)	Non-Point	X X . . X . X
ANTELOPE MU, MINOR STREAMS	626.00	1	0	0	0	1					. . . . .
ANTELOPE MU, SPRINGS	626.00	1	0	0	0	1					. . . . .
ANTELOPE VALLEY (NL) WETLANDS	631.00	0	1	0	0	1		Yes	Grazing impacts (see West Walker River)	Non-Point	. . . . .
BARTLETT RANCH SPRINGS	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BENTON HOT SPRINGS	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .

R0033524

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	4	1
BICYCLE MU, EPHEMERAL STREAMS	616.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.
BIG MEADOW WETLANDS	634.10	0	1	0	0	1		Yes	Grazing impacts (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.
BISCAR RESERVOIR AREA WETLANDS	637.40	0	1	0	0	1			Fish kills	Non-Point	X	.	.	.	.	.	.	.	.	.
BLACK ROCK SPRINGS	603.00	0	0	0	1	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
BRIDGEPORT VALLEY WETLANDS	630.10	0	1	0	0	1		Yes	Metals/Grazing impacts Wetlands alteration (see East Walker River)	Non-Point	X	.	.	.	.	.	.	.	.	.
BROADWELL MU, MINOR STREAMS	629.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.
BROADWELL MU, SPRINGS	629.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.
BROCKWAY SPRINGS	634.10	0	1	0	0	1			Geothermal springs	Non-Point	X	.	.	.	.	.	.	.	.	.
BROWN MA, EPHEMERAL STREAMS	620.70	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.
BURTON CREEK SEZ WETLANDS	634.20	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.
CADY SPRINGS	637.20	1	0	0	0	1		Yes	Threat of septic system impacts (see Honey Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.

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Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
CARNELIAN CREEK SEZ WETLANDS	634.20	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	. . . . .
CARSON RIVER E FK HU, MINOR STREAMS	632.00	0	0	0	1	1					. . . . .
CARSON RIVER E FK HU, SPRINGS	632.00	0	0	0	1	1					. . . . .
CARSON RIVER W FK HU, MINOR STREAMS	633.00	0	0	0	1	1					. . . . .
CARSON RIVER W FK HU, SPRINGS	633.00	0	0	0	1	1					. . . . .
CHINA LAKE HA, MINOR STREAMS	624.20	1	0	0	0	1					. . . . .
CHINA LAKE HA, N SPRINGS	624.20	1	0	0	0	1					. . . . .
CINDER CONE SPRINGS	635.00	0	0	1	0	1		Yes	Objectives violated Domestic wastewater impacts (see Truckee River)	Non-Point	X X . . X . X
COSO HU, MINOR STREAMS	622.00	1	0	0	0	1					. . . . .
COSO HU, SPRINGS	622.00	1	0	0	0	1					. . . . .
COTTONBALL MARSH WETLANDS	609.00	0	0	0	1	1					. . . . .

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Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists (1 D M S L)
COWHEAD LAKE WETLANDS	641.30	0	0	0	1	1					. . . . .
COYOTE MU, MINOR STREAMS	618.00	1	0	0	0	1					. . . . .
COYOTE MU, SPRINGS	618.00	1	0	0	0	1					. . . . .
CUDDEBACK MU, MINOR STREAMS	627.00	1	0	0	0	1					. . . . .
CUDDEBACK MU, SPRINGS	627.00	1	0	0	0	1					. . . . .
DARWIN MA, EPHEMERAL STREAMS	620.50	1	0	0	0	1					. . . . .
DEEP SPRINGS MU, OTHER STREAMS	605.00	1	0	0	0	1					. . . . .
DEEP SPRINGS MU, SPRINGS	605.00	1	0	0	0	1					. . . . .
DEEP SPRINGS LAKE/MARSH WETLANDS	605.00	0	1	0	0	1			Natural high salinity	Non-Point	. . . . .
DIAMOND VALLEY WETLANDS	633.10	0	1	0	0	1			Grazing impacts	Non-Point	. . . . .
EAGLE MA, MINOR STREAMS	637.30	0	0	0	1	1					. . . . .

R0033527

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
EAGLE MA, SPRINGS	637.30	0	0	0	1	1					. . . . .
EAGLE LAKE AREA WETLANDS	637.31	0	1	0	0	1		Yes	Metals/Grazing impacts Fluctuating lake levels (see Eagle Lake)	Non-Point	X . . . . .
EAST WALKER RIVER MU, MINOR STREAMS	630.00	0	0	0	1	1					. . . . .
EAST WALKER RIVER MU, SPRINGS	630.00	0	0	0	1	1					. . . . .
EUREKA MU, MINOR STREAMS	606.00	1	0	0	0	1					. . . . .
EUREKA MU, SPRINGS	606.00	1	0	0	0	1					. . . . .
FALES HOT SPRINGS	631.00	0	0	1	0	1		Yes	Geothermal springs Arsenic, uranium (see West Walker River)	Non-Point	X X . . X . X
FISH LAKE MU, SPRINGS	604.00	1	0	0	0	1					. . . . .
FISH SLOUGH WETLANDS	603.20	1	0	0	0	1		Yes	Threat of Rare & Endangered Species impa Water diversion (see Owens River)	Non-Point	. . . . .
FISH SPRINGS	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
FISH VALLEY WETLANDS	632.10	0	0	0	1	1					. . . . .

R0033528

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
FOUNTAIN PLACE WETLANDS	634.10	0	1	0	0	1		Yes	Grazing impacts (see Lake Tahoe)	Non-Point	. . . . .
FREMONT MU, MINOR STREAMS	625.00	1	0	0	0	1					. . . . .
FREMONT MU, SPRINGS	625.00	1	0	0	0	1					. . . . .
GOLDSTONE MU, EPHEMERAL STREAMS	617.00	1	0	0	0	1					. . . . .
GRANITE MU, EPHEMERAL STREAMS	615.00	1	0	0	0	1					. . . . .
GRASS LAKE WETLANDS	634.10	0	0	0	360	360		Yes	Threat of ASBS impairment (see Lake Tahoe)	Non-Point	. . . . .
GREEN CREEK WETLANDS	630.40	0	0	0	1	1		Yes	(see East Walker River)		. . . . .
GRIZZLY MEADOW WETLANDS	631.40	0	0	0	1	1					. . . . .
GROVER HOT SPRINGS	632.00	0	1	0	0	1		Yes	Geothermal springs (see Carson River, E Fk)	Non-Point	X . . . . .
HAIWEE RESERVOIR AREA WETLANDS	603.30	0	1	0	0	1		Yes	Water diversions (see Owens River)	Non-Point	. . . . .
HARPER LAKE WETLANDS	628.42	0	0	0	1	1					. . . . .

R0033529

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Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
HARTSON LAKE WETLANDS	637.20	0	1	0	0	1		Yes	Agricultural drainage Trace elements (see Honey Lake)	Non-Point	X . . . . .
HAYPRESS MEADOWS WETLANDS	634.10	1	0	0	0	1					. . . . .
HEENAN LAKE AREA WETLANDS	632.10	0	1	0	0	1		Yes	Grazing impacts (see Carson River, E Fk)	Non-Point	. . . . .
HERLONG MA, MINOR STREAMS	637.10	0	0	0	1	1					. . . . .
HERLONG MA, SPRINGS	637.10	0	0	0	1	1					. . . . .
HOBART MILLS AREA WETLANDS	635.20	0	1	0	0	1		Yes	Possible industrial impact (see Truckee River)	Non-Point	X . . . . .
HONEY LAKE AREA WETLANDS	637.20	0	0	1	0	1		Yes	Geothermal impacts Agricultural impacts (see Honey Lake)	Point & Non-Point	X X . . X . X
HOPE VALLEY WETLANDS	633.20	0	1	0	0	1		Yes	Grazing impacts (see Carson River, W Fk)	Non-Point	. . . . .
HORSE LAKE WETLANDS	637.40	0	0	0	1	1					. . . . .
HOT SPRINGS CREEK VALLEY WETLANDS	632.10	0	0	0	1	1		Yes	Geothermal impacts (see Carson River, E Fk)	Point & Non-Point	X . . . . .
HUNTOON VALLEY WETLANDS	630.40	0	1	0	0	1		Yes	Grazing impacts (see East Walker River)	Non-Point	X . . . . .

R0033530

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CO-CO

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
INDEPENDENCE LAKE AREA WETLANDS	636.00	0	0	0	1	1		Yes	(see Little Truckee River)		. . . . .
IVANPAH HU, MINOR STREAMS	612.00	1	0	0	0	1					. . . . .
IVANPAH HU, SPRINGS	612.00	1	0	0	0	1					. . . . .
KEOUGH HOT SPRINGS	603.00	0	0	1	0	1		Yes	High fluoride (see Owens River)	Non-Point	X X . . X . X
KYBURZ MARSH	636.00	0	300	0	0	300		Yes	Grazing/ORV impacts Military impacts (see Truckee River)	Non-Point	. . . . .
LEACH HU, MINOR STREAMS	614.00	1	0	0	0	1					. . . . .
LEACH HU, SPRINGS	614.00	1	0	0	0	1					. . . . .
LEAVITT MEADOWS WETLANDS	631.40	0	1	0	0	1		Yes	Grazing impacts Possible mining impacts (see West Walker River)	Non-Point	X . . . . .
LEE FLAT HA, EPHEMERAL STREAMS	620.30	1	0	0	0	1					. . . . .
LITTLE TRUCKEE RIVER HU, MINOR STREAMS	636.00	0	0	0	1	1					. . . . .
LITTLE TRUCKEE RIVER HU, SPRINGS	636.00	0	0	0	1	1					. . . . .

R0033531

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3 1	3 0	3 0	3 4	3 4	3 4	3 6	1 9
LONG VALLEY CREEK WETLANDS	637.10	0	1	0	0	1		Yes	Grazing impacts Possible trace elements (see Honey Lake)	Non-Point	X	.	.	.	.	.	.	.	.	.	.	.
MADELINE PLAINS, COLD SPRINGS	638.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.	.
MADELINE PLAINS, MINOR STREAMS	638.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.	.
MADELINE PLAINS, SPRINGS	638.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.	.
MARTIS VALLEY WETLANDS	635.20	0	1	0	0	1		Yes	Possible metals problem Wetlands alteration (see Truckee River)	Non-Point	X	.	.	.	.	.	.	.	.	.	.	.
MEEKS CREEK MEADOW/MARSH WETLANDS	634.20	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.
MEISS MEADOWS WETLANDS	634.10	0	1	0	0	1		Yes	Grazing impacts (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.
MESQUITE HU, MINOR STREAMS	611.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.	.	.
MESQUITE HU, SPRINGS	611.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.	.	.
MOJAVE HU, MINOR STREAMS	628.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.	.	.

R0033532

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 6 4 4 4 9 / 1 0 M S L
MOJAVE HU, SPRINGS	628.00	1	0	0	0	1					. . . . .
MOJAVE HU, ZYZYX SPRING	628.00	1	0	0	0	1					. . . . .
MOJAVE RIVER WETLANDS	628.00	0	1	0	0	1			Water diversions Natural high salinity	Non-Point	X . . . . .
MONO HU, MINOR STREAMS	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
MONO LAKE AREA WETLANDS	601.00	0	0	1	0	1		Yes	Water diversions (see Mono Lake)	Non-Point	X X . . X . X
NORTH TAHOE HA, MINOR STREAMS	634.10	0	0	0	1	1					. . . . .
NORTH TAHOE HA, SPRINGS	634.10	0	0	0	1	1					. . . . .
OSGOOD SWAMP WETLANDS	634.10	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	. . . . .
OWENS HU, MINOR STREAMS - CHALFANT V.	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
OWENS HU, MINOR STREAMS - LOWER OWENS	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
OWENS HU, OTHER	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .

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Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 (3 1 0 3 4 0 3 4 0 4 1 4 0 9 1 D M S L)
SPRINGS - CHALFANT V.											
OWENS MU, SPRINGS - LOWER OWENS MA	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
OWENS MU, WARM SPRINGS - CHALFANT V.	603.00	1	0	0	0	1		Yes	(see Owens River)		. . . . .
OWENS LAKE WETLANDS	603.30	0	0	1	0	1		Yes	Water diversions (see Owens River)	Non-Point	X X . . X . X
OWENS RIVER WETLANDS	603.00	0	1	0	0	1		Yes	Water diversions (see Owens River)	Non-Point	X . . . . .
OWL CREEK MARSH WETLANDS	641.00	0	0	0	100	100			Potential water diversion impacts	Non-Point	. . . . .
OWLSHEAD MU, MINOR STREAMS	613.00	1	0	0	0	1					. . . . .
OWLSHEAD MU, SPRINGS	613.00	1	0	0	0	1					. . . . .
PAHRUMP MU, EPHEMERAL STREAMS	610.00	1	0	0	0	1					. . . . .
PAHAMINT MA, EPHEMERAL STREAMS	620.60	1	0	0	0	1					. . . . .
PERAZZO VALLEY WETLANDS	636.00	0	0	0	1	1		Yes	(see Little Truckee River)		. . . . .

R0033534

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
PICKEL MEADOWS WETLANDS	631.40	0	1	0	0	1		Yes	Grazing impacts Possible mining impacts (see West Walker River)	Non-Point	X . . . . .
PLEASANT VALLEY WETLANDS	632.10	0	1	0	0	1		Yes	Grazing impacts (see Carson River, E Fk)	Non-Point	. . . . .
POLE CREEK WETLANDS	635.20	0	1	0	0	1		Yes	Grazing impacts Threat of sedimentation (see Truckee River)	Non-Point	. . . . .
POPE MARSH WETLANDS	634.10	0	1	0	0	1		Yes	Urban runoff Wetlands alteration (see Lake Tahoe)	Non-Point	. . . . .
RACE TRACK MU, EPHEMERAL STREAMS	608.00	1	0	0	0	1					. . . . .
RED ROCK CREEK MEADOW WETLANDS	638.00	0	0	0	1	1					. . . . .
ROBBERS MA, EPHEMERAL STREAMS	620.80	1	0	0	0	1					. . . . .
ROGERS LAKE WETLANDS	601.00	0	0	0	1	1		Yes	(see Mono Lake)		. . . . .
ROSE MA, MINOR STREAMS	624.10	1	0	0	0	1					. . . . .
ROSE MA, SPRINGS	624.10	1	0	0	0	1					. . . . .

R0033535

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Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D H S L
SAGEHEN CREEK FENS WETLANDS	636.00	1	0	0	0	1		Yes	Threat of ASBS impairment (see Little Truckee River)	Non-Point	. . . . .
SALINE HU, EPHEMERAL STREAMS	607.00	1	0	0	0	1					. . . . .
SANTA ROSA HA, EPHEMERAL STREAMS	620.40	1	0	0	0	1					. . . . .
SEARLES HA, SPRINGS	621.00	1	0	0	0	1					. . . . .
SEARLES HU, MINOR STREAMS	621.00	1	0	0	0	1					. . . . .
SILVER KING VALLEY WETLANDS	632.10	0	0	0	1	1		Yes	(see Carson River, E Fk)		. . . . .
SNOW CREEK SEZ WETLANDS	634.20	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	. . . . .
SNOWSTORM HA, MINOR STREAMS	637.40	0	0	0	1	1					. . . . .
SNOWSTORM HA, SPRINGS	637.40	0	0	0	1	1					. . . . .
SODA CONE	632.00	0	0	0	1	1		Yes	Geothermal springs (see Carson River, E Fk)	Non-Point	X . . . . .
SOUTH TAHOE HA, MINOR STREAMS	634.10	0	0	0	1	1					. . . . .

R0033536

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D M S L
SQUAW CREEK MEADOW WETLANDS	635.20	0	0	1	0	1		Yes	Wetlands alteration Impacts of recreation (see Truckee River)	Non-Point	X X . . X . X
SUPERIOR MU, MINOR STREAMS	619.00	1	0	0	0	1					. . . . .
SUPERIOR MU, SPRINGS	619.00	1	0	0	0	1					. . . . .
SURPRISE VALLEY MU, MINOR STREAMS	641.00	0	0	0	1	1					. . . . .
SURPRISE VALLEY MU, SPRINGS	641.00	0	0	0	1	1			Some geothermal springs	Non-Point	X . . . . .
SUSAN RIVER MA, MINOR STREAMS	637.20	0	0	0	1	1					. . . . .
SUSAN RIVER MA, SPRINGS	637.20	0	0	0	1	1					. . . . .
TAHOE MEADOWS WETLANDS	634.10	0	1	0	0	1		Yes	Wetlands alteration (see Lake Tahoe)	Non-Point	X . . . . .
TAYLOR CREEK MEADOWS/MARSH WETLANDS	634.10	0	1	0	0	1 4		Yes	Grazing impacts Possible metals impacts (see Lake Tahoe)	Non-Point	X . . . . .
YECOPA HOT SPRINGS WETLANDS	609.40	0	1	0	0	1			Threat of Rare & Endangered Species impa Water diversions	Non-Point	. . . . .

R0033537

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
TOP SPRING	637.20	0	0	1	0	1		Yes	Drinking water impairment Objectives violated (see Honey Lake)	Non-Point	X X . . X . X
TROUT CREEK MEADOW WETLANDS	634.10	0	1	0	0	1		Yes	Wetlands alteration Possible industrial impacts (see Lake Tahoe)	Non-Point	X . . . . .
TRUCKEE RIVER HU, MINOR STREAMS	635.00	0	0	0	1	1					. . . . .
TRUCKEE RIVER HU, SPRINGS	635.00	0	0	0	1	1					. . . . .
UPPER CACTUS HU, MINOR STREAMS	623.00	1	0	0	0	1					. . . . .
UPPER CACTUS HU, SPRINGS	623.00	1	0	0	0	1					. . . . .
UPPER TRUCKEE RIVER MEADOW WETLANDS	634.10	0	1	0	0	1		Yes	Wetlands alteration Urban runoff (see Lake Tahoe)	Non-Point	X . . . . .
WATSON CREEK SEZ WETLANDS	634.20	0	1	0	0	1		Yes	Offroad vehicles (see Lake Tahoe)	Non-Point	. . . . .
WENDEL HOT SPRINGS	637.20	0	0	1	0	1		Yes	Objectives violated Geothermal springs (see Honey Lake)	Non-Point	X X . . X . X
WEST WALKER RIVER	631.00	0	0	0	1	1					. . . . .

EXHIBIT 6

R0033538

VOL 12

Region 6

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	9
HU, MINOR STREAMS																			
WEST WALKER RIVER	631.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.
HU, SPRINGS																			
WILDROSE HA, EPHEMERAL STREAMS	620.20	1	0	0	0	1					.	.	.	.	.	.	.	.	.
WINGATE HA, EPHEMERAL STREAMS	620.10	1	0	0	0	1					.	.	.	.	.	.	.	.	.

R0033539

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Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 N S L
ADOBE CREEK	602.00	1	0	0	0	1	MILE				. . . . .
ALDER CREEK	635.20	0	0	0	1	1		Yes	(see Truckee River)		. . . . .
AMARGOSA RIVER	609.00	0	140	58	0	198		Yes	Sedimentation Natural high salinity	Non-Point	X X . . X . X
ASH CREEK	603.30	0	1	0	0	1		Yes	Grazing impacts (see Owens River)	Non-Point	. . . . .
ASPEN CREEK	632.10	0	0	4	0	4		Yes	Objectives violated Fish kills (see Bryant Creek)	Non-Point	X X . . X . X
BAIRS CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BAKER CREEK	603.20	1	0	0	0	1		Yes	Meadow disturbance (see Owens River)	Non-Point	. . . . .
BALLS CREEK	637.10	0	0	0	1	1					. . . . .
BARE CREEK	641.30	0	0	0	1	1					. . . . .
BAXTER CREEK	637.20	0	1	0	0	1		Yes	Agricultural drainage (see Honey Lake)	Non-Point	. . . . .
BEAR CREEK	635.20	0	1	0	0	1		Yes	Sedimentation (see Truckee River)	Non-Point	. . . . .
BIDWELL CREEK	641.30	0	1	0	0	1			Grazing impacts	Non-Point	. . . . .

R0033540

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
BIG MEADOW CREEK	634.10	1	0	0	0	1		Yes	Possible grazing impacts Possible highway runoff impacts (see Lake Tahoe)	Non-Point	. . . . .
BIG PINE CANAL	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BIG PINE CREEK	603.20	0	0	1	0	1		Yes	Recreational impacts Water diversions (see Owens River)	Non-Point	. X . . X . X
BIG ROCK CREEK	626.00	1	0	0	0	1					. . . . .
BIRCH CREEK	603.20	1	0	0	0	1		Yes	Possible arsenic problem (see Owens River)	Non-Point	X . . . . .
BISHOP CREEK	603.20	1	0	1	28	30	MI	Yes	Recreational impacts Water diversions (see Owens River)	Non-Point	. X . . X . X
BISHOP CREEK CANAL	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BLACKWOOD CREEK	634.20	0	0	1	0	1		Yes	Objectives violated Sedimentation (see Lake Tahoe)	Non-Point	. X . . X . X
BODIE CREEK	632.10	0	0	0	1	1		Yes	Grazing impacts Possible mining impacts (see East Walker River)	Non-Point	X . . . . .
BRONCO CREEK	635.20	0	0	0	1	1		Yes	(see Truckee River)		. . . . .

R0033541

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
BRYANT CREEK	632.10	0	0	4	0	4		Yes	Objectives violated Fish kills Sedimentation	Non-Point	X X . . X . X
BUCKEYE CREEK	630.30	0	1	0	0	1		Yes	Grazing impacts (see East Walker River)	Non-Point	. . . . .
BURTON CREEK	634.20	1	0	0	0	1		Yes	(see Lake Tahoe)		. . . . .
BY-DAY CREEK	630.00	0	1	0	0	1		Yes	Grazing impacts (see East Walker River)	Non-Point	. . . . .
CABIN CREEK	604.00	1	0	0	0	1					. . . . .
CALIFORNIA AQUEDUCT	626.28	0	1	0	0	1			Criteria violations Possible metals problems	Non-Point	X . . . . .
CARNELIAN CREEK	634.20	1	0	0	0	1		Yes	(see Lake Tahoe)		. . . . .
CARROLL CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
CARSON RIVER, E FK	632.00	0	0	1	45	46		Yes	Objectives violated Recreational impacts	Non-Point	X X . . X . X
CARSON RIVER, W FK	633.00	0	0	1	27	28		Yes	Objectives violated Recreational impacts Grazing impacts	Non-Point	X X . . X . X
CARTAGO CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .

R0033542

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists (1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L)
CASCADE CREEK	634.10	0	0	0	1	1		Yes	Possible septic system problems Possible urban runoff impacts (see Lake Tahoe)	Non-Point	. . . . .
CATHEDRAL CREEK	634.10	0	1	0	0	1		Yes	Possible metals problems (see Lake Tahoe)	Non-Point	X . . . . .
CEDAR CREEK	641.30	0	1	0	0	1			Sedimentation Grazing impacts		. . . . .
CHENEY CREEK	637.20	0	0	0	1	1		Yes	(see Honey Lake)		. . . . .
CHIATOVICH CREEK	604.00	1	0	0	0	1					. . . . .
CLARK CANYON	630.30	0	1	0	0	1		Yes	Grazing impacts (see East Walker River)	Non-Point	X . . . . .
CLEARWATER CREEK	630.40	0	1	0	0	1		Yes	Sedimentation Possible metals problems (see East Walker River)	Non-Point	X . . . . .
COLD CREEK	634.10	0	7	0	0	7		Yes	Sedimentation Possible metals problems (see Lake Tahoe)	Non-Point	X . . . . .
COLD SPRING CREEK	638.00	0	0	0	1	1					. . . . .
COLD STREAM	635.20	0	1	0	0	1		Yes	Sedimentation (see Truckee River)	Non-Point	. . . . .
COLD WATER CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .

R0033543

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Region 6

Report Date : 04/16/90

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 P	3 M	3 S	3 L	3	3	3	1	0	0	0	1	1	.	3	4	4	4	9	1
COLLINS CANAL	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CONVICT CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COTTONWOOD CANYON	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COTTONWOOD CREEK (1)	603.30	1	0	1	0	1		Yes	Recreational impacts Water Diversions (see Owens River)	Non-Point	.	X	.	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
COTTONWOOD CREEK (2)	604.00	1	0	0	0	1																								
COTTONWOOD CREEK (3)	631.00	0	0	0	1	1		Yes	Possible metals problems Possible grazing impacts (see West Walker River)	Non-Point	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
COXEY CREEK	628.00	1	0	0	0	1																								
COYOTE CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CRAB CREEK	628.00	1	0	0	0	1																								
CROOKED CREEK	605.00	1	0	0	0	1																								
DART CREEK	628.00	0	0	0	1	1																								
DAVIES CREEK	636.00	0	0	0	1	1		Yes	Possible impacts of watershed disturbance (see Little Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
DEADMAN CREEK	603.00	1	1	0	0	1		Yes	Water diversion (see Owens River)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

R0033544

Region 6

Rivers and Streams.

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
DEEP CREEK (1)	628.00	1	0	0	0	1		Yes	(see Mojave River)		. . . . .
DEEP CREEK (2)	631.30	0	0	0	1	1		Yes	Possible metals problems (see West Walker River)	Non-Point	X . . . . .
DEEP CREEK (3)	639.40	0	0	0	1	1					. . . . .
DEEP CREEK (4)	635.20	1	0	0	0	1		Yes	Threat of sedimentation (see Truckee River)	Non-Point	. . . . .
DESERT CREEK	631.30	0	0	0	1	1		Yes	Possible metals problems (see West Walker River)	Non-Point	X . . . . .
DIAZ CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
DIRCH CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
DIVISION CREEK	603.30	1	0	1	0	1		Yes	Recreational impacts Water diversions (see Owens River)	Non-Point	. X . . X . X
DOG VALLEY CREEK	635.10	0	0	0	1	1		Yes	(see Truckee River)		. . . . .
DOLLAR CREEK	634.20	1	0	0	0	1		Yes	(see Lake Tahoe)		. . . . .
DONNER CREEK	635.20	0	1	0	0	1		Yes	Hydrologic modification Possible metals problems (see Truckee River)	Non-Point	X . . . . .
DRY CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
EAGLE CREEK (1)	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
EAGLE CREEK (2)	641.30	0	0	0	1	1			Grazing impacts	Non-Point	. . . . .
EAST WALKER RIVER	630.10	1	0	1	11	13		Yes	Objectives violated Recreational impacts Sedimentation	Non-Point	X X . . X . X
EMERSON CREEK	641.30	0	1	0	0	1			Grazing impacts	Non-Point	. . . . .
EVANS CANYON CREEK	637.10	0	0	0	1	1					. . . . .
FALLS CANYON	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
FREDERICKSBURG CAN	633.10	0	1	0	0	1		Yes	Sedimentation (see Carson River, W Fk)	Non-Point	. . . . .
FRYINGPAN CAN	630.10	0	0	0	1	1		Yes	Possible metals problems (see East Walker River)	Non-Point	X . . . . .
FURNACE CREEK	604.00	1	0	0	0	1					. . . . .
GENERAL CREEK	634.20	1	0	0	0	1		Yes	(see Lake Tahoe)		. . . . .
GEORGE CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
GLASS CREEK	603.10	0	1	0	0	1		Yes	Water Diversion (see Owens River)	Non-Point	. . . . .
GLEN ALPINE CREEK	634.10	0	1	0	0	1		Yes	Possible septic system impacts Mineral springs (see Lake Tahoe)	Non-Point	X . . . . .

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Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D N S L
GOLD RUN CREEK	637.20	0	1	0	0	1		Yes	Agricultural/Geothermal impacts Septic system impacts (see Honey Lake)	Non-Point	X . . . . .
GRASS LAKE CREEK	634.10	1	0	0	0	1		Yes	Possible highway runoff impacts (see Lake Tahoe)	Non-Point	. . . . .
GRASSHOPPER CREEK	637.30	0	1	0	0	1			Grazing impacts	Non-Point	. . . . .
GRAY CREEK	635.00	0	0	0	1	1		Yes	(see Truckee River)		. . . . .
GREEN CANYON	630.10	0	0	0	1	1		Yes	(see East Walker River)		. . . . .
GREEN CREEK	630.40	0	1	0	0	1		Yes	Grazing impacts Hydrologic modifications (see East Walker River)	Non-Point	. . . . .
GREEN LAKE CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
GREEN VALLEY LAKE CREEK	628.20	0	0	5	0	5		Yes	Objectives violated Drinking water impairment (see Mojave River)	Non-Point	X X . . X . X
GRIFF CREEK	634.20	0	1	0	0	1		Yes	Sedimentation Urban runoff (See Lake Tahoe)	Non-Point	. . . . .
HEAVENLY VALLEY CREEK	634.10	0	0	1	0	1		Yes	Objectives violated Sedimentation (see Lake Tahoe)	Non-Point	. X . . X . X
HILTON CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .

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Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 1 0 . 1 D	3 0 3 4 H	3 0 4 4 N	3 0 4 4 S	3 1 4 9 L
HOGBACK CREEK (1)	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.
HOGBACK CREEK (2)	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.
HOLCOMB CREEK	628.00	1	0	0	0	1		Yes	(see Mojave River)		.	.	.	.	.
HOOKS CREEK	628.00	0	1	0	0	1		Yes	Coliform bacteria (see Mojave River)	Non-Point	.	.	.	.	.
HORSETHIEF CREEK	633.00	0	1	0	0	1		Yes	Grazing impacts (see Carson River, W Fk)	Non-Point	.	.	.	.	.
HORTON CREEK	603.20	1	0	1	0	1		Yes	Fish population decline (see Owens River)	Non-Point	.	X	.	.	X	.	X
HOT CREEK (1)	630.40	0	0	1	0	1		Yes	Possible metals problems (see West Walker River)	Non-Point	X	X	.	.	X	.	X
HOT CREEK (2)	603.10	3	0	7	0	10		Yes	Elevated fish tissue levels Eutrophication (see Owens River)	Non-Point	X	X	.	.	X	.	X
HOT SPRINGS CREEK	632.10	0	1	0	0	1		Yes	Geothermal impacts (see Carson River, E FK)	Non-Point	X	.	.	.	.	.	.
HOUSTON CREEK	628.00	1	0	0	0	1		Yes	(see Mojave River)		.	.	.	.	.
INDEPENDENCE CREEK (1)	636.00	1	0	0	0	1		Yes	Possible water diversion impacts (see Little Truckee River)	Non-Point	.	.	.	.	.
INDEPENDENCE CREEK (2)	603.30	0	0	0	1	1		Yes	(see Owens River)		.	.	.	.	.

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Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
INDIAN CREEK (1)	632.20	0	1	1	0	1		Yes	Water Diversions Grazing impacts	Non-Point	. X . . X . X
INDIAN CREEK (2)	604.00	0	0	0	1	1					. . . . .
INDIAN GARDEN CREEK	604.00	1	0	0	0	1					. . . . .
IRON CREEK	604.00	1	0	0	0	1					. . . . .
JACKASS CREEK	631.30	0	0	0	1	1		Yes	Possible grazing impacts Possible metals impacts (see West Walker River)	Non-Point	X . . . . .
JUNIPER CREEK	635.20	0	0	0	1	1		Yes	(see Truckee River)		. . . . .
LASSEN CREEK	637.00	0	0	1	0	1		Yes	Water diversions Agricultural drainage (see Honey Lake)	Non-Point	. X . . X . X
LAUREL CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
LEAVITT CREEK	631.40	0	0	0	1	1		Yes	Possible mining impacts Possible grazing impacts (see West Walker River)	Non-Point	X . . . . .
LEE VINING CREEK	601.00	0	0	1	0	1		Yes	Recreational impacts Water Diversions (see Mono Lake)	Non-Point	X X . . X . X
LEIDY CREEK	604.00	1	0	0	0	1					. . . . .

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Region 6

Report Date : 04/16/90

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D N S L
LEVIATHAN CREEK	632.10	2	0	2	0	4		Yes	Objectives violated Fish kills (see Bryant Creek)	Non-Point	X X . . X . X
LITTLE BEAR CREEK	628.00	1	0	0	0	1		Yes	(see Mojave River)		. . . . .
LITTLE ROCK CREEK	626.00	1	0	0	0	1					. . . . .
LITTLE TRUCKEE RIVER	636.00	0	33	0	0	33		Yes	Sedimentation Hydrologic modification Impacts of recreation	Non-Point	. . . . .
LITTLE WALKER RIVER	631.40	0	1	0	0	1		Yes	Sedimentation Possible metals problems (see West Walker River)	Non-Point	X . . . . .
LONE PINE CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
LONE TREE CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
LONELY GULCH CREEK	634.20	0	2	0	0	2		Yes	Sedimentation Urban runoff (see Lake Tahoe)	Non-Point	. . . . .
LONG VALLEY CREEK (1)	630.10	0	0	0	1	1					. . . . .
LONG VALLEY CREEK (2)	637.10	0	55	0	0	55		Yes	Grazing impacts Agricultural Drainage (see Honey Lake)	Non-Point	X . . . . .
LOST CANNON CREEK	631.10	0	0	0	1	1		Yes	(see West Walker River)		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
LUBKIN CREEK, N FK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
LUBKIN CREEK, S FK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MADDEN CREEK	634.20	0	1	0	0	1		Yes	Sedimentation Poor watershed condition (see Lake Tahoe)	Non-Point	. . . . .
MAMMOTH CREEK	603.10	0	22	0	0	22		Yes	Geothermal impacts Grazing impacts (see Owens River)	Non-Point	X . . . . .
MARBLE CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MARKLEEVILLE CREEK	632.10	0	1	0	0	1		Yes	Geothermal impacts Urban runoff (see Carson River, E Fk)	Non-Point	X . . . . .
MARTIS CREEK	634.20	0	0	1	11	12		Yes	Elevated fish tissue levels Hydrologic modification (See Truckee River)	Non-Point	X X . . X . X
MCAFEE CREEK	604.00	1	0	0	0	1					. . . . .
MCGEE CREEK (1)	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MCGEE CREEK (2)	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MCKINNEY CREEK	634.20	0	1	0	0	1			Sedimentation	Non-Point	. . . . .
MCNALLY CANALS	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists (1 D M S L)
MEEKS CREEK	634.20	1	1	0	0	1		Yes	Sedimentation Impacts of marina (see Lake Tahoe)	Non-Point	. . . . .
MERRILL CREEK	637.30	0	1	0	0	1		Yes	Grazing impacts Possible lead problem (see Eagle Lake 2)	Non-Point	X . . . . .
MESCAL CREEK	626.00	1	0	0	0	1					. . . . .
MIDDLE CANYON	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MILBERRY CREEK	632.10	0	0	0	1	1		Yes	(see Carson River, E Fk)		. . . . .
MILL CREEK (1)	601.00	1	0	1	0	1		Yes	Recreational impacts Water Diversions (See Mono Lake)	Non-Point	. X . . X . X
MILL CREEK (2)	631.10	0	0	0	1	1		Yes	Possible septic system impacts Possible highway runoff impacts (see West Walker River)	Non-Point	. . . . .
MILL CREEK (3)	641.30	0	0	1	0	1		Yes	Sedimentation Objectives violated	Non-Point	. X . . X . X
MILNER CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MOJAVE RIVER	628.20	90	0	10	0	100		Yes	Recreational impacts Elevated fish tissue levels Sedimentation	Point & Non-Point	X X . . X . X
MOJAVE RIVER, E FK	628.00	0	0	0	1	1		Yes	(see Mojave River)		. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
OF W FK											
MOJAVE RIVER, W FK	628.00	0	0	0	1	1		Yes	(see Mojave River)		. . . . .
MOLYBDENITE CREEK	631.00	0	1	0	0	1		Yes	Possible metals problems Grazing impacts (see West Walker River)	Non-Point	X . . . . .
MONITOR CREEK	632.10	0	0	4	0	4		Yes	Objectives violated Elevated fish tissue levels (see Carson River, E Fk)	Non-Point	X X . . X . X
MONTGOMERY CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MORRIS CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MOUNTAINEER CREEK	632.00	0	7	0	0	7		Yes	Possible metals problem Possible grazing impacts (see Bryant Creek)	Non-Point	X . . . . .
MURPHY CREEK	630.10	0	0	0	1	1		Yes	Possible metals problem (see East Walker River)	Non-Point	X . . . . .
NINEMILE CANYON	624.20	1	0	0	0	1					. . . . .
NORTH CANYON CREEK	602.00	1	0	0	0	1					. . . . .
OAK CREEK (1)	603.30	4	0	0	0	4		Yes	(see Owens River)		. . . . .
OAK CREEK (2)	626.00	1	0	0	0	1					. . . . .
OAK CREEK, N FK	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
OAK CREEK, S FK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
OLANCHA CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
OWENS RIVER	603.30	1	0	1	118	120		Yes	Elevated fish tissue levels Fish kills Fish population decline	Non-Point	X	X	.	.	X	.	X		
OWENS RIVER CANAL	603.00	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
PAPOOSE CREEK	637.30	0	0	0	1	1		Yes	Grazing impacts Possible metals problems (see Eagle Lake 2)	Non-Point	X	.	.	.	.	.	.		
PARKER CREEK	601.00	1	0	1	0	1		Yes	Recreational impacts Water Diversions (See Mono Lake)	Non-Point	.	X	.	.	X	.	X		
PELLISIER CREEK	603.20	0	0	1	1	1		Yes	Threat of drinking water impairment Threat of objectives violated (see Owens River)	Non-Point	X	X	.	.	X	.	X		
PERRY AIKEN CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
PETES CREEK	604.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.
PINE CREEK (1)	603.00	0	1	0	0	1		Yes	Elevated fish tissue levels (see Owens River)	Non-Point	X	.	.	.	.	.	.		
PINE CREEK (2)	637.30	0	0	1	1	1		Yes	Fish population decline Sedimentation (see Eagle Lake 2)	Non-Point	.	X	.	.	X	.	X		

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	.	1
PINE CREEK (3)	637.40	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.
PINYON CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
PIUTE CREEK	637.20	0	0	0	1	1		Yes	Possible grazing impacts (see Honey Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.
PLEASANT VALLEY CREEK	632.10	1	0	0	0	1		Yes	(see Carson River, E Fk)		.	.	.	.	.	.	.	.	.	.
POLE CREEK	635.20	1	0	0	0	1		Yes	Possible sedimentation (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.	.
PROSSER CREEK	635.20	0	1	0	0	1		Yes	Impacts of recreation Hydrologic modification (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.	.
PURDY CREEK	637.10	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.
RAIDER CREEK	641.20	0	1	0	0	1			Grazing impacts	Non-Point	.	.	.	.	.	.	.	.	.	.
RAWSON CANAL	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
RED MOUNTAIN CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
RED ROCK CREEK	638.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.
REVERSED CREEK	601.00	0	1	0	0	1		Yes	Sedimentation Eutrophication (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.

R0033555

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 H	3 S	3 L	3	3	3
ROBINSON CREEK	630.30	0	1	0	0	1		Yes	Hydrologic modification Possible sedimentation (see East Walker River)	Non-Point	.	.	.	.	.	.	.
ROCK CREEK (1)	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
ROCK CREEK (2)	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
RODRIGUEZ CREEK	631.10	0	0	1	1	1		Yes	Threat of objectives violated Threat of toxic bioassay results (see West Walker River)	Non-Point	X	X	.	.	X	.	X
ROUGH CREEK	630.00	0	1	0	0	1		Yes	Threat of toxic bioassay results Grazing impacts (see East Walker River)	Non-Point	X	.	.	.	.	.	.
RUSH CREEK (1)	601.00	1	0	1	0	1		Yes	Recreational impacts Water Diversions (See Mono Lake)	Non-Point	.	X	.	.	X	.	X
RUSH CREEK (2)	639.00	0	0	0	1	1					.	.	.	.	.	.	.
SAGE HEN CREEK	636.00	0	1	0	0	1		Yes	Hydrologic modification (see Little Truckee River)	Non-Point	.	.	.	.	.	.	.
SALT CREEK	609.00	0	1	0	0	1			Natural high salinity	Non-Point	X	.	.	.	.	.	.
SAWMILL CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
SAWMILL POND CREEK	634.10	0	1	0	0	1			Sedimentation	Non-Point	.	.	.	.	.	.	.
SAWPIT CREEK	628.00	0	0	0	1	1					.	.	.	.	.	.	.

R0033556

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3 1	3 0	3 0	3 0	3 1	3 1	3 .	4 3	4 4	4 4	4 9	1
SAXON CREEK	634.10	1	1	0	0	1		Yes	Past watershed disturbance Reclaimed landfill (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SECRET CREEK	639.40	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SEELEY CANYON CREEK	628.00	1	0	0	0	1		Yes	(see Mojave River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SHALE CREEK	628.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SHEEP CREEK	628.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SHEPHERD CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SHERWIN CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SILVER CANYON CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SILVER CREEK (1)	632.10	1	0	0	0	1			Possible mining impacts	Non-Point	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SILVER CREEK (2)	631.10	1	0	0	0	1					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SILVER KING CREEK	632.10	1	0	0	0	1		Yes	Possible mining impacts Past grazing problems (see Carson River, E Fk)	Non-Point	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SKEDADDLE CREEK	637.10	0	1	0	0	1			Grazing impacts	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLINKARD CREEK	631.20	0	1	0	0	1		Yes	Grazing impacts Possible radioactivity (see West Walker River)	Non-Point	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

R0033557

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 P	3 M	3 S	3 L	3 3	3 4	3 4	3 4	1 9
SMOKE CREEK	639.00	0	1	0	0	1			Grazing impacts	Non-Point	.	.	.	.	.	.	.	.	.
SNOW CREEK	634.20	0	1	0	0	1		Yes	Watershed disturbance (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.
SNOWSTORM CREEK	639.40	0	0	0	1	1					.	.	.	.	.	.	.	.	.
SQUAW CREEK	635.20	0	1	0	0	1		Yes	Sedimentation Recreational impacts (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.
SUMMIT CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
SUSAN RIVER	637.20	0	45	14	0	59		Yes	Objectives violated Water diversions (see Honey Lake)	Point & Non-Point	X	X	.	.	X	.	X		
SWAUGER CREEK	630.40	0	0	0	1	1		Yes	Possible grazing problems Possible metals problems (see East Walker River)	Non-Point	X	.	.	.	.	.	.	.	
SWEETWATER CANYON	633.00	0	0	0	1	1		Yes	Possible metals probelms (see East Walker River)	Non-Point	X	.	.	.	.	.	.	.	
SYMMES CREEK	633.00	1	0	0	0	1					.	.	.	.	.	.	.	.	.
TABOOSE CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.
TALLAC CREEK	634.10	1	0	0	0	1		Yes	Possible septic system impacts (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.

R0033558

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D	3 M	3 S	3 L	3	3	3
TAYLOR CREEK	634.10	0	2	0	0	2		Yes	Hydrologic modification Possible metals problems (see Lake Tahoe)	Non-Point	X	.	.	.	.	.	.
THIBAUT CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
TINEMAHA CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
TOLER CREEK	604.00	1	0	0	0	1					.	.	.	.	.	.	.
TROUT CREEK (1)	634.10	0	1	0	0	1		Yes	Urban runoff Grazing impacts (see Lake Tahoe)	Non-Point	X	.	.	.	.	.	.
TROUT CREEK (2)	635.20	0	1	0	0	1		Yes	Urban runoff Possible industrial impacts (see Truckee River)	Non-Point	X	.	.	.	.	.	.
TRUCKEE RIVER	635.20	29	31	0	0	60		Yes	Elevated fish tissue levels Hydrologic modification	Non-Point	X	.	.	.	.	.	.
TRUCKEE RIVER, UPPER	634.10	0	1	0	0	1		Yes	Sedimentation Grazing impacts (see Lake Tahoe)	Non-Point	X	.	.	.	.	.	.
TUTTLE CREEK	603.30	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
TWELVE MILE CREEK	642.00	0	0	0	1	1			Possible grazing impacts	Non-Point	.	.	.	.	.	.	.
TWIN PEAKS CREEK	628.00	0	0	0	1	1					.	.	.	.	.	.	.

R0033559

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L (3 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 1)
VIRGINIA CREEK	630.40	0	1	0	0	1		Yes	Sedimentation Grazing impacts (see East Walker River)	Non-Point	. . . . .
WALKER CREEK	601.00	0	0	1	0	1		Yes	Water Diversions (see Mono Lake)	Non-Point	. X . . X . X
WARD CREEK	634.20	0	1	0	0	1		Yes	Sedimentation Barriers to fish migration (see Lake Tahoe)	Non-Point	. . . . .
WATSON CREEK	634.20	0	0	0	1	1		Yes	Sedimentation (see Lake Tahoe)	Non-Point	. . . . .
WEST WALKER RIVER	631.00	0	0	1	0	47		Yes	Sedimentation Agricultural drainage	Non-Point	X X . . X . X
WILDHORSE CREEK	604.00	1	0	0	0	1					. . . . .
WILFRID CREEK	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
WILLARD CREEK	637.20	0	1	0	0	1		Yes	Habitat impairment Possible grazing impacts (see Honey Lake)	Non-Point	. . . . .
WILLOW CREEK (1)	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
WILLOW CREEK (2)	637.40	0	1	0	0	1			Grazing impacts	Non-Point	. . . . .
WILLOW CREEK (3)	637.20	0	0	0	1	1					. . . . .
WILLOW CREEK (4)	637.10	0	0	0	1	1					. . . . .

R0033560

Region 6

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D M S L
WILLOW CREEK (5)	633.20	0	6	0	0	6		Yes	Grazing impacts Possible iron problem (see Carson River, W Fk)	Non-Point	X . . . . .
WILLOW CREEK (6)	609.00	0	1	0	0	1			Natural high salinity Grazing problems	Non-Point	. . . . .
WILSON CREEK	601.00	0	0	1	0	1		Yes	Recreational impacts Water diversions (See Mono Lake)	Non-Point	. X . . X . X
WOLF CREEK (1)	632.10	1	0	0	0	1		Yes	Sedimentation Grazing impacts (see Carson River, E Fk)	Non-Point	. . . . .
WOLF CREEK (2)	631.40	1	0	0	0	1		Yes	Grazing impacts (see West Walker River)	Non-Point	. . . . .
WYMAN CREEK	605.00	1	0	0	0	1					. . . . .
YELLOWJACKET CREEK	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .

R0033561

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1
ADOBE RES	602.00	1	0	0	0	1					.	.	.	.	.	.	.	.
AGNEW LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modification (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.
ALGER LAKES	601.00	1	0	0	0	1		Yes	(see Mono Lake)		.	.	.	.	.	.	.	.
ALKALI LAKE, LOWER	641.00	0	0	10855	0	10855	AC	Yes	Natural high salinity Geothermal/agricultural drainage (see Alkali Lakes, Middle)	Non-Point	X	X	.	.	X	X	X	.
ALKALI LAKE, MIDDLE	641.00	0	0	39475	0	39475		Yes	Geothermal drainage Natural high salinity Agricultural drainage	Non-Point	X	X	.	.	X	X	X	.
ALKALI LAKE, UPPER	641.00	0	0	24250	0	24250		Yes	Geothermal/Agricultural drainage Natural high salinity (see Alkali Lakes, Middle	Non-Point	X	X	.	.	X	X	X	.
ALTA MORRIS LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		.	.	.	.	.	.	.	.
AMGORA LAKES	634.10	0	0	0	1	1		Yes	Possible eutrophication (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.
ARROWBEAR LAKE	628.00	0	0	0	1	1					.	.	.	.	.	.	.	.
ARROWHEAD LAKE	603.00	0	0	0	1	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.
ASA LAKE	632.10	0	1	0	0	1		Yes	Possible eutrophication (see Carson River, E Fk)	Non-Point	.	.	.	.	.	.	.	.

R0033562

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
BARNEY LAKE	630.40	0	1	0	0	1		Yes	Possible acidification (see East Walker River)	Non-Point	. . . . .
BIG PINES LAKES 2	603.20	0	0	0	28	28		Yes	(see Owens River)		. . . . .
BIG PINES LAKES 6	603.20	0	0	0	7	7		Yes	(see Owens River)		. . . . .
BIRCHIM LAKE	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BLACK LAKE	602.00	1	0	0	0	1					. . . . .
BLUE LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
BOCA RES	636.00	0	980	0	0	980		Yes	Hydrologic modification Impacts of recreational use (see Little Truckee River)	Non-Point	. . . . . X .
BOOT LAKE	638.00	0	0	0	1	1					. . . . .
BRIDGEPORT RES	630.30	0	3000	0	0	3000		Yes	Sedimentation Recreational impacts (see East Walker River)	Non-Point	X . . . . X .
BUCKLEY PONDS	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
BURNSIDE LAKE	632.10	0	0	0	1	1		Yes	(see Carson River, E Fk)		. . . . .
CAGWIN LAKE	634.00	0	0	0	1	1		Yes	Possible impacts of recreation (see Lake Tahoe)	Non-Point	. . . . .
CARIBOU LAKE	637.20	0	0	0	1	1		Yes	(see Honey Lake)		. . . . .

R0033563

VOL 12

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
CASCADE LAKE	634.10	1	0	0	0	1		Yes	Threat of eutrophication Threat of drinking water impairment (see Lake Tahoe)	Non-Point	. . . . . X .
CONVICT LAKE	603.10	0	168	0	0	168		Yes	Possible nutrient loading from past septic system discharges (see Owens River)	Non-Point	. . . . .
COTTONWOOD	603.30	0	0	0	1	1		Yes	(see Owens River)		. . . . .
COXEY POND	628.00	1	0	0	0	1					. . . . .
CROWLEY LAKE	603.10	0	5280	0	0	5280		Yes	Possible arsenic problems Possible vessel waste problems (see Owens River)	Non-Point	. . . . . X .
CRYSTAL LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
DARDANELLES LAKE	634.10	0	0	0	1	1		Yes	Possible impacts of recreation (see Lake Tahoe)	Non-Point	. . . . .
DEEP SPRINGS LAKE	605.00	0	0	1	0	1		Yes	Natural high salinity	Non-Point	. X . . X . X
DIAZ LAKE	603.30	1	0	0	0	1		Yes	(see Owens River)		. . . . .
DICKS LAKE	634.20	0	0	0	72	72		Yes	(see Lake Tahoe)		. . . . .
DODGE RES	628.00	0	0	0	1	1					. . . . .
DONNER LAKE	635.20	0	960	0	0	960		Yes	Threat of drinking water impairment Threat of eutrophication (see Truckee River)	Non-Point	X . . . . X .

R0033564

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
DOROTHY LAKE (1)	632.10	0	0	0	2	2					. . . . .
DOROTHY LAKE (2)	603.10	150	0	0	0	150		Yes	(see Owens River)		. . . . .
DUNN RES	638.00	0	0	0	1	1					. . . . .
EAGLE LAKE (1)	634.10	0	0	0	1	1		Yes	Eutrophication Possible impacts of recreation (see Lake Tahoe)	Non-Point	. . . . .
EAGLE LAKE (2)	637.30	0	0	25000	0	25000		Yes	Fish kills Eutrophication Possible metals problems	Non-Point	X X . . X X X
EASTERN BROOK LAKES	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
ECHO LAKES UPPER & LOWER	634.10	0	0	0	48	48		Yes	Threat of eutrophication Threat of drinking water impairment (see Lake Tahoe)	Non-Point	. . . . .
ELLERY LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modification (see Mono Lake)	Non-Point	. . . . .
FAIRMONT RES	626.00	1	0	0	0	1					. . . . .
FALLEN LEAF LAKE	634.10	0	1410	0	0	1410		Yes	Drinking water impairment Threat of eutrophication (see Lake Tahoe)	Non-Point	X . . . . X .
FERN LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
FONTANILLIS LAKE	634.10	0	0	0	27	27		Yes	(see Lake Tahoe)		. . . . .

R0033565

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3 1	3 0	3 4	3 4	3 4	3 6	1 1 9
GABLE LAKE	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.	.
GEM LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modifications (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.	.
GIBBS LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		.	.	.	.	.	.	.	.	.	.	.
GILMORE LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		.	.	.	.	.	.	.	.	.	.	.
GRANITE LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		.	.	.	.	.	.	.	.	.	.	.
GRANT LAKE	601.00	0	1	0	0	1		Yes	Recreational impacts Hydrologic modification (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.	.
GRASS LAKE (1)	634.10	0	0	0	20	20		Yes	Possible eutrophication (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.	.
GRASS LAKE (2)	634.10	0	0	0	360	360		Yes	Possible highway runoff impacts Possible impacts of recreation (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.	.	.	.
GRASS VALLEY LAKE	628.20	0	0	20	0	20		Yes	Eutrophication Elevated fish tissue levels (see Mojave River)	Non-Point	X	X	.	.	X	.	X				
GREEN LAKE	630.40	0	0	0	1	1		Yes	(see East Walker River)		.	.	.	.	.	.	.	.	.	.	.
GREEN VALLEY LAKE	628.00	0	0	0	1	1					.	.	.	.	.	.	.	.	.	.	.
GULL LAKE	601.00	0	1	0	0	1		Yes	Eutrophication (see Mono Lake)	Non-Point	.	.	.	.	.	X	.				

R0033566

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 W	3 S	3 L	3	3	3
HAIWEE RES	603.30	1800	0	0	0	1800		Yes	(see Owens River)		.	.	.	.	.	.	.
HALF MOON LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		.	.	.	.	.	.	.
HALLSIDE RES	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
HAROLD RES	626.00	1	0	0	0	1					.	.	.	.	.	.	.
HARTSON LAKE	637.20	0	0	0	1	1		Yes	Agricultural drainage Geothermal impacts (see Honey Lake)	Non-Point	X	.	.	.	.	.	.
HEATHER LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		.	.	.	.	.	.	.
HEENAN LAKE	632.10	0	0	0	1	1		Yes	Water diversion Possible threatened species impacts (see Carson River E Fk)	Non-Point	.	.	.	.	.	.	.
HILTON LAKES	603.10	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
HOG FLAT RES	637.20	0	1000	0	0	1000		Yes	Water Diversion (see Honey Lake)		.	.	.	.	.	X	.
HONEY LAKE	637.20	0	0	55327	0	55327		Yes	Toxic bioassay results	Point & Non-Point	X	X	.	.	X	X	X
HONEY LAKE WILDFOWL MGMT.	637.20	0	0	500	0	500		Yes	Threat of toxic bioassay results (see Honey Lake)		X	X	.	.	X	.	X
HONEYMOON LAKE	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.
HOOVER LAKES (NE)	630.40	0	0	0	11	11		Yes	(see East Walker River)		.	.	.	.	.	.	.

R0033567

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
HORSE LAKE	637.40	0	3000	0	0	3000			Water diversion	Non-Point	. . . . . X .
HORSESHOE LAKE	603.10	1	0	0	0	1		Yes	Impacts of recreation (see Owens River)	Non-Point	. . . . .
HORTON LAKE (2)	603.20	0	0	0	17	17		Yes	(see Owens River)		. . . . .
INDEPENDENCE LAKE	636.00	725	0	0	0	725		Yes	Threat of Rare & Endangered Species impa Hydrologic modification (see Little Truckee River)	Non-Point	. . . . . X .
INDIAN CREEK RES	632.20	0	0	160	0	160			Eutrophication Recreational impacts	Point & Non-Point	X X . . X X X
JACKSON LAKE	626.80	0	0	0	7	7		Yes	Surface runoff Possible eutrophication	Non-Point	. . . . . X .
JUNE LAKE	601.00	0	1	0	0	1		Yes	Eutrophication (see Mono Lake)	Non-Point	. . . . .
KIDNEY LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
KOENIG LAKE	631.40	0	1	0	0	1		Yes	Possible acidification Possible eutrophication (see West Walker River)	Non-Point	. . . . .
LAKE ARROWHEAD	628.20	0	700	0	0	700		Yes	Possible metals problems	Non-Point	X . . . . .
LAKE GEORGE	603.10	1	0	0	0	1		Yes	Impacts of recreation (see Owens River)	Non-Point	. . . . .
LAKE GREGORY	628.20	0	0	0	120	120		Yes	(see Mojave River)		. . . . . X .

R0033568

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D N S L
LAKE LECONTE	634.10	1	0	0	0	1		Yes	Threat of acidification (see Lake Tahoe)	Non-Point	. . . . .
LAKE MAMIE	603.10	19	0	0	0	19		Yes	(see Owens River)		. . . . .
LAKE MARY	603.10	140	0	0	0	140		Yes	Possible metals problems Impacts of recreation (see Owens River)	Non-Point	X . . . . X .
LAKE PALMDALE	626.00	0	0	0	1	1		Yes			. . . . .
LAKE TAHOE	634.30	0	0	120000	0	120000	AC	Yes	Eutrophication Sedimentation Objectives violated	Non-Point	X X . . X X X
LAMARCK LAKE, UPPER	603.20	0	0	0	38	38		Yes	(see Owens River)		. . . . .
LARK SEEP LAGOON	624.20	1	0	0	0	1					. . . . .
LEAVITT LAKE	637.20	0	0	0	58	58		Yes	(see Honey Lake)		. . . . .
LILY LAKE	634.10	0	1	0	0	1		Yes	Eutrophication Possible septic system impacts (see Lake Tahoe)	Non-Point	. . . . .
LITTLE ROCK RES	626.00	1	0	0	0	1					. . . . .
LONG LAKE (1) (INYO)	603.30	0	0	0	8	8		Yes	(see Owens River)		. . . . .
LOST LAKE	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
LOST LAKE (E)	633.20	0	0	0	8	8					. . . . .

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Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
(SISKIYOU)											
LUNDY LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modification Possible mining impacts (see Mono Lake)	Non-Point	X . . . . .
MARTIS CREEK RES	635.20	0	768	0	0	768		Yes	Threat of elevated fish tissue levels Hydrologic modificaiton (see Truckee River)	Non-Point	X . . . . X .
MCCLOUD LAKE	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
MCCOY FLAT RES	627.30	0	1800	0	0	1800		Yes	Water diversion (see Honey Lake)	Non-Point	. . . . .
MEISS LAKE	633.20	0	18	0	0	18		Yes	Eutrophication Grazing impacts (see Lake Tahoe)	Non-Point	. . . . .
MONO LAKE	601.00	0	0	35000	0	35000		Yes	Objectives violated Fish kills Fish population decline	Non-Point	X X . . X X X
NOBEL (NOBLE) LAKE	632.10	0	5	0	0	5		Yes	Eutrophication (see Carson River E Fk)	Non-Point	. . . . .
NORTH LAKE	603.20	22	0	0	0	22		Yes	(see Owens River)		. . . . .
ONEIDA LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .

R0033570

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists (1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L)
OWENS LAKE	603.30	0	0	175	0	175		Yes	Water diversion High natural salinity (see Owens River)	Non-Point	X X . . X X X
PINE LAKE	603.20	0	0	0	1	1		Yes	(see Owens River)		. . . . .
PLEASANT VALLEY RES	603.20	0	115	0	0	115		Yes	Eutrophication (see Owens River)	Non-Point	. . . . . X .
PROSSER RES	635.20	0	0	0	734	734		Yes	Hydrologic modification (see Truckee River)	Non-Point	. . . . .
QUAIL LAKE	634.20	1	0	0	0	1		Yes	Watershed disturbance (see Lake Tahoe)	Non-Point	. . . . .
RALSTON LAKE	634.10	0	0	0	1	1		Yes	(see Lake Tahoe)		. . . . .
RED LAKE (1)	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
RED LAKE (2)	633.20	0	0	0	1	1		Yes	Hydrologic modification Highway runoff (see Carson River W Fk.)	Non-Point	. . . . .
RIVER SPRING LAKE	602.00	1	0	0	0	1					. . . . .
ROCK CREEK LAKE	603.20	1	0	0	0	1		Yes	(see Owens River)		. . . . .
ROUND LAKE	634.10	0	0	0	1	1	AC	Yes	Possible impacts of recreation (see Lake Tahoe)	Non-Point	. . . . .
ROUND VALLEY RES	637.40	0	0	0	1	1					. . . . .

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EXHIBIT 6

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Region 6

Lakes

Report Date : 04/16/90

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 D	3 M	3 S	3 L	3	3	3	1	.	1
SABRINA LAKE	603.20	186	0	0	0	186		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
SADDLEBAG LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modification Possible impacts of recreation (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.
SAID RES	638.00	0	0	0	1	1														
SAWMILL POND (1)	603.20	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
SAWMILL POND (2)	634.10	0	1	0	0	1			Sedimentation	Non-Point	.	.	.	.	.	.	.	.	.	.
SCOTTS LAKE	633.20	0	1	0	0	1			Sedimentation	Non-Point	.	.	.	.	.	.	.	.	.	.
SEARLES LAKE	621.00	0	0	26100	0	26100	AC	Yes	Natural high salinity	Non-Point	X	X	.	.	X	.	X			
SHELTON LAKE	603.10	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
SHERWIN LAKES	603.10	1	0	0	0	1		Yes	(see Owens River)		.	.	.	.	.	.	.	.	.	.
SILVER LAKE	637.20	0	0	0	110	110		Yes	Threat of eutrophication Threat of recreational impacts (see Honey Lake)	Non-Point	.	.	.	.	.	.	X	.		
SILVER LAKE (1)	601.00	0	1	0	0	1		Yes	Eutrophication (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.	.	.
SILVER LAKES	628.30	1	0	0	0	1														
SILVERWOOD LAKE	628.20	1010	0	0	0	1010		Yes	(see Mojave River)		.	.	.	.	.	.	.	.	.	.
											.	.	.	.	.	.	X	.		

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 6

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	1	1
SMOKE CREEK RES	639.00	0	0	0	1	1					.	.	.	.	.	.	.	.
SOUTH LAKE	603.20	180	0	0	0	180		Yes	(see Owens River)		.	.	.	.	.	.	.	.
SPRING VALLEY LAKE	628.30	1	0	0	0	1					.	.	.	.	.	.	.	.
STAMPEDE RES	636.00	0	0	0	3444	3444	AC	Yes	Hydrologic modification Low levels affect recreation use (see Little Truckee River)	Non-Point	.	.	.	.	.	X	.	.
SUSIE LAKE	634.10	0	0	0	1	1		Yes	Possible impacts of recreation (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.
TAMARACK LAKE	634.10	0	0	0	1	1		Yes	Possible impacts of recreation (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.
TINEMAHA RES	603.20	0	180	0	0	180		Yes	Water diversion (see Owens River)	Point	.	.	.	.	.	X	.	.
TIOGA LAKE	601.00	1	0	0	0	1		Yes	Hydrologic modification (see Mono Lake)	Non-Point	.	.	.	.	.	.	.	.
TOPAZ LAKE	631.10	0	0	2300	0	2300		Yes	Objectives violated Sedimentation (see West Walker River)	Non-Point	X	X	.	.	X	.	X	.
TWIN LAKE, LOWER	630.40	0	265	0	0	265	AC		Eutrophication Threat of drinking water impairment (see East Walker River)	Non-Point	.	.	.	.	.	X	.	.

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 0 M S L
TWIN LAKE, UPPER	630.40	0	375	0	0	375	AC	Yes	Eutrophication Threat of drinking water impairment (see East Walker River)	Non-Point	. . . . . X .
TWIN LAKES	603.10	0	1	0	0	1		Yes	Eutrophication (see Owens River)	Non-Point	. . . . .
VALENTINE LAKE	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .
VIRGINIA LAKES	630.40	0	0	0	1	1					. . . . .
WALKER LAKE	601.00	1	0	0	0	1		Yes	(see Mono Lake)		. . . . .
WAUGH LAKE	601.00	0	1	0	0	1		Yes	Hydrologic modification (see Mono Lake)	Non-Point	. . . . .
WEBBER LAKE	636.00	0	0	0	1	1		Yes	(see Little Truckee River)		. . . . .
WIT-SO-MAH-PAH LAKE	603.10	0	0	0	5	5		Yes	(see Owens River)		. . . . .
WOODS LAKE	603.10	1	0	0	0	1		Yes	(see Owens River)		. . . . .

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COMMO

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Region 6

Report Date : 04/16/90

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1	1
											1	0	0	0	0	1	1	3	9
											.	3	4	4	4	4	9	1	
ADOBE LAKE VALLEY		60	0	0	0	60			Local high salinity		.	.	.	.	.	.	.	.	.
AIR FORCE PLANT 42 AREA		0	0	1	0	1			Unknown problem	Non-Point	.	.	.	.	.	.	.	.	.
ANTELOPE VALLEY (NL)		36	0	0	0	36		Yes	Threat of drinking water impairment (see West Walker River)	Non-Point	.	.	.	.	.	.	.	.	.
AVAWATZ VALLEY		0	0	0	70	70		Yes	Ground water overdraft (See Langford Valley)		.	.	.	.	.	.	.	.	.
BICYCLE VALLEY		0	0	120	0	120		Yes	Natural high salinity (see Langford Valley)	Non-Point	.	.	.	.	.	.	.	.	.
BISHOP AREA		0	0	1	0	1		Yes	Drinking water impairment Underground tank leaks	Non-Point	.	.	.	.	.	.	.	.	.
BLACK SPRINGS VALLEY		50	0	0	0	50					.	.	.	.	.	.	.	.	.
BRIDGEPORT VALLEY		0	100	0	0	100		Yes	Threat of drinking water impairment Possible metals problems (see East Walker River)	Non-Point	.	.	.	.	.	.	.	.	.
BROADWELL VALLEY		0	0	0	120	120					.	.	.	.	.	.	.	.	.
BROWN MOUNTAIN VALLEY		30	0	0	0	30					.	.	.	.	.	.	.	.	.
BULL FLAT		0	0	0	10	10					.	.	.	.	.	.	.	.	.
BUTTE VALLEY (REG 6)		0	0	0	27	27					.	.	.	.	.	.	.	.	.

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists 1 1 D M S L
BUTTERBREAD CANYON		0	0	0	3	3					. . . . .
CACTUS FLAT		0	0	0	2	2					. . . . .
CADY FAULT AREA		0	0	0	17	17					. . . . .
CALIFORNIA VALLEY		0	60	0	0	60			Natural high salinity	Non-Point	. . . . .
CAMEO AREA		0	0	0	20	20					. . . . .
CARSON VALLEY		20	0	0	0	20		Yes	Possible wastewater impacts Possible agricultural impacts (see Carson River, W Fk)	Non-Point	. . . . .
CAVES CANYON VALLEY		0	100	0	0	100			Natural high salinity	Non-Point	. . . . .
CHINA LAKE AREA		0	0	1	0	1		Yes	Drinking water impairment Threat of drinking water impairment Overdraft	Non-Point	. . . . .
COLES FLAT		0	0	0	8	8					. . . . .
COSO VALLEY		0	50	0	0	50			Natural high salinity	Non-Point	. . . . .
COTTONWOOD SPRING A		0	0	0	15	15					. . . . .
COW HEAD LAKE VALLEY		0	0	0	7	7					. . . . .
COYOTE LAKE VALLEY		0	0	150	0	150			Natural high salinity	Non-Point	. . . . .
CRONISE VALLEY		0	0	0	150	150		Yes	(see Langford Valley)		. . . . .

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
CUDDEBACK VALLEY		0	150	30	0	130			Natural high salinity	Non-Point	. . . . .
DARWIN VALLEY		0	70	0	0	70			Natural high salinity	Non-Point	. . . . .
DEATH VALLEY		0	0	1320	0	1320		Yes	Natural high salinity Possible water diversions	Non-Point	. . . . .
DEEP SPRINGS VALLEY		40	0	0	0	40			Local high fluoride	Non-Point	. . . . .
DENNING SPRING VALLEY		0	18	0	0	18			Natural high salinity	Non-Point	. . . . .
DOG VALLEY		0	0	1	0	1		Yes	Some wells with high arsenic Possible water diversion for export (see Truckee River)	Non-Point	. . . . .
DRY VALLEY		0	0	0	9	9					. . . . .
EAGLE LAKE AREA		0	0	1	21	22		Yes	Septic systems (see Eagle Lake)	Non-Point	. . . . .
EDWARDS AFB AREA		0	0	1	0	1			Jet fuel/solvents	Non-Point	. . . . .
EL MIRAGE VALLEY		50	50	20	0	120			Natural high salinity	Non-Point	. . . . .
EUREKA VALLEY		0	0	0	160	160					. . . . .
FISH LAKE VALLEY		0	70	0	0	70			Natural high salinity	Non-Point	. . . . .
FISH SLOUGH VALLEY		0	0	0	5	5					. . . . .
FORT IRWIN AREA		0	0	1	0	1			unknown	Non-Point	. . . . .

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 1 . 1 / 3 0 3 4 0 3 3 4 0 4 3 4 4 1 4 9 / I D N S L
FREMONT VALLEY		110	110	110	0	330			Natural high salinity Ground water overdraft	Non-Point	. . . . .
FURNACE CREEK AREA		0	33	0	0	33			Natural high salinity	Non-Point	. . . . .
GEORGE AFB AREA		0	0	1	0	1			TCE	Non-Point	. . . . .
GOLD VALLEY		0	0	0	19	19					. . . . .
GOLDSTONE VALLEY		0	30	0	0	30		Yes	Natural high salinity (see Langford Valley)	Non-Point	. . . . .
GRANITE MOUNTAIN A		0	0	0	3	3		Yes	(see Langford Valley)		. . . . .
GRASS VALLEY		30	0	0	0	30					. . . . .
GRASSHOPPER VALLEY		0	0	0	24	24					. . . . .
GREENWATER VALLEY		0	0	0	150	150					. . . . .
HARPER VALLEY		300	160	50	0	510			Natural high salinity	Non-Point	. . . . .
HARRISBURG FLATS		0	0	0	24	24					. . . . .
HARVEY VALLEY		0	0	0	6	6					. . . . .
HIDDEN VALLEY (REG 6)		0	0	0	18	18					. . . . .
HONEY LAKE VALLEY		0	490	0	0	490		Yes	Water diversion/geothermal impacts Agricultural drainage (see Honey Lake)	Non-Point	. . . . .

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D M S L
HORSE LAKE VALLEY		0	0	0	16	16					. . . . .
INDIAN WELLS VALLEY		500	0	20	0	520		Yes	Natural high salinity Ground water overdraft (see China Lake area)	Non-Point	. . . . .
IVANPAH VALLEY		120	100	80	0	300			Natural high salinity	Non-Point	. . . . .
KANE WASH AREA		0	0	0	15	15					. . . . .
KELSO LANDER VALLEY		0	17	0	0	17			Natural high salinity	Non-Point	. . . . .
KELSO VALLEY		370	0	0	0	370					. . . . .
LANCASTER/W.MUROC		1500	60	60	0	1620	SQMI	Yes	Threat of drinking water impairment Overdraft GW contamination	Non-Point	. . . . .
LANGFORD VALLEY		0	0	50	0	50		Yes	Drinking water impairment Natural high salinity	Non-Point	. . . . .
LEACH VALLEY		0	70	0	0	70		Yes	Natural high salinity (see Langford Valley)	Non-Point	. . . . .
LEE FLAT		0	0	0	55	55					. . . . .
LEVIATHAN MINE AREA		0	0	1	0	1		Yes	Acid mine drainage Metals (see Bryant Creek)	Non-Point	. . . . .
LITTLE ANTELOPE VALLEY		0	0	0	5	5					. . . . .

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REGION 6

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 D	3 0 M	3 0 S	3 0	3 4 L	4 4	4 6	9 1
LONG VALLEY (WL)		0	0	0	28	28		Yes	Agricultural drainage Possible nitrate drainage (see Honey Lake)	Non-Point	.	.	.	.	.	.	.	.
LONG VALLEY (SL)		120	0	0	0	120					.	.	.	.	.	.	.	.
LOST LAKE VALLEY		30	0	0	0	30					.	.	.	.	.	.	.	.
LOWER KINGSTON VALLEY		0	0	290	0	290			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.
LOWER MOJAVE RIVER VALLEY		250	50	0	0	300		Yes	Natural high salinity "Barstow Slug" (see Upper Mojave River Valley)	Non-Point	.	.	.	.	.	.	.	.
MADELINE PLAINS		0	270	0	0	270			Local natural high salinity Possible septic system problems	Non-Point	.	.	.	.	.	.	.	.
MARBLE CANYON AREA		0	0	0	30	30					.	.	.	.	.	.	.	.
MARTIS VALLEY		0	0	0	25	25		Yes	Possible metals problems Possible wastewater impacts (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.
MESQUITE VALLEY		50	40	30	0	120			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.
MIDDLE AMARGOSA VALLEY		0	200	420	0	620			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.
MIDDLE MOJAVE RIVER VALLEY		330	50	50	0	430			Natural high salinity (see Upper Mojave River Valley)	Non-Point	.	.	.	.	.	.	.	.

R0033580

Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
MIDDLE PARK CANYON		0	0	0	5	5					. . . . .
MODOC PLATEAU PVA (REG 6)		0	0	0	100	100					. . . . .
MODOC PLATEAU RVA (REG 6)		0	0	0	18	18					. . . . .
MONO VALLEY		200	50	0	0	250		Yes	Natural high salinity Water diversions (see Mono Lake)	Non-Point	. . . . .
OWENS VALLEY		800	100	130	0	1030		Yes	Natural high salinity/Water diversions Local septic system problems (see Owens River)	Non-Point	. . . . .
OWL LAKE VALLEY		0	0	0	33	33					. . . . .
PAHRUMP VALLEY		400	0	0	0	400					. . . . .
PAINTERS FLAT		0	0	0	9	9					. . . . .
PANAMINT VALLEY		0	360	0	0	360			Natural high salinity	Non-Point	. . . . .
PILOT KNOB VALLEY		200	0	0	0	200					. . . . .
PINE CREEK VALLEY		0	0	0	9	9					. . . . .
RACE TRACK VALLEY		0	0	0	15	15					. . . . .
RED PASS VALLEY		0	0	0	150	150		Yes	(see Langford Valley)		. . . . .

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 R	3 S	3 L	3	3	3	1	1	9
RHODES HILL AREA		0	0	0	23	23					.	.	.	.	.	.	.	.	.	.
RIGGS VALLEY		0	0	100	0	100			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.
ROSE VALLEY		60	0	0	0	60					.	.	.	.	.	.	.	.	.	.
SALINE VALLEY		0	0	1	209	210			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.
SALT WELLS VALLEY		0	0	0	30	30					.	.	.	.	.	.	.	.	.	.
SANTA ROSA FLAT		0	0	0	40	40					.	.	.	.	.	.	.	.	.	.
SEARLES VALLEY		0	0	250	0	250			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.
SECRET VALLEY		0	0	0	19	19					.	.	.	.	.	.	.	.	.	.
SILVER LAKE VALLEY		0	10	30	0	40			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.
SLINKARD VALLEY		0	0	0	11	11		Yes	Possible radioactivity problems Possible metals problems (see West Walker River)	Non-Point	.	.	.	.	.	.	.	.	.	.
SODA LAKE VALLEY		90	0	500	0	590			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.
SPRING CANYON VALLEY		0	0	0	12	12					.	.	.	.	.	.	.	.	.	.
SQUAW VALLEY		0	0	1	0	1		Yes	Threat of drinking water impairment Wastewater impacts/leaking UGTs (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.	.
SUPERIOR VALLEY		0	90	80	0	170			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.

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Region 6

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3	3	3	1
SURPRISE VALLEY		0	350	0	0	350			Local natural high salinity Water diversions Overdraft	Non-Point	.	.	.	.	.	.	.	.
SWEETWATER FLAT		0	0	0	5	5					.	.	.	.	.	.	.	.
TAHOE SOUTH "T" AREA		0	0	1	0	1		Yes	Drinking water impairment PCE leak or spill	Non-Point	.	.	.	.	.	.	.	.
TAHOE VALLEY-NORTH		1	0	1	0	4		Yes	Natural high arsenic Toxic leaks/spills (see Lake Tahoe)	Non-Point	.	.	.	.	.	.	.	.
TAHOE VALLEY-SOUTH		1	1	1	18	21		Yes	Threat of drinking water impairment Underground tanks/Urban Runoff Natural high uranium	Non-Point	.	.	.	.	.	.	.	.
TEHACHAPI VALLEY, EAST		20	0	0	0	20					.	.	.	.	.	.	.	.
TROY VALLEY		10	30	90	0	130			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.
TULEDAD CANYON AR		0	0	0	9	9					.	.	.	.	.	.	.	.
TWIN LAKE AREA		0	1	0	0	1		Yes	Threat of drinking water impairment (see East Walker River)	Non-Point	.	.	.	.	.	.	.	.
UPPER KINGSTON VALLEY		0	130	140	0	270			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3 L	3 1	3 0	3 0	3 0	3 1	1 1	.3 4	4 4	6 6	4 9
UPPER MOJAVE RIVER VALLEY		550	25	25	0	600		Yes	Drinking water impairment Threat of drinking water impairment Overdraft	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.
USMC LOGISTICS BASE AREA		0	0	1	0	1			TCE	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VERDI AREA		0	0	1	1	1		Yes	Natural high arsenic (see Truckee River)	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WILD HORSE MESA A		0	0	0	5	5					.	.	.	.	.	.	.	.	.	.	.	.	.	.
WILDROSE CANYON		0	0	0	17	17					.	.	.	.	.	.	.	.	.	.	.	.	.	.
WILLOW CREEK VALLEY		1	1	0	18	20			Possible nitrate problem	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WINGATE VALLEY		0	70	0	0	70			Natural high salinity	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Region 7

Wetlands

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D	3 M	3 S	3 L	3	3	3	3
CIBOLA NWR		0	0	0	280	280	AC				.	.	.	.	.	.	.	.
FINNEY-RAMER WA		0	0	0	2600	2600	AC				.	.	.	.	.	.	.	.
HAVASU NWR		0	0	0	520	520	AC				.	.	.	.	.	.	.	.
HAZARD TRACT		0	0	0	535	535	AC				.	.	.	.	.	.	.	.
IMPERIAL NWR		0	0	0	3640	3640	AC				.	.	.	.	.	.	.	.
IMPERIAL WA		0	0	0	3800	3800	AC				.	.	.	.	.	.	.	.
SALTON SEA NWR		0	0	0	1565	1565	AC				.	.	.	.	.	.	.	.
WISTER UNIT		0	0	0	5255	5255	AC				.	.	.	.	.	.	.	.

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 N S L
ALAMO RIVER	723.10	0	0	52	0	52	MI	Yes	Elevated fish tissue levels Recreational impacts Threat of toxic bioassay results	Non-Point	X X . . X . X
ANDREAS CREEK	719.47	0	0	0	7	7					. . . . .
ANTELOPE CREEK	705.00	16	0	0	0	16					. . . . .
ARRASTRE CREEK	717.30	10	0	0	0	10					. . . . .
AZALEA CREEK	702.00	4	0	0	0	4					. . . . .
BANNER CREEK	722.40	0	10	0	0	10	MI	No	Threat of objective violated (bacteria)	Non-Point	. . . . .
BIG MORONGO CREEK	719.10	15	0	0	0	15					. . . . .
BORREGO PALM CANYON CREEK	727.13	0	10	0	0	10		No	Threat of objective violated (bacteria)	Unknown	. . . . .
BOUNDARY CREEK	722.72	0	10	0	0	10		No	Threat of objective violated (bacteria)	Non-Point	. . . . .
BROWN CREEK	719.37	0	0	0	2	2					. . . . .
CARRIZO CREEK	722.70	0	45	0	0	45		No	Threat of objective violated (bacteria)	Non-Point	. . . . .
CHINO CANYON CREEK	719.47	0	0	0	3	3					. . . . .
COACHELLA VALLEY STORM CHANNEL	719.47	0	0	20	0	20	MI	Yes	Bacteria objective violated Threat of toxic bioassay results	Non-Point	. X . . X . X

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
COLORADO RIVER	715.00	230	0	0	0	230	MI	Yes	Threat of objectives violated (Selenium & Salinity); Threat of elevated fish tissue levels (Selenium).	Point & Non-Point	. . . . .
COPPER BASIN CREEK	715.10	5	0	0	0	5					. . . . .
COYOTE CREEK	722.10	0	26	0	0	26	MI		Threat of objective violated (bacteria)	Non-Point	. . . . .
CRYSTAL CREEK	701.00	0	3	0	0	3			Threat of sedimentation due to mining	Non-Point	. . . . .
DUTCH CREEK	719.32	3	0	0	0	3					. . . . .
FALLS CREEK	719.47	4	0	0	0	4					. . . . .
GRAPEVINE CANYON CREEK	722.30	0	0	0	8	8					. . . . .
HATHAWAY CREEK	719.31	0	0	0	3	3					. . . . .
HOMER WASH	712.00	0	0	0	40	40					. . . . .
LITTLE MORONGO CREEK	719.10	15	0	0	0	15					. . . . .
MILLARD CANYON CREEK	719.32	5	0	0	0	5					. . . . .
MISSION CREEK	719.42	15	0	0	0	15					. . . . .
NEW RIVER	723.10	0	0	60	0	60	MI	Yes	Public health hazard Objectives violated Fish kills	Point & Non-Point	X X . . X . X
PALM CANYON CREEK	719.47	0	0	0	15	15					. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 (T D M S L)
PINTO WASH	717.30	0	0	0	56	56					.....
PIPES CANYON CREEK	705.00	0	0	0	12	12					.....
PIUTE CREEK	713.10	0	1	0	0	1	MI		Threat of objective violated (bacteria)	Non-Point	.....
POTRERO CREEK	719.32	0	0	0	5	5					.....
SALT CREEK	725.00	0	6	0	0	6	MI		Threat of objective violated (bacteria)	Non-Point	.....
SAN FELIPE CREEK	722.40	0	60	0	0	60	MI		Threat of objective violated (bacteria)	Non-Point	.....
SAN GORGONIO RIVER	719.32	0	0	0	30	30					.....
SNOW CREEK	719.47	7	0	0	0	7					.....
TAHQUITZ CREEK	719.47	0	10	0	0	10	MI		Threat of objective violated (bacteria)	Unknown	.....
THOUSAND PALMS CANYON CREEK	719.46	1	0	0	0	1					.....
TUBB CANYON CREEK	722.13	0	0	0	3	3					.....
TULE CREEK	721.00	0	15	0	0	15	MI		Threat of objective violated (bacteria)	Non-Point	.....
TWIN PINES CREEK	719.32	0	3	0	0	3	MI		Threat of objective violated (bacteria)	Non-Point	.....
VALLECITO CREEK	722.61	0	0	0	26	26					.....
WALKER CREEK	722.71	0	8	0	0	8	MI		Threat of objective violated (bacteria)	Unknown	.....
WHITEWATER RIVER	719.47	25	0	0	0	25	MI				.....

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1	3	3	3	3	3	3	1	0	0	0	0	1	1	.	3	4	4	4	4	9	1	D	M	S	L
WILLOW CREEK	719.47	0	0	0	3	3																														

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Lakes

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1	0	0	0	1	1	.3	4	4	4	4	9
CAHUILLA LAKE	714.00	135	0	0	0	135					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FINNEY LAKE	723.10	0	310	0	0	310	AC	No	Sedimentation	Non-Point	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
HAUGHTELIN LAKE	727.00	0	0	0	50	50																							
HAVASU LAKE	714.00	25000	0	0	0	25000	AC	Yes	Threat of objectives violated (Selenium & Salinity); Threat of elevated fish tissue levels (Selenium).	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
IMPERIAL LAKE	715.50	0	0	0	7296	7296																							
RAMER LAKE	723.10	0	180	0	0	180	AC	No	Sedimentation	Non-Point	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SALTON SEA	728.00	0	0	220000	0	220000	AC	Yes	Objective violated (Salinity) Elevated fish tissue levels (Selenium) Recreational impacts	Non-Point	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
										Non-Point	X	X	.	.	X	X	X												
SENATOR WASH RES	715.50	354	0	0	0	354																							
SUNBEAM LAKE	723.10	0	0	0	15	15					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WEST POND	723.10	50	0	0	0	50					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WIEST LAKE	723.10	0	0	0	55	55					.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
											.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 . 3 4 4 4 4 9 1 1 D M S L
AMES VALLEY		0	0	0	150	150					. . . . .
AMOS VALLEY		220	0	0	0	220					. . . . .
ARROYO SECO VALLEY		0	0	0	430	430					. . . . .
BESSEMER VALLEY		85	0	0	0	85					. . . . .
BORREGO VALLEY		110	0	0	0	110					. . . . .
BRISTOL VALLEY		710	0	0	0	710					. . . . .
BUCK RIDGE FAULT VALLEY		0	0	0	47	47					. . . . .
CADIZ VALLEY		430	0	0	0	430					. . . . .
CALZONA VALLEY		0	0	0	150	150					. . . . .
CANEBRAKE VALLEY		0	0	0	16	16					. . . . .
CHEMEHUEVI VALLEY		440	0	0	0	440					. . . . .
CHOCOLATE VALLEY		0	0	0	120	120					. . . . .
CHUCKWALLA VALLEY		870	0	0	0	870					. . . . .
CLARK VALLEY		40	0	0	0	40					. . . . .
COACHELLA VA. GW.	719.47	680	0	10	0	690	SQMJ	Yes	Threat of drinking water impairment 10 mile impaired due to organic solvents	Point & Non-Point	. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 1 0 9	3 3 3 3 3 3 3 . 4	0 0 0 0 1 1 4	4 4 4 9 1	0 1 1
COLLINS VALLEY		0	0	0	25	25					.	.	.	.	.
COPPER MOUNTAIN VALLEY		0	110	0	0	110					.	.	.	.	.
COYOTE WELLS VALLEY		0	100	0	0	100					.	.	.	.	.
DALE VALLEY		260	0	0	0	260					.	.	.	.	.
DAVIES VALLEY		0	0	0	13	13					.	.	.	.	.
DEADMAN VALLEY		160	0	0	0	160					.	.	.	.	.
EAST SALTON SEA BASIN		150	0	0	0	150					.	.	.	.	.
FENNER VALLEY		720	0	0	0	720					.	.	.	.	.
HELENDALE FAULT		0	0	0	4	4					.	.	.	.	.
HEXIE MOUNTAIN AREA		0	0	0	35	35					.	.	.	.	.
IMPERIAL VA. GW.		1870	0	0	0	1870					.	.	.	.	.
IRON RIDGE AREA		0	0	0	12	12					.	.	.	.	.
JACUMBA VALLEY		0	0	0	10	10					.	.	.	.	.
JACUMBA VALLEY-E		0	0	0	8	8					.	.	.	.	.
JOHNSON VALLEY		150	0	0	0	150					.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 W	3 S	3 L	3	3	3	1	1
LANFAIR VALLEY		0	280	0	0	280					.	.	.	.	.	.	.	.	.
LAVIC VALLEY	706.00	35	0	5	0	40					.	.	.	.	.	.	.	.	.
LOST HORSE VALLEY		0	0	0	40	40					.	.	.	.	.	.	.	.	.
LUCERNE VALLEY		260	0	0	0	260					.	.	.	.	.	.	.	.	.
MASON VALLEY		0	0	0	17	17					.	.	.	.	.	.	.	.	.
MEANS VALLEY		25	0	0	0	25					.	.	.	.	.	.	.	.	.
MORONGO VALLEY		14	0	0	0	14					.	.	.	.	.	.	.	.	.
NEEDLES VALLEY		140	0	0	0	140					.	.	.	.	.	.	.	.	.
OCOTILLO VALLEY		0	0	0	410	410					.	.	.	.	.	.	.	.	.
OGILBY VALLEY		220	0	0	0	220					.	.	.	.	.	.	.	.	.
OROCOPIA VALLEY		0	0	0	140	140					.	.	.	.	.	.	.	.	.
PALO VERDE MESA		0	0	0	280	280					.	.	.	.	.	.	.	.	.
PALO VERDE VA.		0	0	0	200	200					.	.	.	.	.	.	.	.	.
PINTO VALLEY		0	0	0	310	310					.	.	.	.	.	.	.	.	.
PINYON WASH AREA		0	0	0	16	16					.	.	.	.	.	.	.	.	.
PIPES CANYON FAULT VALLEY		0	0	0	9	9					.	.	.	.	.	.	.	.	.

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 I D M S L
PIUTE VALLEY		270	0	0	0	270					3 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1
PLEASANT VALLEY		0	0	0	26	26					. . . . .
QUIEN SABE POINT VALLEY		0	0	0	40	40					. . . . .
RICE VALLEY		300	0	0	0	300					. . . . .
SAN FELIPE VALLEY		0	0	0	40	40					. . . . .
TERWILLIGER VALLEY		0	0	0	10	10					. . . . .
TWENTYNINE PALMS VALLEY		0	0	0	180	180					. . . . .
VALLECITO-CARRIZO VALLEY		0	0	0	200	200					. . . . .
VIDAL VALLEY		0	0	0	160	160					. . . . .
WARD VALLEY		770	0	0	0	770					. . . . .
WARREN VALLEY		0	20	0	0	20					. . . . .
WEST SALTON SEA BASIN		190	0	0	0	190					. . . . .
WHALE PEAK AREA		0	0	0	3	3					. . . . .
YAQUI WELL AREA		0	0	0	32	32					. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D M S L
YUMA VALLEY		170	0	0	0	170					

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Agricultural Drains

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D M S L
BARD VALLEY DRAINS	727.00	0	20	0	0	20	MI	Yes	Threat of objectives violated Threat of toxic bioassay results Threat of sedimentation	Non-Point	. . . . .
COACHELLA VA. DRAINS	719..47	0	63	0	0	63	MI	No	Threat of objectives violated Threat of toxic bioassay results Threat of sedimentation	Non-Point	. . . . .
IMPERIAL VALLEY DRAINS	723.10	0	0	1305	0	1305	MI	Yes	Threat of objectives violated Fish kills Threat of toxic bioassay results	Non-Point	X X . . X . X
PALO VERDE OUTFALL DRAIN	715.40	0	0	16	0	16	MI	Yes	Bacteria objective violated Threat of toxic bioassay results Threat of sedimentation	Non-Point	X X . . X . X
PALO VERDE VALLEY DRAINS	715.40	0	131	0	0	131	MI	Yes	Threat of objectives violated Threat of toxic bioassay results Threat of sedimentation	Non-Point	. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 0 3 0 3 0 0 4 0 0 1 4 4 1 9 1 D M S L
ALGER CREEK	801.70	3	0	0	0	3		No			. . . . .
BAILEY CANYON CREEK	801.52	2	0	0	0	2		No			. . . . .
BARTON CREEK	801.57	6	0	0	0	6		No			. . . . .
BAUTISTA CREEK	802.23	10	0	0	0	10		No			. . . . .
BEAR CREEK	801.71	8	0	0	0	8		Yes			. . . . .
CAJON CREEK	801.51	12	0	0	0	12		No			. . . . .
CHINO CREEK	801.21	12	0	0	0	12	MI	Yes	Threat of toxic bioassay results Recreational impacts	Non-Point	. . . . .
CITY CREEK	801.57	15	0	0	0	15		Yes			. . . . .
COLDWATER CANYON CREEK	801.32	3	0	0	0	3		Yes			. . . . .
CUCAMONGA CREEK, MOUNTAIN REACH	801.24	5	0	0	0	5		No			. . . . .
CUCAMONGA CREEK, VALLEY REACH	801.21	17	0	0	0	17		Yes	Objectives violated Threat of toxic bioassay results	Non-Point	. . . . .
DAY AND EAST ETIWANDA CREEKS	801.24	5	0	0	0	5		Yes			. . . . .
EAST TWIN AND STRAWBERRY CYN CREEKS	801.57	5	0	0	0	5		Yes			. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D N S L
FALLS CREEK	801.70	4	0	0	0	4		No			. . . . .
FISH CREEK	801.57	5	0	0	0	5		No			. . . . .
FORSEE CREEK	801.57	5	0	0	0	5		No			. . . . .
FULLER MILL CREEK	802.22	3	0	0	0	3		No			. . . . .
GROUT CREEK	801.72	2	0	0	0	2		No			. . . . .
HIGH CREEK	801.70	2	0	0	0	2		No			. . . . .
LITTLE SAN GORGONIO CREEK	801.69	1	0	0	0	1		No			. . . . .
LYTLE CREEK	801.40	18	0	0	0	18	MI	Yes			. . . . .
METCALF CREEK	801.72	2	0	0	0	2		No			. . . . .
MILL CREEK, REACH 1	801.58	5	0	0	0	5		Yes	Threat of recreational impacts	Non-Point	. . . . .
MILL CREEK, REACH 2	801.58	8	0	0	0	8		Yes			. . . . .
MONKEY FACE CREEK	801.70	1	0	0	0	1		No			. . . . .
MOUNTAIN HOME CREEK	801.58	4	0	0	0	4		No			. . . . .
MOUNTAIN HOME CREEK, EAST FORK	801.70	1	0	0	0	1		No			. . . . .
NORTH CREEK	801.72	1	0	0	0	1		No			. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
OAK GLEN, POTATO CANYON, BIRCH CREEKS	801.69	2	0	0	0	2		No			. . . . .
PLUNGE CREEK	801.57	5	0	0	0	5		Yes	Threat of recreational impacts	Non-Point	. . . . .
RATHBONE (RATHBUN) CREEK	801.72	2	0	0	0	2		Yes			. . . . .
SALT CREEK	802.21	6	0	0	0	6		No			. . . . .
SAN ANTONIO CREEK	801.23	2	0	0	0	2		No			. . . . .
SAN DIEGO CREEK, REACH 1	801.11	0	0	6	0	6	MI	Yes	Elevated fish tissue levels Elevated shellfish tissue levels Eutrophication	Non-Point	X X . . X . X
SAN DIEGO CREEK, REACH 2	801.11	0	0	6	0	6		Yes	Elevated fish tissue levels Elevated shellfish tissue levels	Non-Point	X X . . X . X
SAN JACINTO RIVER, REACH 1	802.12	6	0	0	0	6		No			. . . . .
SAN JACINTO RIVER, REACH 3	802.13	9	0	0	0	9	MI	No			. . . . .
SAN JACINTO RIVER, REACH 4	802.14	7	0	0	0	7	MI	No			. . . . .
SAN JACINTO RIVER, REACH 5	802.21	7	0	0	0	7	MI	No			. . . . .
SAN JACINTO RIVER,	802.21	2	0	0	0	2	MI	No			. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D N S L (1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1)
REACH 6											
SAN JACINTO RIVER, REACH 7	802.22	7	0	0	0	7	MI	No			. . . . .
SAN TIMOTEO CREEK, REACH 1	801.62	5	0	0	0	5	MI	No			. . . . .
SAN TIMOTEO CREEK, REACH 2	801.62	3	0	0	0	3	MI	No			. . . . .
SAN TIMOTEO CREEK, REACH 3	801.62	2	0	0	0	2	MI	No			. . . . .
SAN TIMOTEO CREEK, REACH 4	801.62	0	0	14	0	14	MI	Yes	Recreational impacts Secondary treated wastewater discharge	Point	. X . . X . .
SANTA ANA RIVER, REACH 1	801.10	0	0	0	9	9	MI	Yes		Non-Point	X . . . . .
SANTA ANA RIVER, REACH 2	801.13	0	0	19	0	19	MI	Yes	Threat of toxic bioassay results Recreational impacts Objectives violated due to Reach 4	Non-Point	X X . . X . X
SANTA ANA RIVER, REACH 3	801.20	0	0	18	0	18	MI	Yes	Threat of toxic bioassay results Recreational impacts Objectives violated due to Reach 4	Point & Non-Point	X X . . X . X
SANTA ANA RIVER, REACH 4	801.27	0	0	12	0	12	MI	Yes	Objectives violated Threat of toxic bioassay results Recreational impacts	Point & Non-Point	X X . . X . X

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D N S L
SANTA ANA RIVER, REACH 5	801.52	17	0	0	0	17	MI	Yes	Varied threats to water quality	Non-Point	. . . . .
SANTA ANA RIVER, REACH 6	801.72	18	0	0	0	18	MI	Yes			. . . . .
SANTIAGO CREEK, REACH 1	801.12	9	0	0	0	9		No			. . . . .
SANTIAGO CREEK, REACH 3	801.12	6	0	0	0	6		No			. . . . .
SANTIAGO CREEK, REACH 4	801.12	2	0	0	0	2		Yes			. . . . .
SKAT CREEK	801.72	1	0	0	0	1		Yes			. . . . .
SIBERIA CREEK	801.71	1	0	0	0	1		No			. . . . .
SILVERADO CREEK	801.12	2	0	0	0	2		No			. . . . .
SLIDE CREEK	801.71	1	0	0	0	1		No			. . . . .
STONE CREEK	802.21	3	0	0	0	3		No			. . . . .
STRAWBERRY CR./SAN JACINTO R., N. FORK	802.21	9	0	0	0	9		Yes			. . . . .
TEMESCAL CREEK, REACH 1	801.32	6	0	0	0	6		No			. . . . .
TEMESCAL CREEK,	801.32	7	0	0	0	7		No			. . . . .

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Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 W	3 S	3 L	3	3	3	1	1	0	0	0	1	1	.	3	4	4	4	4	9
REACH 2																															
TEMESCAL CREEK, REACH 4	801.34	5	0	0	0	5		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TEMESCAL CREEK, REACH 5	801.35	7	0	0	0	7		Yes			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TEMESCAL CREEK, REACH 6	801.35	1	0	0	0	1		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TEQUESQUITE ARROYO (SYCAMORE CREEK)	801.59	2	0	0	0	2		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VIVIAN CREEK	801.70	1	0	0	0	1		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WATERMAN CREEK	801.57	5	0	0	0	5		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TUCAIPA CREEK	801.61	2	0	0	0	2		No			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 0 M S L
BALDWIN LAKE	801.73	0	1100	0	0	1100	AC	Yes	Threat of eutrophication Seasonally intermittent	Non-Point	. . . . .
BIG BEAR LAKE	801.71	0	2970	0	0	2970	AC	Yes	Eutrophication Sedimentation Elevated fish tissue levels	Non-Point	X . . . . X .
CANYON LAKE	802.12	2017	0	0	0	2017	AC	Yes	Eutrophication Recreational impacts Threat of fish population decline	Non-Point	. . . . .
ELSINORE, LAKE	802.31	0	2600	0	0	2600	AC	Yes	Eutrophication Occasional bacterial violations	Non-Point	. . . . . X .
EVANS, LAKE	801.27	0	0	42	0	42	AC	Yes	Fish kills Sedimentation	Non-Point	. X . . X X X
FULMOR, LAKE	802.21	9	0	0	0	9	AC	No			. . . . .
HEMET, LAKE	802.22	470	0	0	0	470	AC	Yes			. . . . .
IRVINE LAKE	801.12	650	0	0	0	650	AC	No			. . . . .
JENKS LAKE	801.72	9	0	0	0	9	AC	No			. . . . .
LEE LAKE	801.25	0	70	0	0	70	AC	Yes	Objectives violated	Non-Point	. . . . .
MATHEWS, LAKE	801.33	2750	0	0	0	2750	AC	Yes			. . . . .
PERRIS, LAKE	802.11	2340	0	0	0	2340	AC	Yes	Threat of drinking water impairment Concrn for potential THM precursors	Non-Point	. . . . .

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Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 1 . 1 3 0 3 4 0 3 4 0 4 1 4 0 4 1 4 0 9 1 1 1
PRADO PARK LAKE		0	60	0	0	60	AC	Yes	Recreational impacts Eutrophication Occasional fish kills	Point & Non-Point	. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 0 N S L
ARLINGTON GW	801.26	0	0	13	0	13	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
BIG BEAR I GW	801.71	7	0	0	0	7	SQMI	No			. . . . .
BIG BEAR II GW	801.71	16	0	0	0	16	SQMI	No	Threat of drinking water impairment		. . . . .
BUNKER HILL I GW	801.52	17	0	5	0	22	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
BUNKER HILL II GW	801.52	48	0	29	0	77	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
BUNKER HILL PRESSURE GW	801.52	0	0	24	0	24	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
CHINO I GW	801.21	86	0	4	0	90	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
CHINO II GW	801.21	60	0	44	0	104	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
CHINO III GW	801.21	4	0	44	0	48	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
COLTON GW	801.44	2	0	12	0	14	SQMI	Yes	Drinking water impairment	Point & Non-Point	. . . . .
CUCAMONGA GW	801.24	22	1	1	0	24	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
ELSINORE GW	802.31	21	0	0	0	21	SQMI	No			. . . . .
GARNER VALLEY GW	802.22	10	0	0	0	10	SQMI	No			. . . . .
HEMET GW	802.15	0	42	0	0	42	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
IDYLLWILD GW	802.22	1	0	0	0	1	SQMI	Yes			. . . . .
IRVINE FOREBAY I GW	801.11	0	8	10	0	18	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
IRVINE FOREBAY II GW	801.11	0	2	5	0	7	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
IRVINE PRESSURE GW	801.11	0	19	20	0	39	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
LA HABRA GW	845.62	0	0	40	0	40	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
LAKEVIEW GW	802.14	0	25	0	0	25	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
LYTLE CREEK GW	801.42	9	0	0	0	9	SQMI	No			. . . . .
MENIFEE I GW	802.12	0	9	0	0	9	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
MENIFEE II GW	802.12	0	6	0	0	6	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
PERRIS NORTH GW	802.11	37	0	0	0	37	SQMI	No			. . . . .
PERRIS SOUTH I GW	802.11	0	11	0	0	11	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
PERRIS SOUTH II GW	802.11	0	17	0	0	17	SQMI	No	Drinking water impairment	Non-Point	. . . . .
PERRIS SOUTH III GW	802.11	0	5	0	0	5	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
RIALTO GW	801.43	27	0	5	0	32	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
RIVERSIDE I GW	801.27	0	0	17	0	17	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
RIVERSIDE II GW	801.27	0	0	11	0	11	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
RIVERSIDE III GW	801.27	0	0	14	0	14	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
SAN JACINTO - CANYON GW	802.20	4	0	0	0	4	SQMI	Yes			. . . . .

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Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 0 M S L
SAN JACINTO - INTAKE GW	802.20	19	0	0	0	19	SQMI	Yes			. . . . .
SAN JACINTO - LOWER PRESSURE GW	802.20	0	14	0	0	14	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
SAN JACINTO - UPPER PRESSURE GW	802.20	1	8	0	0	9	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
SAN TIMOTEO GW	801.60	61	0	0	0	61	SQMI	No			. . . . .
SANTA ANA FOREBAY GW	801.11	0	50	55	0	105	SQMI	Yes	Drinking water impairment	Point & Non-Point	. . . . .
SANTA ANA PRESSURE GW	801.11	0	70	69	0	139	SQMI	Yes	Upper aquifer impaired	Point & Non-Point	. . . . .
SANTIAGO GW	801.12	0	77	0	0	77	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
TEMESCAL GW	801.25	0	0	22	0	22	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
UPPER TEMESCAL I (BEDFORD) GW	801.32	0	9	0	0	9	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
UPPER TEMESCAL II (LEE LAKE) GW	801.34	0	7	0	0	7	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .
UPPER TEMESCAL III (COLDWATER) GW	801.31	3	0	0	0	3	SQMI	Yes			. . . . .
WINCHESTER GW	802.13	0	16	0	0	16	SQMI	Yes	Drinking water impairment	Non-Point	. . . . .

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Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 / 1 D N S L
ANAHEIM BAY MARSH	801.11	780	0	0	0	780	AC	Yes	Threat of elevated shellfish tissue leve	Non-Point	. . . . .
BOLSA BAY MARSH	801.11	0	900	0	0	900	AC	Yes	Threat of elevated shellfish tissue leve Threat of elevated metals from urban runoff	Non-Point	X . . . . .
BOLSA CHICA ECOLOGICAL RESERVE	801.11	0	294	0	0	294	AC	Yes	Suspected toxics from urban runoff	Non-Point	X . . . . .
SAN JOAQUIN FRESHWATER MARSH	801.11	0	400	0	0	400	AC	Yes	Threat of Rare & Endangered Species impa Threat of increasing salinities Threat of heavy metal contamination	Non-Point	. . . . .
SANTA ANA RIVER MOUTH	801.11	270	0	0	0	270	AC	Yes	Possible input of toxics	Non-Point	. . . . .
UPPER NEWPORT BAY ECOLOGICAL RESERVE	801.11	0	0	752	0	752	AC	Yes	Elevated shellfish tissue levels Eutrophication Sedimentation	Non-Point	X X . . X . X

EXHIBIT 8

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Coastal Shoreline

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
BOLSA CHICA STATE BEACH	801.11	7	0	0	0	7	MI	Yes			. . . . .
CORONA DEL MAR STATE BEACH	801.11	1	0	0	0	1	MI	Yes			. . . . .
HUNTINGTON BEACH STATE PARK	801.11	3	0	0	0	3	MI	Yes			. . . . .
NEWPORT BEACH	801.11	6	0	0	0	6	MI	Yes	Threat of recreational impacts	Point	. . . . .
SEAL BEACH	801.11	1	0	0	0	1	MI	Yes	Potential contamination from S.G. River Spills from offshore oil facilities	Non-Point	. . . . .
SUNSET BEACH	801.11	3	0	0	0	3	MI	Yes			. . . . .

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EXHIBIT 8

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Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
ANAHEIM BAY	801.11	0	180	0	0	180	AC	Yes	Elevated shellfish tissue levels	Non-Point	. . . . .
HUNTINGTON HARBOUR	801.11	0	0	150	0	150	AC	Yes	Elevated shellfish tissue levels Threat of sedimentation	Non-Point	X X . . X . X
NEWPORT BAY, LOWER	801.11	680	0	20	0	700	AC	Yes	Elevated shellfish tissue levels Recreational impacts Eutrophication	Non-Point	X X . . X . X

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Areas of Special Biological Significance

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D N S L
IRVINE COAST REFUGE	801.11	1024	0	0	0	1024	AC	Yes			. . . . .
NEWPORT BEACH REFUGE	801.11	166	0	0	0	166	AC	Yes			. . . . .

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Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 R	3 S	3 L	3	3	3
AGUA MEDIONDA CREEK	904.30	0	9	0	0	9	MI				.	.	.	.	.	.	.
ALISO CREEK	901.10	0	0	1	19	20	MI	Yes	Bacterial contamination		.	X	.	.	X	.	X
ARROYO TRABUCO	901.20	0	0	1	0	1	MI	Yes	Heavy metals		.	X	.	.	X	.	X
BOULDER CREEK	907.41	11	0	0	0	11	MI				.	.	.	.	.	.	.
BUENA VISTA CREEK	904.20	0	8	0	0	8	MI				.	.	.	.	.	.	.
CAHUILLA CREEK	902.71	0	0	0	17	17	MI				.	.	.	.	.	.	.
CAMPO CREEK	911.80	0	0	0	19	19	MI				.	.	.	.	.	.	.
CANYON DE LAS ENCINAS	904.40	0	0	0	4	4	MI				.	.	.	.	.	.	.
CHOLLAS CREEK	908.22	0	0	0	6	6	MI				.	.	.	.	.	.	.
COTTONWOOD CREEK, LOWER	911.20	0	0	0	14	14	MI				.	.	.	.	.	.	.
COTTONWOOD CREEK, UPPER	911.60	12	0	0	0	12	MI				.	.	.	.	.	.	.
DELUZ CREEK	902.21	14	0	0	0	14	MI				.	.	.	.	.	.	.
ESCONDIDO CREEK	904.60	0	23	0	0	23	MI				.	.	.	.	.	.	.
FORESTER CREEK	907.13	0	3	0	0	3	MI				.	.	.	.	.	.	.
GUEJITO CREEK	905.32	10	0	0	0	10	MI				X	.	.	.	.	.	.

R0033612

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 0 M S L
LA POSTA CREEK	911.70	18	0	0	0	18	MI				. . . . .
LOMA ALTA CREEK	904.10	0	0	0	6	6	MI				. . . . .
LOS COCHES CREEK	907.14	0	0	0	9	9	MI				. . . . .
LOS PENASQUITOS CREEK, LOWER	906.10	0	8	0	0	8	MI				. . . . .
LOS PENASQUITOS CREEK, UPPER	906.20	9	0	0	0	9	MI				. . . . .
MURRIETA CREEK	902.30	13	0	0	0	13	MI				. . . . .
OTAY RIVER, LOWER	910.20	0	5	0	0	5	MI				X . . . . .
PARADISE CREEK	908.32	0	0	0	4	4	MI				. . . . .
PINE VALLEY CREEK	911.40	10	0	0	0	10	MI				. . . . .
ROSE CANYON	906.30	0	0	0	13	13	MI				. . . . .
SAN CLEMENTE CANYON	906.40	0	0	0	13	13	MI				. . . . .
SAN DIEGO RIVER, LOWER	907.11	0	13	0	0	13	MI				X . . . . .
SAN DIEGO RIVER, MIDDLE	907.15	0	30	0	0	30	MI				. . . . .
SAN DIEGUITO RIVER, LOWER	905.10	0	11	0	0	11	MI				. . . . .

R0033613

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 P M S L
SAN JUAN CREEK	901.20	0	8	1	0	9	MI	Yes	Recreational impacts Objectives violated periodic beach closures	Unknown	. X . . X . X
SAN LUIS REY RIVER, LOWER	903.10	0	21	0	0	21	MI		No evidence of impairment of beneficial uses		. . . . .
SAN LUIS REY RIVER, MIDDLE	903.20	0	30	0	0	30	MI				. . . . .
SAN MARCOS CREEK	904.50	0	0	0	13	13	MI				. . . . .
SAN MATEO CREEK	901.40	0	0	0	17	17	MI				. . . . .
SAN ONOFRE CREEK	901.51	0	0	0	13	13	MI				. . . . .
SANTA MARGARITA RIVER	902.10	11	0	0	0	11	MI				. . . . .
SANTA MARIA CREEK	905.41	6	0	0	0	6	MI				. . . . .
SANTA YSABEL CREEK	905.50	24	0	0	0	24	MI				. . . . .
SECUNDA DESVECHA CANADA	901.30	0	0	0	6	6	MI				. . . . .
SWEETWATER RIVER, LOWER	909.10	11	0	0	0	11	MI				. . . . .
SYCAMORE CREEK	907.12	0	0	0	8	8	MI				. . . . .
TECOLOTE CREEK	906.50	0	0	0	6	6	MI				. . . . .

R0033614

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Rivers and Streams

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
TEMECULA CREEK, LOWER	902.51	10	0	0	0	10	MI				. . . . .
TEMECULA CREEK,UPPER	902.91	9	0	0	0	9	MI				. . . . .
TIJUANA RIVER	911.11	0	0	7	0	7	MI	Yes	untreated domestic and industrial wastewater from city of Tijuana. Severe health problem exists. extensive rec impacts.	Point & Non-Point	X X . . X . X
TUCALOTA CREEK	902.41	0	0	0	26	26	MI				. . . . .
WILSON CREEK	902.61	0	0	0	16	16	MI				. . . . .

R0033615

Region 9

Ocean

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D N S L
COASTLINE OF SAN DIEGO REGION	.	78	12	12	0	102	MI	Yes	impaired length of the San Diego coastline is HA 911.11. impairment is as listed for the HA.	Point & Non-Point	X X . . X . X
LA JOLLA (O)	906.30	0	12	0	0	12	MI				X . . . . .
TIJUANA EST SHORELINE	911.11	0	0	10	0	10	MI	Yes	Objectives violated Recreational impacts beach area permanently quarantined	Point & Non-Point	. X . . X . X

R0033616

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 1 . 1 D	3 0 3 4 M	3 0 4 4 $	3 0 4 4 L	3 1 4 9	3 1
BARRETT LAKE	911.30	811	0	0	0	811	AC				.	.	.	.	.	.
CALAVERA LAKE	904.31	0	0	0	35	35	AC				.	.	.	.	.	.
CHOLLAS RES	908.22	0	0	0	16	16	AC				.	.	.	.	.	.
CUYAMACA LAKE	907.43	930	0	0	0	930	AC				.	.	.	.	X	.
DIXON LAKE	904.62	71	0	0	0	71	AC				.	.	.	.	.	.
EL CAPITAN RES	907.31	1562	0	0	0	1562	AC				.	.	.	.	X	.
EL TORO RES	901.20	22	0	0	0	22	AC				.	.	.	.	.	.
GUAJOME LAKE	903.11	0	0	0	25	25	AC				.	.	.	.	.	.
HENSHAW LAKE	903.31	6020	0	0	0	6020	AC				.	.	.	.	X	.
HODGES LAKE	905.21	0	1234	0	0	1234	AC				.	.	.	.	X	.
LAGUNA MIGUEL LAKE	901.13	0	0	0	40	40	AC				.	.	.	.	X	.
LAKE JENNINGS	907.12	176	0	0	0	176	AC				.	.	.	.	.	.
LAKE POMAY	905.21	62	0	0	0	62	AC				.	.	.	.	.	.
LOVELAND RES	909.31	454	0	0	0	454	AC				.	.	.	.	.	.
LOWER OTAY RES	910.31	1110	0	0	0	1110	AC				.	.	.	.	X	.
MIRAMAR LAKE	906.10	162	0	0	0	162	AC				.	.	.	.	.	.

R0033617

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Lakes

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Intermediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 M	3 S	3	3	3	3	1 L
MISSION VIEJO LAKE	901.20	150	0	0	0	150	AC				.	.	.	.	.	.	.	.
MORENA RES	911.50	1541	0	0	0	1541	AC				.	.	.	.	.	.	.	.
MURRAY LAKE	907.11	141	0	0	0	141	AC				.	.	.	.	.	.	.	.
RED MOUNTAIN LAKE	903.12	7	0	0	0	7	AC				.	.	.	.	.	.	.	.
SAN DIEGUITO LAKE	904.61	75	0	0	0	75	AC				.	.	.	.	.	.	.	.
SAN ELIJO LAKE	904.61	0	150	0	0	150	AC				.	.	.	.	.	.	X	.
SAN MARCOS LAKE	904.52	68	0	0	0	68	AC				.	.	.	.	.	.	.	.
SAN VICENTE RES	907.21	1069	0	0	0	1069	AC				.	.	.	.	.	.	.	.
SKINNER LAKE	902.41	860	0	0	0	860	AC				.	.	.	.	.	.	.	.
SUTHERLAND LAKE	905.53	557	0	0	0	557	AC				.	.	.	.	.	.	.	.
SWEETWATER RES	909.21	950	0	0	0	950	AC				.	.	.	.	.	.	X	.
TURNER LAKE	903.13	46	0	0	0	46	AC				.	.	.	.	.	.	X	.
UPPER OTAY RES	910.32	139	0	0	0	139	AC				.	.	.	.	.	.	.	.
VAIL LAKE	902.81	1000	0	0	0	1000	AC				.	.	.	.	.	.	.	.
WOHLFORD LAKE	904.63	222	0	0	0	222	AC				.	.	.	.	.	.	.	.

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STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
AGUA HEDIONDA HA GW	904.30	0	30	0	0	30	SQMI				. . . . .
AGUANGA HA GW	902.80	102	0	0	0	102	SQMI				. . . . .
AULD HA GW	902.40	96	0	0	0	96	SQMI				. . . . .
BARRETT LAKE HA GW	911.30	97	0	0	0	97	SQMI				. . . . .
BATIQUITOS LAGOON GW	904.51	0	2	0	0	2	SQMI				. . . . .
BOULDER CREEK HA GW	907.40	105	0	0	0	105	SQMI				. . . . .
BUENA VISTA CREEK HA GW	904.20	0	0	23	0	23	SQMI	Yes	objectives exceeded	Non-Point	. . . . .
CAMERON HA GW	911.70	45	0	0	0	45	SQMI				. . . . .
CAMPO HA GW	911.80	107	0	0	0	107	SQMI				. . . . .
CAMPO VALLEY	911.82	4	0	0	0	4	SQMI				. . . . .
CAVE ROCKS HA GW	902.70	85	0	0	0	85	SQMI				. . . . .
COAHUILA VALLEY	902.70	25	0	0	0	25	SQMI				. . . . .
COTTONWOOD HA GW	911.60	45	0	0	0	45	SQMI				. . . . .
COTTONWOOD VALLEY	911.60	3	0	0	0	3	SQMI				. . . . .
DELUZ HA GW	902.20	112	0	0	0	112	SQMI				. . . . .
DULZURA HA GW	910.30	100	0	0	0	100	SQMI				. . . . .

R0033619

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 P M S L
EL CAJON VALLEY	907.13	0	0	8	0	8	SQMI	Yes	this subbasin is located within the Lowe r San Diego HA GW basin. The impairment is as listed for the HA.	Non-Point	. . . . .
EL CAPITAN HA GW	907.30	88	0	0	0	88	SQMI				. . . . .
ESCONDIDO CREEK HA GW	906.60	0	0	89	0	89	SQMI	Yes	drinking water objectives exceeded	Non-Point	. . . . .
ESCONDIDO VALLEY	906.62	0	0	20	0	20	SQMI	Yes	This subbasin is located within the Esco ndido Creek HA GW. Impairment is as list ed for the HA.	Non-Point	. . . . .
HODGES HA GW	905.20	0	50	0	0	50	SQMI				. . . . .
JAMUL VALLET	909.21	5	0	0	0	5	SQMI				. . . . .
LAGUNA HA GW	901.10	0	64	0	0	64	SQMI				. . . . .
LAS PULGAS VALLEY	901.52	3	0	0	0	3	SQMI				. . . . .
LOMA ALTA HA GW	904.10	0	10	0	0	10	SQMI				. . . . .
LOWER SAN DIEGO HA GW	907.10	0	15	155	0	170	SQMI	Yes	Threat of drinking water impairment water quality objectives exceeded	Non-Point	. . . . .
LOWER SAN LUIS REY HA GW	903.10	0	146	40	0	186	SQMI	Yes	Threat of drinking water impairment objectives exceeded	Non-Point	. . . . .
LOWER SWEETWATER HA GW	909.10	0	0	49	0	49	SQMI	Yes	Drinking water impairment objectives exceeded	Non-Point	. . . . .

R0033620

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3 L	3	3	3	1
MIDDLE SWEETWATER HA GW	909.20	85	0	0	0	85	SQMI				.	.	.	.	.	.	.	.
MIRAMAR HA GW	906.40	0	41	0	0	41	SQMI				.	.	.	.	.	.	.	.
MIRAMAR RESERVOIR HA GW	906.10	0	55	0	0	55	SQMI				.	.	.	.	.	.	.	.
MISSION VALLEY	907.11	0	0	11	0	11	SQMI	Yes	water quality objectives exceeded. This subbasin is located within the Lowe r San Diego HA GW. Impairment same as HA	Non-Point	.	.	.	.	.	.	.	.
MISSION VIEJO HA GW	901.20	0	177	0	0	177	SQMI				.	.	.	.	.	.	.	.
MONSERATE HA GW	903.20	171	0	0	0	171	SQMI				.	.	.	.	.	.	.	.
MONUMENT HA GW	911.40	37	0	0	0	37	SQMI				.	.	.	.	.	.	.	.
MORENA HA GW	911.50	24	0	0	0	24	SQMI				.	.	.	.	.	.	.	.
MURRIETA HA GW	902.30	133	0	0	0	133	SQMI				.	.	.	.	.	.	.	.
NATIONAL CITY HA GW	908.30	11	0	0	0	11	SQMI				.	.	.	.	.	.	.	.
OAKGROVE HA GW	902.90	75	0	0	0	75	SQMI				.	.	.	.	.	.	.	.
OTAY VALLEY	910.20	0	4	0	0	4	SQMI				.	.	.	.	.	.	.	.
OTAY VALLEY HA GW	910.20	0	47	0	0	47	SQMI				.	.	.	.	.	.	.	.
PAMO VALLEY	905.50	4	0	0	0	4	SQMI				.	.	.	.	.	.	.	.

R0033621

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 0 M S L
PECHANGA HA GW	902.50	44	0	0	0	44	SQMI				. . . . .
PINE VALLEY	911.30	2	0	0	0	2	SQMI				. . . . .
POTRERO HA GW	911.20	81	0	0	0	81	SQMI				. . . . .
POTRERO VALLEY	911.25	2	0	0	0	2	SQMI				. . . . .
POWAY HA GW	906.20	0	41	0	0	41	SQMI				. . . . .
POWAY VALLEY	906.20	0	4	0	0	4	SQMI				. . . . .
RANCHITA TOWN AREA	903.31	0	4	0	0	4	SQMI				. . . . .
SAN CLEMENTE HA GW	901.30	21	0	0	0	21	SQMI				. . . . .
SAN DIEGO RIVER VALLEY	907.15	0	15	0	0	15	SQMI				. . . . .
SAN DIEGUITO VALLEY	905.11	0	0	6	0	6	SQMI	Yes	water quality exceeds objectives This subbasin is located within the Sola ne Beach HA GW. Impairment same as HA.	Non-Point	. . . . .
SAN ELIJO VALLEY	904.61	0	0	3	0	3	SQMI	Yes	This subbasin is located within the Esco ndido Creek HA GW. The impairment is as listed for the HA.	Non-Point	. . . . .
SAN JUAN VALLEY	901.20	0	18	0	0	18	SQMI				. . . . .
SAN LUIS REY VALLEY	903.10	0	0	40	0	40	SQMI	Yes	This subbasin is located within the Lowe r San Luis Rey HA GW. The impairment is the same as listed in the HA.	Non-Point	. . . . .

R0033622

STATE WATER RESOURCES CONTROL BOARD 1990 WATER QUALITY ASSESSMENT

Report Date : 04/16/90

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D M S L
SAN MARCOS HA GW	904.50	0	55	0	0	55	SQMI				. . . . .
SAN MATEO CANYON HA GW	901.40	135	0	0	0	135	SQMI				. . . . .
SAN MATEO VALLEY	901.40	4	0	0	0	4	SQMI				. . . . .
SAN ONOFRE HA GW	901.50	103	0	0	0	103	SQMI				. . . . .
SAN ONOFRE VALLEY	901.51	2	0	0	0	2	SQMI				. . . . .
SAN PASQUAL HA GW	905.30	66	0	0	0	66	SQMI				. . . . .
SAN PASQUAL VALLEY	905.30	12	0	0	0	12	SQMI				. . . . .
SAN VICENTE HA GW	907.20	75	0	0	0	75	SQMI				. . . . .
SANTA MARGARITA GW	902.11	0	13	0	0	13	SQMI				. . . . .
SANTA MARIA VALLEY	905.40	0	0	24	0	24	SQMI	Yes	Nitrates std. threatened. Public health warning. This is a subbasin of the Sant a Maria HA GW. Same impairment as listed	Non-Point	. . . . .
SANTA MARIA VALLEY HA GW	905.40	33	0	24	0	57	SQMI	Yes	Threat of drinking water impairment Threat of objectives violated Public health warning issued-cty. health	Non-Point	. . . . .
SANTA YSABEL HA GW	905.50	129	0	0	0	129	SQMI				. . . . .
SOLANA BEACH HA GW	905.10	0	0	45	0	45	SQMI	Yes	Threat of drinking water impairment water quality exceeds objectives	Non-Point	. . . . .

R0033623

Region 9

Ground Water

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 1 0 0 0 0 1 1 . 3 4 4 4 4 9 1 1 D N S L
SWEETWATER VALLEY	909.11	0	0	3	0	3	SQMI	Yes	This subbasin is a portion of the Lower Sweetwater HA GW. The impairment is the same as listed for the HA.	Non-Point	. . . . .
TECATE VALLEY	911.81	1	0	0	0	1	SQMI				. . . . .
TEMECULA VALLEY	902.50	150	0	0	0	150	SQMI				. . . . .
TIJUANA GW	911.11	0	0	8	0	8	SQMI	Yes	This subbasin is a portion of the Tijuan a Valley GW HA. The impairment is the sa me as listed for the HA.	Point & Non-Point	. . . . .
TIJUANA VALLEY HA GW	911.10	0	0	30	0	30	SQMI	Yes	Drinking water impairment Objectives violated public health threatened	Point & Non-Point	. . . . .
UPPER SWEETWATER HA GW	909.30	100	0	0	0	100	SQMI				. . . . .
WARNER VALLEY	903.31	0	40	0	0	40	SQMI				. . . . .
WARNER VALLEY HA GW	903.30	0	208	0	0	208	SQMI				. . . . .
WILSON HA GW	902.60	60	0	0	0	60	SQMI				. . . . .
YSIDORA HA GW	902.10	0	43	0	0	43	SQMI				. . . . .

R0033624

Region 9

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 1 D M S L
AGUA HEDIONDA LAGOON	904.31	0	0	1	399	400	AC	Yes	Elevated shellfish tissue levels Threat of objectives violated Sedimentation	Unknown	. X . . X . X
BATIQUITOS LAGOON	904.51	0	0	420	0	420	AC	Yes	Eutrophication Fish kills Recreational impacts	Non-Point	. X . . X . X
BUENA VISTA LAGOON	904.21	0	200	0	350	350	AC				. . . . .
FAMOSA SLOUGH	906.40	0	0	31	0	31	AC	Yes	Eutrophication	Non-Point	. X . . X . X
KENDALL-FROST MISSION BAY MARSH	906.40	0	0	0	25	25	AC				X . . . . .
LOMA ALTA SLOUGH	904.10	0	0	0	8	8	AC				. . . . .
LOS FLORES CREEK ESTUARY	901.52	0	0	0	10	10	AC				. . . . .
LOS PENASQUITOS LAGOON	906.10	0	0	1	384	385	AC	Yes	Recreational impacts Eutrophication Threat of objectives violated	Point & Non-Point	. X . . X . X
SAN DIEGO RIVER ESTUARY	907.11	0	0	0	320	320	AC				. . . . .
SAN DIEQUITO LAGOON	905.11	0	300	0	0	300	AC				. . . . .
SAN ELIJO LAGOON	904.61	0	0	150	180	330	AC	Yes	Eutrophication Recreational impacts Threat of recreational impacts	Non-Point	. X . . X . X

R0033625

Region 9

Estuaries

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 1 D M S L
SAN LUIS REY RIVER ESTUARY	903.11	0	0	0	160	160	AC				. . . . .
SAN MATEO CREEK ESTUARY	901.41	0	0	0	30	30	AC				. . . . .
SANTA MARGARITA LAGOON	902.11	0	0	268	0	268	AC	Yes	Eutrophication Recreational impacts Objectives violated	Point & Non-Point	. X . . X . X
SOUTH SAN DIEGO BAY WETLANDS	908.21	0	0	0	2400	2400	AC				. . . . .
SWEETWATER MARSH	909.12	0	936	0	0	936	AC				X . . . . .
TIJUANA RIVER ESTUARY	911.11	0	0	150	0	150	AC	Yes	Objectives violated Recreational impacts Elevated fish tissue levels	Point & Non-Point	X X . . X . X

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Bays and Harbors

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Need Description	Problem Source	Federal Lists 1 3 3 3 3 3 3 / 1 0 0 0 0 1 1 / . 3 4 4 4 4 9 / 1 D N S L
DANA POINT HARBOR	901.14	0	0	0	215	215	AC				. . . . .
MISSION BAY	906.40	0	0	1520	0	1520	AC	Yes		Point & Non-Point	X X . . X . X
OCEANSIDE HARBOR	902.11	0	0	1	209	210	AC	Yes	Objectives violated Recreational impacts Elevated shellfish tissue levels	Point & Non-Point	X X . . X . X
SAN DIEGO BAY	908.21	0	0	12000	0	12000	AC	Yes	Objectives violated Elevated shellfish tissue levels Elevated fish tissue levels	Point & Non-Point	X X . . X . X

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Areas of Special Biological Significance

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/Weed Description	Problem Source	Federal Lists: 1 D	3 N	3 S	3	3	3	1
											0	0	0	0	1	1	1
											.	3	4	4	4	4	9
HEISLER PARK ECOLOGICAL RESERVE	901.11	1536	0	0	0	1536	AC				.	.	.	.	.	.	.
SAN DIEGO MARINE LIFE REFUGE	906.30	92	0	0	0	92	AC				.	.	.	.	.	.	.
SAN DIEGO-LA JOLLA ECOLOGICAL REFUGE	906.30	518	0	0	0	518	AC				.	.	.	.	.	.	.

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APPENDIX 1: THE BAY-DELTA
A DISCUSSION OF ITS WATER QUALITY PROBLEMS

I. INTRODUCTION

Because of the over 2500 waterbodies listed in the Water Quality Assessment, a detailed description of each waterbody's quality is impossible. To avoid the appearance of minimizing the importance of California's water resources and the complexity of its attendant water quality issues, this appendix has been prepared to offer a more complete discussion of what is perhaps California's most important waterbody, the San Francisco Bay-Sacramento/San Joaquin Delta Estuary, together with its particular water quality problems.

II. THE SACRAMENTO RIVER

This discussion begins with the Central Valley Regional Board's assessment of the 327 miles of the Sacramento River (a major tributary of the Delta) illustrating how the Regional Board assessed the three hydrological sections, of the river separately. The entry appears as follows:

Water Body Name	Hydro Unit #	Water Quality Condition: Good	Inter-mediate	Impaired	Unknown	Total Size	Units	Fact Sheet	Problem/ Need Desc.	Problem Source	Federal Lists: 1 3 1 . 3 4 1 D	3 0 4 M	3 0 4 S	3 0 4 L	3 1 9 L
Sacramento R. (Shasta Dam to Red Bluff)	508.10	0	12	60	0	72		Yes			X	X	.	X	X . X
Sacramento R. (above Shasta Lake)	511.20	20	20	0	0	40					.	.	.	.	. . .
Sacramento R. (Red Bluff to Delta)	500.00	80	75	60	0	215		Yes			X	X	.	.	X . X

The water quality of each river section is indicated. The scientific basis for this listing includes extensive toxicity testing of river water, examination of pollutant concentrations in fish tissue and in water, information on the health and abundance of aquatic organisms, and a knowledge of point and nonpoint pollution sources. These

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water quality data are summarized on the map of the Sacramento River (Figure 1). Upstream of Shasta Lake, the water quality is good, except for the 20-mile stretch between Box Canyon Dam and Shasta Lake. The dam releases water at a temperature that is higher than beneficial for the cold water fishery. Twelve miles of river downstream of Lake Shasta periodically exceed Basin Plan objectives for metals and are, therefore, classified "intermediate".

The next 60 miles, from the confluence with Spring Creek to Red Bluff, are impacted by acid mine discharges from Iron Mountain Mine runoff. This runoff, polluted with copper, zinc, and cadmium, causes fish kills and reduces the abundance of aquatic life. The river also receives pulp mill discharge from Simpson Paper Company at Anderson. The discharge contains toxic dioxins, which accumulate in fish. The California Department of Health Services (DHS) has posted a health advisory warning against eating certain fish caught in this section of the river. In some years when reservoir levels are low, warm water released from Shasta Dam in the summer and early fall also adversely affects the fall and winter runs of the Chinook salmon population.

Further downstream, the water quality improves. Only periodic toxicity has been observed, probably attributable to upstream mines, the pulp mill discharge, and other unknown factors. The assessment indicates a recovery zone in the river with an intermediate section just below the impacted zone, and a relatively good quality zone further downstream.

From Colusa Drain to the Delta, the Sacramento River water quality declines. Bioassay testing indicates significant toxicity associated with agricultural discharge from the Colusa Basin Drain. In addition, mercury levels in fish tissue are high enough to warrant concern for human health and aquatic life. Mercury was used historically in now-abandoned Sierra-Nevada mines. Mercury was also mined in the Coastal Range. Mine runoff enters tributaries of the Sacramento River and flows to the Delta.

More detailed information on the Sacramento River is included in a State Board draft report titled, "Sacramento River Toxic Chemical Risk Assessment Project", which will be available when the State Board approves the report.

The following is a detailed discussion of Bay-Delta water quality concerns:

III. WATER QUALITY CONCERNS OF THE BAY-DELTA WATERS

Summary of Bay-Delta Water Quality: The Bay-Delta is impacted because some representatives of the aquatic community contain toxic substances in concentrations which are potentially hazardous to human health. The aquatic

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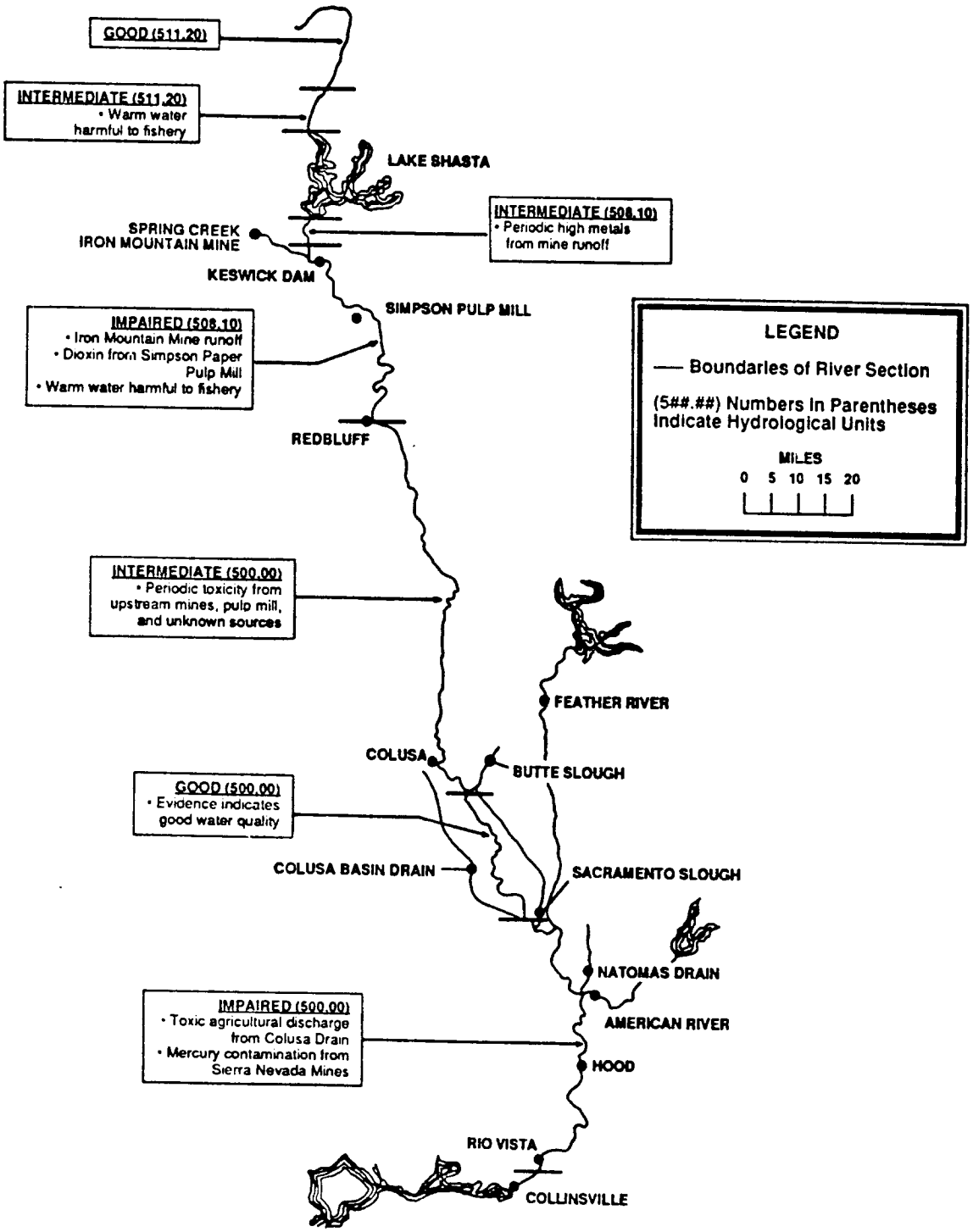
Figure 1.
Assessment of Sacramento River Quality



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community in some instances is not fully supported or is severely stressed. Evidence of beneficial use impact and human health risk include the DHS health advisories posted for selenium and mercury contamination in all basins of the Bay and Delta. Localized impact and health risks occur because of elevated levels of dioxins, PCBs, and pesticides which bioconcentrate in aquatic organisms such as fish.

The toxicity observed in the Bay-Delta and tributary waters also suggest that the aquatic community is not fully supported. Evidence of toxicity also violates the narrative water quality objective of "no toxics in toxic amounts". Evidence of widespread metals contamination warrants additional concern for the health of the Bay-Delta biota. Substantial declines in fish populations that support commercial and sport fishing indicate a stressed fish community. There is evidence that fish population declines may be associated with physical conditions in addition to toxic pollutants. Other issues, as well as issues dealing with toxic pollutants, are the focus of the State Board's Bay-Delta proceedings. This multi-year process will culminate in a new Bay-Delta water quality control plan, a state policy regulating pollutants, and a water rights decision.

The Importance of the Bay-Delta: The San Francisco Bay/ Sacramento-San Joaquin Delta Estuary (Bay-Delta) is the largest estuary on the west coast of North America. It is an extensive network of 700 miles of inflowing fresh waterways and over 350,000 acres of marsh, estuary, and open bay (Figure 2). Forty percent of California's land area is within the Bay-Delta watershed, which includes some of the most intensively cultivated land on earth (SWRCB 1989). Urban development, major industrial and chemical facilities, and active and abandoned mines all contribute to the composition of the Delta's inflowing rivers. Rainfall and snow melt from the Sierra Nevada feed the Sacramento River in the northern Central Valley while the southern watershed empties into the San Joaquin River and then to the Bay-Delta.

These waters support a diverse and productive Bay-Delta ecosystem. The estuary and the surrounding wetlands are habitat for over 100 fish species, 230 bird species, 43 mammal species, 15 species of reptiles, and 8 different amphibians (SWRCB 1990). Some of these animals are threatened or presently in danger of extinction (SWRCB 1990). Some plant species are also listed by the State or federal government as rare, threatened, or endangered. The Delta also supports animals in great numbers. A large number (450,000 to 600,000) of migratory waterfowl spend the winter in the estuary. The Delta's rich faunal diversity supports recreation and commerce. Bay shrimp, Dungeness crab, oysters, Chinook salmon, striped bass, and American shad are the basis for important recreation and commercial

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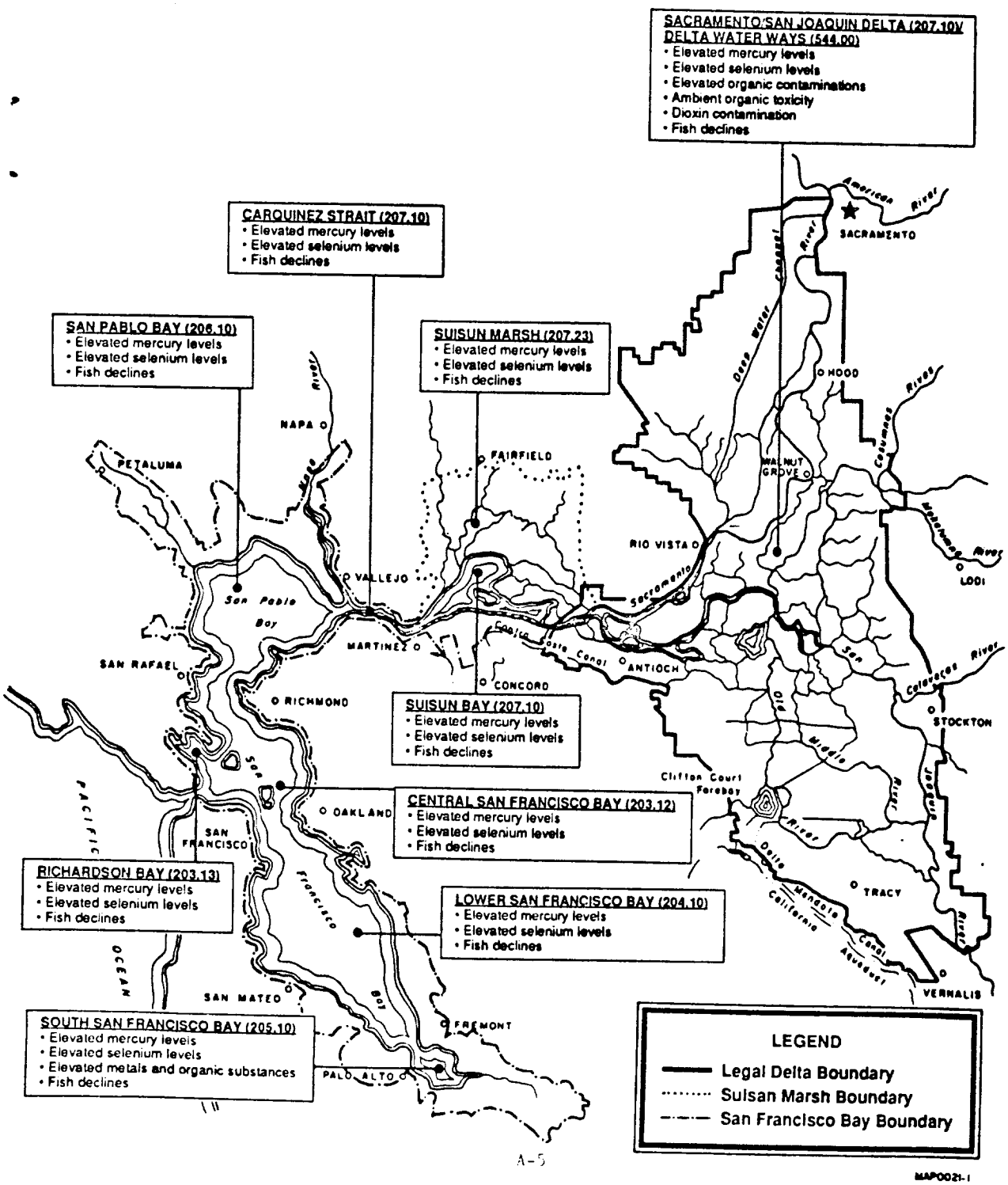
Figure 2. Water Quality Conditions of the Sacramento – San Joaquin Delta and San Francisco Bay (Bay-Delta)



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fisheries/shellfisheries. The commercial and salmon fisheries annual value, estimated at approximately $20 million, is indicative of the Delta's instream value (SWRCB 1990).

While sport fishing is considered the most popular recreation in the Bay-Delta, other activities, such as swimming, hunting, water-skiing, bird watching, and sight-seeing contribute to a significant recreational use. The Department of Water Resources (DWR) estimates the annual recreational use of the Delta at 12 million user-days (DWR 1987).

Extensive municipal, industrial, and agricultural uses are supported by water diverted from the Bay-Delta estuary. Two major water projects deliver about 6 million acre-feet to 18 million Californians and to several million acres of farmland in the San Joaquin Valley and Tulare Lake Basin (SWRCB 1990). In addition, water is delivered within the Delta boundaries to four cities, 515,000 acres of farmland, and many industries (SWRCB 1990).

The extensive instream and out-of-stream resource uses of the Bay-Delta waters justify an outstanding ranking for its resource value. Both the Central Valley Regional Board and the San Francisco Bay Regional Board gave the highest ranking to these waters based on the resource size, the number and quality of its beneficial uses, and the number of people benefited by the Bay-Delta.

Beneficial Use Impact: The San Francisco Bay Regional Board and the Central Valley Regional Board have determined that the Bay-Delta and the major tributaries that feed the Delta (the Sacramento River, the American River, and the San Joaquin River) do not fully support all of the beneficial uses of these waters. A summary of impact in Bay-Delta waters is depicted in Figure 2. Fish populations declines and the contamination of fish and waterfowl tissue are the primary water resource concerns. The DHS has posted health warnings advising the public of mercury contamination of striped bass caught in Delta waters. A similar advisory has been issued because of selenium contamination in diving ducks from San Pablo Bay, Suisun Bay, and San Francisco Bay. Fishing and shellfishing are not the only beneficial uses impacted. Declines in fishes suggest that water quality does not fully protect these organisms. Elevated concentrations of metals and organic pollutants, habitat destruction, water diversions, reverse flows in the Delta, and the introduction of exotic aquatic species all probably contribute to a lower Bay-Delta resource value. The San Francisco and Central Valley Regional Boards recommended federal listing of the Bay-Delta waters, as required in the Clean Water Act under Sections 304(l), 303(d), and 319, and 40 CFR 131.11. The justification for federal listing is given in the problem description of the WQA.

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The following water quality problems are addressed below: (1) mercury contamination, (2) selenium contamination, (3) metals contamination, (4) impact due to dioxin, (5) organic substance contamination, (6) aquatic toxicity, and (7) evidence of declines in fish population.

Mercury Contamination: Mercury accumulation in Bay-Delta fish impact the beneficial uses of ocean commercial and sport fishing. Because of the risk associated with eating mercury-contaminated fish, DHS advises the public not to eat more than four meals per month of striped bass from the Bay-Delta. Pregnant women, nursing mothers, and young children should not consume fish from these waters. The DHS advisory was based on sampling conducted in the 1970s. More recent sampling of sediment, fish, and shellfish indicate that mercury contamination has not declined (Long et al. 1988). Levels of mercury in sediment and shellfish are two or three times higher than reference stations in Bodega Bay and Tomales Bay. Although there is substantial variability in mercury contamination throughout the Bay-Delta, there are indications that mercury loading is coming from the Coast Range drainages and rivers that drain the Sierra Nevada. Samples of sediment and shellfish indicate that the periphery of the Bay-Delta near these drainages has higher mercury levels than the Central Bay (Long et al. 1988). The Sacramento River and two of its tributaries, the American River and the Feather River, receive mercury from now-abandoned gold mines in the Sierra Nevada. Fish collected from these waters periodically exceed the U. S. Food and Drug Administration (FDA) standard for protection of human health and the Median International Standard (MIS). The MIS is a median value of international standards that are established to protect human health. The State Board has used the MIS as an indicator of undesirable levels of pollutants in edible tissue. The MIS is used when an FDA standard has not been set. The South Bay receives mercury from the Guadalupe River/Coyote Creek drainage, an area where fish have been intensively sampled by the State Board's Toxic Substances Monitoring Program (TSMP). Mercury levels in these fish have consistently exceeded either the MIS or FDA standard. DHS has also posted a health advisory for fishing in this area.

Selenium Concentration: Health advisories have been issued by DHS for the consumption of diving ducks caught in Suisun Bay, San Pablo Bay, and San Francisco Bay. These advisories were based on a selenium verification study conducted by the Department of Fish and Game under contract to the State Board. The diving ducks showed elevated selenium residues, although other waterfowl and shorebirds did not have tissue burdens that warranted concern (White et al. 1988).

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Selenium in high concentration may be deleterious to diving ducks. Selenium burden in these birds is comparable to levels detected in waterfowl from Kesterson National Wildlife Refuge where embryonic abnormalities and mortalities were above normal (Phillips 1987). It should be noted that ambient water concentrations of selenium do not exceed either the EPA freshwater or saltwater criteria for protection of aquatic organisms.

The major sources of selenium to the Bay-Delta are rivers, particularly the San Joaquin River, and refinery discharge. The relative importance of these two sources is variable, depending upon discharge rates and bioavailability (Cutter 1989, Johns et al. 1988). Other point and nonpoint sources, ocean discharge and resuspension of Bay sediment probably contribute selenium to the Bay.

Metals Contamination: Metals contamination (the evidence of metals concentrations which exceed background or reference levels) is widespread and prevalent in the biota and sediments of San Francisco Bay. However, contamination alone does not indicate that designated uses are not supported. Therefore, metals contamination should be tied to risks to humans or biota. The health advisories for mercury and selenium demonstrate clearly that the Bay-Delta does not fully support fishing and hunting. Data for other metals are less strong, but infer that aquatic organisms and human health are not fully protected.

Cadmium levels in mussels from San Pablo Bay and all of San Francisco Bay consistently exceed the MIS (for protection of human health) (SWRCB 1987). Arsenic in mussels has exceeded the MIS in San Pablo Bay, and all of San Francisco Bay except the South Bay (SWRCB 1987). Lead has exceeded the MIS in the lower San Francisco Bay (SWRCB 1987). Chromium, copper, and silver concentrations are elevated in sediment and tissue throughout the Bay (Long et al. 1988; Luoma and Phillips 1988), but there is little evidence linking this contamination with deleterious effects on beneficial uses. Nickel, zinc, and arsenic are also elevated in fish tissue collected in the estuarine waters of Suisun Bay (SWRCB 1988), but again these elevated concentrations are not indicative of aquatic life impact or human health risk. Additional testing of the biological effects of these metals should help to identify protective levels of these elements in sediment and tissue.

Impact Due to Dioxin: The San Joaquin River within the Delta is impacted by pollutants in pulp mill discharge. An unwanted by-product of the bleached kraft pulp production process is a chemical group of highly persistent, toxic, and

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bioaccumulative compounds referred to as "dioxins". According to the EPA bioaccumulation study, the effluent concentration of the most toxic dioxin (2,3,7,8-TCDD) exceeds the EPA ambient water quality criterion for protection of human health by a factor of 3,800 (this assumes a cancer risk level of one in a million). It is highly unlikely that dilution could reduce the ambient dioxin concentrations to a level below the criterion. Dioxin-contaminated fish caught off the discharge at Antioch pose a cancer risk slightly greater than one in 100,000. To meet the no significant risk level as determined under Proposition 65, less than two meals of fish should be eaten per month. The Central Valley Regional Board has issued a notification under the requirements of Proposition 65.

There are two other sites within the Bay-Delta where dioxin-contaminated fish were collected in the same EPA study. A bottom-dwelling fish caught near the Port of Stockton had six times the equivalent concentration of dioxins as the bottom-dwelling fish caught off the pulp mill discharge at Antioch. Dioxin concentrations in a fish from the Lauritzen Canal were comparable to those in fish at Antioch. Unlike the Antioch samples, the pattern of dioxins found in fish at Stockton and Lauritzen Canal are characteristic of multiple sources. These sources have not been identified.

Organic Substance Contamination: Pesticide contamination occurs in the upstream drainages to the Delta, the Delta waterways, and drainages upstream of the lower San Francisco Bay. Contamination within the Bay is localized and confined to several pesticides. Thus, system-wide effects on biological resources are unlikely, although localized impact has been documented (Phillips 1987). Fish caught in the major southern drainage to the Delta, the San Joaquin River, have consistently exceeded FDA standards for protection of human health and National Academy of Science (NAS) standards for the protection of predatory organisms. Pesticides in fish tissue have exceeded the NAS standard every year from 1978 to 1987 (SWRCB, in preparation). In three of the last ten years the FDA action level has also been exceeded. The pollutants of concern - chlordane, DDT, and toxaphene - are persistent with high bioconcentration factors. While DDT was banned in the early 1970s, chlordane and toxaphene uses have only recently been discontinued.

Downstream Delta waterways have been sampled less frequently, but have periodically exceeded either FDA or NAS standards for chlordane, DDT, toxaphene, and PCBs (SWRCB, in preparation). Similar pesticide contamination has been documented in the Sacramento River. Fish have consistently exceeded the NAS guideline for chlordane, DDT and toxaphene (SWRCB, in preparation). The NAS guidelines are periodically exceeded for PCBs and chlordane in two lower San Francisco Bay drainages, San Leandro Creek and Coyote Creek.

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DDT and PCB contamination of sediments and biota occur within the Bay. DDT concentrations are extremely high in mussels and sediments from Richmond Inner Harbor/Lauritzen Canal (Long et al. 1988). Areas near Berkeley and in the Delta also have higher levels of DDT than found elsewhere in the Bay. However, overall Bay contamination is relatively insignificant. The distribution of PCBs in the Bay is highest along the Bay's periphery. Contamination occurs in the southern areas of the South Bay and areas offshore of Richmond, Oakland, and Berkeley (Long et al. 1988). Chlorinated hydrocarbon concentrations in fish near Berkeley and Oakland were associated with reduced spawning success (Long et al. 1988). Numerous other pesticides are detected in the Delta and its tributaries frequently in concentrations exceeding water quality criteria.

Aquatic Toxicity: Exceedance of the narrative water quality objective, "no toxics in toxic amounts", can be evaluated by aquatic or chronic toxicity testing. The Bay-Delta and its major upstream drainages have periodically been toxic to test organisms. The Central Valley Regional Board has conducted toxicity testing of the Sacramento River and the San Joaquin River. Significant mortality and reduced reproductive rates of test organisms were observed in a 50-mile stretch of the San Joaquin River upstream of the Delta (CVRWQCB 1988a). Although these studies did not determine the toxicants, subsequent studies indicated pesticide concentrations in excess of the EPA criteria for protection of aquatic life (CVRWQCB, 1989). These high pesticide levels may reflect periodic illegal disposal as well as normal agricultural use (CVRWQCB 1989). Copper was also above the EPA standard and could contribute to the observed toxicity.

The Sacramento River is also periodically toxic to aquatic organisms, including two Delta species, the striped bass (*Morone saxatilis*) and the crustacean, *Neomysis*, an important food source to many fishes (CVRWQCB 1988b). Agricultural pesticides from the Colusa Drain have been detected in the river at levels that could account for the toxicity.

Declines in Fish Populations: Many fish populations that live in or pass through the Bay-Delta Estuary have experienced recent declines for various reasons. The striped bass population has been monitored annually since 1959. Trends in the striped bass population are used as an indication of the health of other fish populations. Data from this monitoring program are transformed into a "striped bass index" (SBI). The SBI is a measure of the relative abundance of young striped bass in the estuary at a specific time in the populations annual life cycle. These data translate to a population which is now one-third to one-quarter of the population levels observed in the 1960s (SWRCB 1990).

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The decline in striped bass is mirrored by declines in American shad (Alosa sapidissima), natural populations of Chinook salmon (Oncorhynchus tshawytscha) and Delta smelt (Hypomesus transpacificus). The abundance of American shad, a popular sport fish, is currently one-third to two-thirds lower than historic abundance recorded in the early 1900s (SWRCB 1990). Abundance of adult shad has been relatively stable over the past two decades. However, abundance of juvenile shad varies from year to year with the strongest year classes occurring with the highest river flows during the spawning and nursery periods (SWRCB 1990). Natural populations of another sport and commercial fish, the Chinook salmon, have also declined. According to the National Marine Fisheries, the winter run of the Chinook salmon, now listed as an endangered species, has declined by 98 percent over the last twenty years. The Department of Fish and Game (DFG) now prohibits the fishing of winter-run Chinook salmon, which historically supported a commercial fishery. Present fisheries are based on the fall run. According to the DFG, the natural production of the fall run has also declined substantially. This population is artificially supported by hatchery fish. Factors that could adversely affect the anadromous salmon population include low spring flows in the Sacramento and San Joaquin Rivers, high water temperatures that are stressful to eggs and smolt, water diversions and reverse flows that transport fish away from migration routes, impediments to salmon migration, modification and loss of spawning and rearing habitat, and toxic pollutants, such as acid-mine runoff and pesticides in the Sacramento River.

The Delta smelt, a native fish endemic to the Delta, is a candidate for listing as an endangered species. The Delta smelt, once one of the most common pelagic fish in the upper estuary, has substantially declined in abundance. The population has remained at low levels for several years. The distribution of this species is now limited to the northwestern Delta, having virtually disappeared from Suisun Marsh. The Delta smelt is a pelagic fish that feeds on zooplankton caught in the freshwater-saltwater mixing zone. Factors that affect the abundance of zooplankton or the location of the mixing zone are among the factors that may affect the Delta smelt. Dr. Peter Moyle, a fish biologist with the University of California, has petitioned to include the smelt as an endangered species. The Fish and Game Commission has accepted this petition and will hear this issue later this year.

These documented declines in fish populations indicate that some instream resources are not fully supported. The State Board is evaluating the factors that will protect these populations and is developing an implementation plan as part of the Bay-Delta proceedings.

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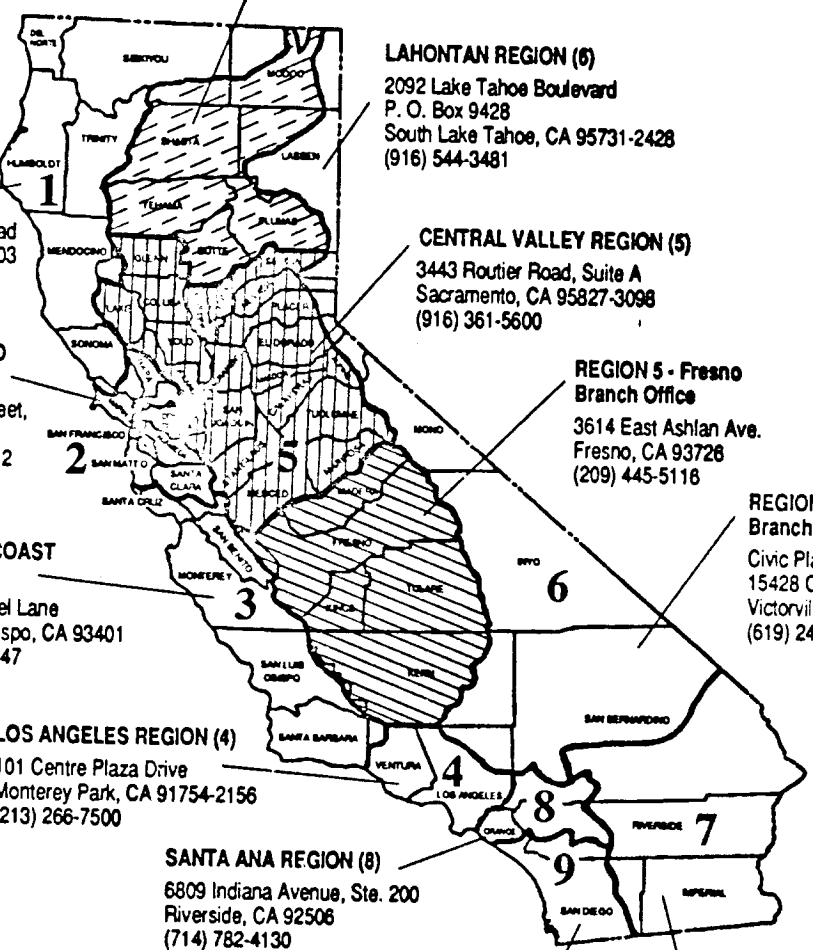

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LA Regional Water Quality Control Board

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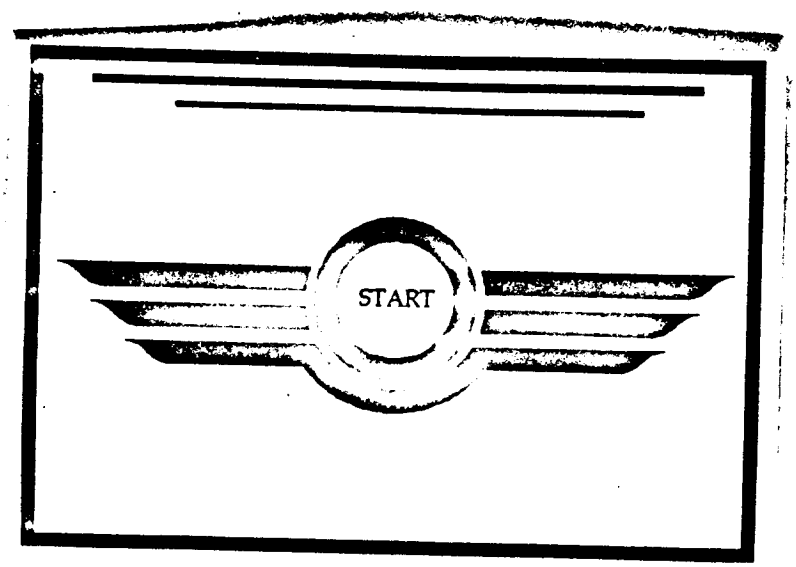
Water Quality Assessment & Documentation



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Regional Water Quality Control Board, Los Angeles Region
1996 California Water Quality Assessment - 305(b) Report
Supporting Documentation for Los Angeles Region

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Introduction

The Clean Water Act (Federal Water Pollution Control Act of 1972 as amended) requires that states submit biennial 305(b) reports that describe the status of the nation's waters. Reports from each state are compiled into the "National Water Quality Inventory Report to Congress." The nine California Regional Water Quality Control Boards prepare individual Water Quality Assessment databases that the State Water Resources Control Board compiles into the 305(b) Report.

In the past year, the United States Environmental Protection Agency (USEPA) has reviewed the 305(b) reporting process and proposed that the reports be generated on 5 or 7 year cycles that correspond to the watershed approach periods. Therefore, the 1996 California 305(b) report including the contribution from this region is most likely the last of the biennial reports.

In 1994, the Los Angeles Regional Water Quality Control Board (hereafter referred to as the Regional Board) did not update the region's Water Quality Assessment Report due to staff constraints. This 1996 report, therefore, involves a more extensive review of data than that of other regions. This 1996 report, as in previous years, will be used to target areas for water quality control programs and special funding efforts. Waterbodies listed on the 303(d) list, a subset of the 305(b) waterbodies, composed of the region's impaired waterbodies (the 303(d) list is described below), qualify for certain USEPA funding programs. In addition, the Regional Board staff plans to use the assessment information as a starting point for work with watershed stakeholder groups developing watershed plans.

In most areas, additional data will be needed in order to link impaired waterbodies with sources of pollutants. It appears that most of the pollutants causing impairments are of a nonpoint source nature. The data for the assessment

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will be used for some Board tasks, as in developing appropriate limits in certain Waste Discharge Requirements. In general, however, Regional Board staff do not intend to use the assessment or the impairments noted on the 303(d) list as a basis for recommending new, advanced, and/or upgraded treatment technologies for POTWs. Rather, these issues will be considered in greater depth by stakeholders within the context of individual watersheds.

In this report, six types of waterbodies are assessed: inland surface waterbodies (including lakes and wetlands), estuaries, nearshore zones, beaches, bays and harbors, and groundwater basins. In this 1996 assessment cycle, most of the major rivers and creeks in the Los Angeles Region are assessed but many small tributaries, small coastal streams, channel island streams are not assessed. Waterbodies that are not frequently sampled (but do have some data) are not assessed in detail at this time due to limited staff resources.

Data

For this report, Regional Board staff supplemented Regional Board ambient water quality data with data from a large number of agencies. These agencies include: United States Geological Survey, Ventura County Flood Control District, Los Angeles County Department of Public Works, City of Thousand Oaks, San BuenaVentura, City of Pasadena, City of Los Angeles, Metropolitan Water District of Southern California, Water Replenishment District of Southern California, Central and West Basin Municipal Water Districts, and local water purveyors. Self-monitoring data was used from major dischargers in the Ventura and Calleguas Creek watersheds (these two areas were Regional Board "target watersheds" in 1995-1996). In general, six years of water quality data (1988 to present) were used for this assessment; for bioaccumulation and sediment toxicity data, up to ten years of data were used. Most of the water column and sediment data were generated from grab samples. In addition to data, information from various articles and reports were used for the assessment. These reports are cited in the attached Data Summary Tables.

The data for the assessment were compiled and organized by watershed. Watersheds in this assessment include:

Coastal Ventura County
Ventura River
Santa Clara River
Calleguas Creek
Santa Monica Bay
Southern Los Angeles County (includes Dominguez and Los Cerritos Channels)
Los Angeles River
San Gabriel River
Ventura County coastal features
Los Angeles County coastal features
Channel Islands (Santa Catalina, Santa Cruz, San Nicholas, Santa Barbara, San Clemente)

Data used for this assessment were limited; a compete suite of water quality parameters were not available for measurement against appropriate water quality standards for each waterbody (e.g., all of the Safe Drinking Water Act constituents or USEPA priority pollutants). **Therefore, it is not correct to assume that constituents *not* cited in the assessment are *not* causing water quality problems.**

Assessment methodology

The Regional Board's water quality assessment follows USEPA (1995) guidance as outlined in the *Guidelines for Preparation of the 1996 State Water Quality Assessments (305(b) Reports)*. The guidance specifies that seven broad beneficial use categories be assessed under the federal guidance; the federal beneficial uses in this assessment report and the corresponding State beneficial uses are shown in Table 1.

Each of these federal beneficial uses is assessed according to the following designations: fully supporting, fully supporting but threatened, partially supporting, not supporting, and not assessed. The fully supporting but threatened category relates to waterbodies where a use is supported but may not be in the future (because of anticipated sources or adverse pollution trends) unless pollution prevention or control action is taken . Waterbodies that are assessed as partially supporting and not supporting are considered "impaired." In addition, the terms "partially supporting" and "not supporting" are federal terms and roughly equate to "intermediate" and "impaired" terms used by the state in preparing previous water quality assessments for the Los Angeles Region.

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Table 1. Correlation between California Beneficial Uses and USEPA 305(b) Beneficial Uses.

State Beneficial Use as designated in 1994 Basin Plan	Federal Beneficial Use assessed in this report
Commercial and sport fishing	Fish consumption
Aquaculture	
Shellfish Harvesting	Shellfish harvesting
Warm freshwater habitat	Aquatic life use support
Cold freshwater habitat	
Inland saline water habitat	
Freshwater replenishment	
Estuarine habitat	
Wetland habitat	
Marine habitat	
Wildlife habitat	
Preservation of biological habitat	
Rare, threatened, or endangered species	
Migration of aquatic organisms	
Spawning, reproduction, and/or early development	
Water contact recreation	Swimming or primary contact recreation use
Non-contact recreation	Secondary contact recreation use
Municipal and domestic supply	Drinking water supply (raw data)
Ground water recharge *(where appropriate)*	
Agricultural supply	Agriculture
Ground water recharge *(where appropriate)*	
Hydropower Generation	Not assessed in this report
Navigation	
Industrial process supply	
Industrial service supply	

When comparing data against standards, the "worst case approach" is used. That is, if one parameter, such as temperature, ammonia, or an organic chemical, indicates impairment for a particular use, the waterbody is designated as impaired for the use affected by this parameter. For example, a waterbody that is not supporting the aquatic life use due to high ammonia concentrations and is partially supporting the use due to elevated metal concentrations would be given an overall classification of "not supporting." Exceptions to this are as follows:

1. For the drinking water use, if constituents (with the exception of volatile organic chemicals) exceed *secondary standards* (i.e., secondary MCLs), and thus are not supporting the use, the overall use is classified as "fully supporting but threatened." If constituents less frequently exceed secondary standards and thus are partially supporting the use, the overall use is classified as "fully supporting."

2. For the contact recreation use, if constituents exceed *secondary drinking water or taste and odor standards* (i.e., pH, turbidity, color, ammonia) and thus are not supporting the use, the overall use is classified as "partially supporting." If these constituents less frequently exceed the secondary standards and thus are partially supporting the use, the overall use is classified as "fully supporting but threatened."

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3. For the secondary contact recreation use, If *color or turbidity* are elevated and are not or are partially supporting the use, the overall use is classified as "fully supporting but threatened" because these parameters may be seasonally controlled and further observations are needed to determine the definitive impairment status.

Each watershed in the region is divided into waterbody reaches (a specified segment of river or creek) and lakes or reservoirs that match those designated in the 1994 Water Quality Control Plan (hereafter referred to as Basin Plan). For this report, some individual reaches are combined into longer reaches while other reaches are listed as "not assessed" due to lack of data. Beneficial uses in each reach are assessed and are given a number of miles (or square miles/acreage for lakes and groundwater basins) that are supporting that use (e.g., 3.5 miles of the xx reach fully supports the agriculture use but 2.5 miles only partially support the aquatic life use support). Data collection stations are located within each reach and cover areas no more than 25 miles but usually no more than a few miles. In this 1996 report, particular emphasis is placed on the Ventura River and Calleguas Creek watersheds because they are the 1995-1996 Regional Board targeted watersheds. The main stem of the Los Angeles River is also assessed in detail because it will be a targeted watershed in the 1996-1997 watershed cycle. Ocean water data are not assessed in this report other than from seafood consumption advisories and review of literature.

In the assessment, potential sources of contamination are identified to the level that is known at this time. For most waterbodies, data were not sufficient to link specific sources to specific pollutants so this is not done in the 1996 assessment. In future assessments for this region, linkage may be possible. Sources are listed for a waterbody that do not contribute necessarily to the listed "causes" of impairment. These potential sources are listed in order to assist staff performing future assessments; incomplete data for waterbodies precluded making a complete list of causes of impairments at this time (many waterbodies have not been analyzed for metals and/or priority pollutants).

Some beneficial uses, notably agriculture and in some cases aquatic life and contact recreation, are impaired due to constituents that have naturally high concentrations within a watershed or subwatershed. Examples of these constituents include total dissolved solids, chlorides, boron and sulfate that are leached from rock formations. In some lakes and estuaries, coliform counts may be high due to a large population of waterfowl. Not enough information is available at this point to classify any of the affected uses as "unattainable". Under the sources column (or in the sources filed in the database), "natural source" is listed for these waterbodies.

Ranking of relative contributions of each cause and source to the overall impairment of a waterbody is classified with slight (S), moderate (M) and high (H) magnitude. For example, contaminant sources for a waterbody that include natural sources, urban runoff and municipal effluent would all be classified as "moderate" because they all contribute to some degree. If there is only one source listed then it is considered to be a high magnitude source contributing to the impairment.

Assessments in this report are distinguished as either "evaluated" or "monitored". "Evaluated" assessments are based on information about land uses, location of sources, predictive modeling, best professional judgement, as well as the use of older data. "Monitored" assessments are based on recent ambient water quality, sediment quality, bioaccumulation and toxicity data that are collected relatively frequently. Most of the assessments in the 1996 cycle are considered "monitored".

Criteria used for assessing each Surface Water Beneficial Use

The USEPA *Guidelines for Preparation of the 1996 State Water Quality Assessments (305(b) Reports)* provides formulas for conducting assessment of the six 305(b) beneficial uses. These guidelines are described below along with the criteria or standards against which the data is compared. References for standards are included in each section.

Aquatic Life Use Support

Aquatic life use support can be assessed based on *biological and habitat factors* or on *physical and chemical data*.

Biological/habitat assessments
Biological/habitat assessments in this region are limited to reported or observed sediment and erosion impacts and personal communication with federal Fish and Wildlife, state Fish and Game biologists and other local experts. The Regional Board does not have resources at this time to perform detailed field biological/habitat assessments. USEPA's application of biological/habitat assessments are described in table 2. In addition, the Regional Board used best

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professional judgement to indicate a few localized habitat-related problems such as areas of high sedimentation, fish kills, barriers to fish migration, and impairment of benthic communities. Information from published documents such as the Santa Monica Bay State of the Watershed Report (1993) was also used.

Table 2. Water Quality Assessment guidelines

Assessment designation	Assessment Guideline
Aquatic life use support: biological and habitat factors	
Fully supporting	Reliable data indicates functioning, sustainable biological communities (e.g., macro-invertebrates, fish, or algae) none of which has been modified significantly beyond the natural range of the reference condition.
Partially supporting	At least one assemblage (e.g., macro-invertebrates, fish, or algae) indicates less than full support with slight to moderate modification of the biological community noted. Other assemblages indicate full support.
Not supporting	At least one assemblage indicates nonsupport. Data clearly indicate severe modification of the biological community.
Aquatic life use support: water column toxic substances- *priority pollutants, chlorine, ammonia*	
Fully supporting	For any one pollutant, no more than 2 violations of chronic criteria (acute if no chronic criteria available) within a 6 year period based on at least 20 grab or 1-day composite samples. If fewer than 20 samples are available, then best professional judgement is used considering the number of pollutants having violations and the magnitudes of the exceedence(s).
Partially supporting	For any one pollutant, criteria exceeded more than twice within a 6-year period, but in ≤ 10 percent of samples.
Not supporting	For any one pollutant, criteria exceeded in > 10 percent of samples.
Aquatic life use support: water column conventional constituents and stressors- *dissolved oxygen, temperature, chloride, pH*	
Fully supporting	For any one pollutant, criteria exceeded in ≤ 10 percent of measurements.
Partially supporting	For any one pollutant, criteria exceeded in 11 to 25 percent of measurements.
Not supporting	For any one pollutant, criteria exceeded in > 25 percent of measurements.
Primary contact and non-contact recreation use and Agriculture use: Taste and Odor (includes secondary drinking water MCLs) and aesthetic stressors	
Fully supporting	For any one pollutant or stressor, criteria exceeded in ≤ 10 percent of measurements or observations.
Partially supporting	For any one pollutant, criteria exceeded in 11 to 25 percent of measurements or observations.
Not supporting	For any one pollutant, criteria exceeded in > 25 percent of measurements or observations.
Coliform bacteria data for Primary and Secondary Contact (inland surface waterbodies) recreation use	
Fully supporting	Criterion 1 and/or Criterion 2 met. (see table 7)
Partially supporting	For contact recreation: Criterion 1 met but not more than 10 percent of samples exceed 2,000 per 100 mL. For non-contact recreation, not more than 10 percent of the samples exceed 10,000 per 100 mL.
Not supporting	Neither criterion met.
Contact Recreation: beach coliform data	
Fully supporting	For entire data set, wet and dry weather fecal coliform standards are exceeded 15% or less times on average and wet and dry weather total coliform data are exceeded 20% or less times on average.
Partially supporting	At least one of the following is exceeded: wet and dry weather fecal coliform greater than 15% and wet and dry weather total coliform greater than 20%.
Not supporting	For entire data set, wet and dry weather fecal coliform standards are exceeded more than 15% or wet and dry weather total coliform data are exceeded more than 20%.

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Assessment designation	Assessment Guideline
Primary Recreation Contact Use: Beach and inland bathing area closure	
Fully supporting	No bathing area closures or restrictions in effect during past 6 years.
Partially supporting	On average, one bathing area closures per year of less than 1 week's duration.
Not supporting	On average, one bathing area closure per year of greater than 1 week's duration, or more than one bathing area closure per year.
Fish and shellfish consumption use: advisories	
Fully supporting	No fish or shellfish restrictions or bans are in effect.
Partially supporting	"Restricted consumption" of fish or shellfish in effect. Restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish or shellfish species.
Not supporting	"No consumption" of fish or shellfish ban in effect for general population, or a subpopulation that could be at potentially greater risk, for one or more fish or shellfish species; or commercial fishing or shellfishing ban in effect.
Primary contact and non-contact recreation: aesthetics stressor-field observations	
Fully supporting	Criteria exceeded in less than or equal to 10 % of observations.
Partially supporting	Criteria exceeded in 11 to 25 % of observations
Not supporting	Criteria exceeded in greater than 25% of observations.
Drinking water use: water quality data	
Fully supporting	No contaminants where the median concentration exceeds the state water quality standard. No restrictions (i.e., no source water closures or advisories, no waters requiring more than conventional treatment to enable drinking water use)
Fully supporting but threatened	No contaminants where the median concentration exceeds the state water quality standards. Increased monitoring imposed on public water supplies supplied by the waterbody (due to previous detections of contaminants that triggered an increased monitoring frequency) or potential for water quality degradation by contaminants that are known to be used or present in the watershed or basin.
Partially supporting	No contaminants where the median concentration exceeds the state water quality standards. One or more drinking water source advisories lasting greater than 30 days per year or public water supplies supplied by the waterbody require more than conventional treatment due to contaminants concentrations in source water that may adversely affect treatment costs or the quality of finished water (e.g., due to taste, odor, turbidity, dissolved solids, etc.).
Not supporting	One or more contaminants where the median concentration exceeds the state water quality standards. One or more contamination-based closures of a drinking water source.
Assessment guideline for cases where there are fewer than 20 data points (all uses)	
Not supporting	For constituents where there are <20 and ≥ 3 samples, more than 40% of the values exceed the standard.

Physical and chemical water column data

Most of the aquatic life use support assessments in the Los Angeles Region are based on physical and chemical water, as well as sediment, toxicity and bioaccumulation data (described below). Physical and chemical data (water column) includes toxic substances (priority pollutants, chlorine and ammonia) and conventional constituents or stressors (dissolved oxygen, pH, and temperature). The assessment guidelines, based on USEPA's guidance document, are shown in table 2.

Criteria for aquatic life use support are drawn from the region's 1994 Basin Plan and the USEPA Water Quality Criteria for Water (1986 and updates). Relevant criteria are listed in tables 3 and 4. Note that the metals data are compared "total recoverable" standards.

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Table 3. Freshwater Aquatic life use support standards (water column)

Note: The most stringent criteria are selected. Constituents are only listed if samples used for assessment had values above detection limits.

Reference: US Environmental Protection Agency National Ambient Water Quality Criteria 1986 with updates, except where noted.

Constituent or Stressor	Status	Criteria (ppb unless noted)
Inorganic Constituent or other stressor		
Aluminum (pH: 6.5 - 9.0)	4-day average	87
Ammonia	4-day average	see table d
Antimony (trivalent)	4-day average	30 (Proposed)
Arsenic	4-day average	190
Cadmium* (dissolved)	4-day average	[e(0.7852[ln(hardness)]-3.490)] x [1.101672-([ln(hardness)] x [0.041838])]
Cadmium* (total recov'ble)	4-day average	[e(0.7852[ln(hardness)]-3.490)]
Chloride (as NaCl)	4-day average	230
Residual chlorine, total	4-day average	11
Chromium VI	4-day average	10
Copper* (dissolved)	4-day average	(e(0.8545[ln(hardness)]-1.465)) x (0.960)
Copper* (total recov'ble)	4-day average	(e(0.8545[ln(hardness)]-1.465))
Cyanide	4-day average	5.2
Lead* (dissolved)	4-day average	(e(1.273[ln(hardness)]-4.705)) x (1.46203-([ln(hardness)] x [0.145712]))
Lead* (total recoverable)	4-day average	(e(1.273[ln(hardness)]-4.705))
Mercury (total recoverable)	4-day average	0.012
Nickel* (dissolved)	4-day average	(e(0.8460[ln(hardness)]+1.1645)) x (0.997)
Nickel* (total recoverable)	4-day average	(e(0.8460[ln(hardness)]+1.1645))
Oxygen, dissolved (1994 Basin Plan)		At a minimum (see specifics below), the mean annual dissolved oxygen concentration of all waters shall be greater than 7 mg/L, and no single determination shall be less than 5.0 mg/L, except when natural conditions cause lesser concentrations. The dissolved oxygen content of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges. The dissolved oxygen content of all surface waters designated as COLD shall not be depressed below 6 mg/L as a result of waste discharges. The dissolved oxygen content of all surface waters designated as both COLD and SPWN shall not be depressed below 7 mg/L as a result of waste discharges. For that area known as the Outer Harbor area of Los Angeles-Long Beach Harbors, the mean annual dissolved oxygen concentrations shall be 6.0 mg/L or greater, provided that no single determination shall be less than 5.0 mg/L.
pH	Instantaneous maximum	6.5 - 9.0 units
Selenium (total recoverable)	4-day average	5.0
Silver* (dissolved)	1-hour average	(e(1.72[ln(hardness)]-6.52)) x (0.85)
Silver* (total recoverable)	1-hour average	(e(1.72[ln(hardness)]-6.52))

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Constituent or Stressor	Status	Criteria (ppb unless noted)
Temperature *(1994 Basin Plan)*		The natural receiving water temperature of all regional waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses. Alterations that are allowed must meet the requirements below. For waters designated WARM, water temperature shall not be altered by more than 5 °F above the natural temperature. At no time shall these WARM-designated waters be raised above 80 °F as a result of waste discharges. For waters designated COLD, water temperature shall not be altered by more than 5 °F above the natural temperature.
Zinc (dissolved)	4-day average	e{0.8473[ln(hardness)]+0.7614) x (0.986)
Zinc (total recoverable)	4-day average	e{0.8473[ln(hardness)]+0.7614)
		Organic Constituents
Aldrin	Instantaneous maximum	3
Benzene	Acute toxicity	5300
Benzene hexachloride (g-BHC; Lindane)	24-hour average	0.08
Bromodichloromethane **	Acute toxicity	11,000 (sum of halomethanes)
Bromoform**	Acute toxicity	11,000 (sum of halomethanes)
Carbon tetrachloride	Acute toxicity	35,200
Chlordane	24-hour average	0.0043
Chloroform	Chronic toxicity	1240
DDD	Acute toxicity	0.6
DDE	Acute toxicity	1050
DDT	24-hour average	0.001
Dibromochloromethane**	Chronic toxicity	11,000 (sum of halomethanes)
1,1-Dichloroethylene (1,1-DCE)†	Acute toxicity	11,600 (sum of dichlorethylenes)
cis-1,2-Dichloroethylene†	Acute toxicity	11,600 (sum of dichlorethylenes)
trans- 1,2-Dichloroethylene†	Acute toxicity	11,600 (sum of dichlorethylenes)
Di(2-ethylhexyl)pthalate	4-day average	360
Di(n-octyl) phthalate	Chronic toxicity	3
Endrin	24-hour average	0.0023
Ethylbenzene	Acute toxicity	32,000
Heptachlor	24-hour average	0.0038
Heptachlor epoxide	24-hour average	0.0038
Toluene	Acute toxicity	17,000
1,1,1-Trichloroethane (1,1,1-TCA)	Acute toxicity	18,000
Trichloroethylene (TCE)	Acute toxicity	45,000

Criteria for metals based on hardness use actual hardness at time of sampling or if not available, use average hardness for reach.** Halomethanes
† Dichlorothylenes

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Table 4. Four-day Average Concentration for Ammonia*

Reference: USEPA: Revised tables for determining average freshwater ammonia concentrations. Office of Water Memorandum, July 30, 1992.

pH	Temperature °C												
	0	5	10	15	20	25	30	0	5	10	15	20	25	30
	Un-ionized ammonia (mg/liter NH_3) for waters designated as COLD							Un-ionized ammonia (mg/liter NH_3) for waters designated as WARM						
6.50	0.0008	0.0011	0.0016	0.0022	0.0022	0.0022	0.0022	0.0008	0.0011	0.0016	0.0022	0.0031	0.0031	0.0031
6.75	0.0014	0.0020	0.0028	0.0039	0.0039	0.0039	0.0039	0.0014	0.0020	0.0028	0.0039	0.0055	0.0055	0.0055
7.00	0.0025	0.0035	0.0049	0.0070	0.0070	0.0070	0.0070	0.0025	0.0035	0.0049	0.0070	0.0099	0.0099	0.0099
7.25	0.0044	0.0062	0.0088	0.0124	0.0124	0.0124	0.0124	0.0044	0.0062	0.0088	0.0124	0.0175	0.0175	0.0175
7.50	0.0078	0.0111	0.0156	0.022	0.022	0.022	0.022	0.0078	0.0111	0.0156	0.022	0.031	0.031	0.031
7.75	0.0129	0.0182	0.026	0.036	0.036	0.036	0.036	0.0129	0.0182	0.026	0.036	0.051	0.051	0.051
8.00	0.0149	0.021	0.030	0.042	0.042	0.042	0.042	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
8.25	0.0149	0.021	0.030	0.042	0.042	0.042	0.042	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
8.50	0.0149	0.021	0.030	0.042	0.042	0.042	0.042	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
8.75	0.0149	0.021	0.030	0.042	0.042	0.042	0.042	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
9.00	0.0149	0.021	0.030	0.042	0.042	0.042	0.042	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
	Total ammonia (mg/liter NH_3) for waters designated as COLD							Total ammonia (mg/liter NH_3) for waters designated as WARM						
6.50	3.0	2.8	2.7	2.5	1.76	1.23	0.87	3.0	2.8	2.7	2.5	2.5	1.73	1.23
6.75	3.0	2.8	2.7	2.6	1.76	1.23	0.87	3.0	2.8	2.7	2.6	2.5	1.74	1.23
7.00	3.0	2.8	2.7	2.6	1.76	1.23	0.87	3.0	2.8	2.7	2.6	2.5	1.74	1.23
7.25	3.0	2.8	2.7	2.6	1.77	1.24	0.88	3.0	2.8	2.7	2.6	2.6	1.75	1.24
7.50	3.0	2.8	2.7	2.6	1.78	1.25	0.88	3.0	2.8	2.7	2.6	2.6	1.76	1.25
7.75	2.8	2.6	2.6	2.4	1.69	1.17	0.84	2.8	2.6	2.6	2.4	2.3	1.66	1.18
8.00	1.82	1.70	1.62	1.57	1.10	0.78	0.56	1.82	1.70	1.62	1.57	1.66	1.10	0.79
8.25	1.03	0.97	0.93	0.90	0.64	0.49	0.33	1.03	0.97	0.93	0.90	0.90	0.64	0.47
8.50	0.56	0.56	0.53	0.53	0.38	0.29	0.21	0.56	0.56	0.53	0.53	0.53	0.39	0.29
8.75	0.34	0.32	0.31	0.31	0.23	0.173	0.135	0.34	0.32	0.31	0.31	0.32	0.24	0.180
9.00	0.195	0.189	0.189	0.195	0.149	0.116	0.094	0.195	0.189	0.189	0.195	0.21	0.163	0.133

* To convert these values to mg/liter N, multiply by 0.822.

Sediment chemistry and toxicity, water column toxicity, benthic community and bioaccumulation data

Lacking USEPA guidelines, the Regional Board developed assessment guidelines for sediment chemistry and toxicity, benthic community and bioaccumulation data for purposes of this water quality assessment report. These general guidelines are described below.

Virtually all of this Region's *sediment toxicity* data has been generated through the Bay Protection & Toxic Cleanup Program (BPTCP). The most commonly used sediment toxicity test is the amphipod (a crustacean) survival test. A review of all the data for the region reveals the number of tests in which less than 60% of the amphipods survive is much less than the number of tests in which at least 60% or more amphipods survive. Consequently, the "significant toxicity" line is drawn at 60% survival. Below that number it's more likely that impairment is occurring (especially since existing benthic data at those sites support this). No statistical analyses or comparison to reference sites were done, however. This is a qualitative analysis utilizing Best Professional Judgement. Also, no conclusions are drawn based solely on one-time toxicity testing.

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Table 5. Sediment and Bioaccumulation chemistry probable "background" levels

Constituent	Sediment Chemistry: Probable "background" levels in the Region	Bioaccumulation: Probable "background" levels in the Region
PAHs (polycyclic aromatic hydrocarbons)	1 ppm	ND
chlordane	100 ppb	100 ppb
PCBs	200 ppb	300 ppb
DDT	200 ppb	300 ppb
zinc	200 ppm	250 ppm
lead	50 ppm	15 ppm
copper	100 ppm	50 ppm
chromium	75 ppm	5 ppm
TBT (tributyltin paint)	1 ppm	ND

Note: older TBT numbers in the database are almost certainly obsolete; levels have dropped dramatically since 1988 when TBT use prohibitions started, also, TBT degrades fairly quickly.

Listed in table 5 are the region's probable "background" numbers for the more common *sediment chemistry* pollutants. These numbers are approximate and based on pollutant levels found in areas removed from direct point sources where impacts do not appear to be occurring in the benthic community. Often background concentrations are due to natural sources or are due to persistent organic chemicals that have not yet biodegraded completely. The background levels were determined by evaluating data from areas that are remote from point sources and significant nonpoint sources.

For *bioaccumulation in sediment*, "background" numbers are also utilized (table 5). These may be adjusted up or down depending on the type of waterbody (commercial port vs. coastal lagoon).

For *bioaccumulation in aquatic organisms*, data from the State Mussel Watch and Toxic Substances Monitoring program were used. These two state programs provide information about the occurrence of toxic substances in fresh, estuarine, and marine waters through analysis of fish, mussels and other aquatic life (referred to as "tissue" in this report). Ten metals and approximately 45 pesticides and other organic chemicals are analyzed from the tissue of these organisms. Not every sample is analyzed for all metals or organic chemicals. For this 305(b) assessment, Mussel Watch data were used only to evaluate the aquatic life use. Toxic Substances Monitoring data were used to evaluate both the fish consumption and the aquatic life use.

Bioaccumulation data collected from tissue are compared to criteria such as Maximum Tissue Residue Levels (MTRLs), U. S. Food and Drug Administration (FDA) action levels, Median International Standards (MIS), and the National Academy of Sciences (NAS) recommended guidelines for predator protection (table 6).

Fish tissue Elevated Data Level (EDL) values are an internal state comparative measure that ranks a given concentration of a particular substance with previous data from the state programs. EDLs are calculated by ranking all of the results for a given chemical from the highest concentration measured down to and including those records where the chemical was not detected. The 85th percentile (EDL85) was chosen as an indication that a chemical is elevated from the median and the 95th percentile (EDL95) was chosen to indicate values that are highly elevated. EDLs were used in the assessment as follows: If no other constituents exceed standards, but if one or two constituents were above the EDL85 or EDL95, then those constituents are listed as "fully supporting but threatened." If three or more constituents are above the EDL then those constituents are listed as "partially supporting".

For *water column toxicity*, the Basin Plan (1994) objective of "no less than 70% in a single test and no less than a mean of 90% in any three consecutive tests" is used.

BPTCP *benthic community* data was collected in Los Angeles and Long Beach Harbor (LA/LB Harbor) and Alamitos Bay. Extrapolations were made from the data, mostly regarding the presence of pollutant-tolerant species. Areas

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Table 6. Standards used for tissue data (State Mussel Watch Toxic Substances Monitoring Programs).

Constituent	Standards-ppb (see text for explanation of abbreviations)				
	NAS Recommended guideline for freshwater fish	FDA Action level for freshwater and marine fish	MTRLs for inland surface waters	MTRLs for ocean waters	MIS for freshwater fish and marine shellfish (range)
Mercury	500	1000	1000	-	100-1000
DDT (total)	1000	5000	32.0	9.1	-
PCBs	500	2000	2.2	-	-
Aldrin	100	300	0.05	0.1	-
Dieldrin	100	300	0.65	0.2	-
Endrin	100	300	3000	-	-
Heptachlor	100	300	1.8	8.1	-
Heptachlor epoxide	100	300	0.8	-	-
Chlordane	100	300	1.1	0.32	-
Lindane	100	-	2.5	-	-
Hexachlorocyclohexane	100	-	alpha: 0.5 beta: 1.8	-	-
Endosulfan	100	-	250	-	-
Toxaphene	100	5000	8.8	2.75	-
Arsenic	-	-	200	-	100-5000
Hexochlorobenzene (HCB)	-	-	6.0	0.6	-
PCBs	-	-	2.2	0.6	-
PAHs	-	-	0.08	-	-
Pentachlorophenol (PCP)	-	-	3.1	-	-
Cadmium	-	-	640	-	50-2000
Nickel	-	-	28000	-	-
Chromium	-	-	-	-	1000
Copper	-	-	-	-	10000-100000
Lead	-	-	-	-	500-10000
Zinc	-	-	-	-	40000-100000

distinctly different in benthic community composition from the "norm" for that kind of waterbody and containing large numbers of pollutant-tolerant species are designated as "not supporting".

BPTCP *benthic community* data was collected in Los Angeles and Long Beach Harbor (LA/LB Harbor) and Alamitos Bay. Extrapolations were made from the data, mostly regarding the presence of pollutant-tolerant species. Areas distinctly different in benthic community composition from the "norm" for that kind of waterbody and containing large numbers of pollutant-tolerant species are designated as "not supporting".

Combining these different data types (sediment chemistry and toxicity, water column toxicity, benthic community and bioaccumulation) into an overall assessment for each waterbody requires balancing quantity of evidence and type of evidence. Using Los Angeles/Long Beach Harbor BPTCP data as an example, most areas of the harbor where background levels of contaminants occur exhibited moderate to low sediment toxicity and, at most, a marginally

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impacted benthic community. Many areas are contaminated with metals and, as BPTCP work has revealed (and expert advice from the program's Scientific Review & Planning Committee supports), generally metals are not bio-available (they tend to bind with the usually generous amounts of sulfides in the sediments) and don't contribute to sediment toxicity. Sediments contaminated with even high levels of metals, but not with organic chemicals, will usually not result in adverse effects. The chief concern is organic chemicals but even here impacts appear minimal at background pollutant levels.

A weight-of-evidence approach, heavily influenced by best professional judgement, is used to judge aquatic life beneficial use support for coastal areas. Ideally, this approach would utilize field-replicated triad data (benthic, sediment toxicity, and sediment chemistry) collected at the same time at least twice over some fairly short time period and use a reference site for comparison purposes. Instead, what is mostly available are data collected under different programs, measuring different media, at different sites, over a number of years, without good reference sites for statistical purposes.

At least two data points are desired for any particular type of data. Thus, one toxicity test result (lab-replicated) is revealing but not necessarily useful without some other kind of information. For example, high sediment toxicity in one test conducted under the BPTCP combined with low sediment contamination and bioaccumulation found through the SMWP would not necessarily lead to assigning the waterbody a "not supporting" status. There are natural causes of toxicity that may be transient. If sampling occurred during rainy weather, other unknown (and often non-anthropogenic) factors may be involved. Test results (especially effects information) obtained during aberrant conditions really shouldn't be used to define the status of a waterbody.

As another example, past SMWP data may show low to moderate PCBs and PAHs in sediment and tissue and more recent sediment toxicity testing may result in less than 60% survival on two sampling dates. The SMWP data may not be obviously high but the toxicity data point out a problem. Benthic data would be helpful, but based on toxicity, bioaccumulation, and sediment chemistry, the waterbody would be designated not fully supporting aquatic life beneficial uses. "Good" effects data are weighed more heavily than simple measurements such as sediment pollutant levels or tissue bioaccumulation (within the limitations described earlier). The latter measurement isn't an effect, it's just an indicator of the presence of pollutants. Unless National Academy of Sciences tissue guidelines are exceeded, effects are not expected.

For SWMP data, "background level guidelines" apply only to transplanted California mussels. Other organisms used by the program include transplanted freshwater clams, resident California mussels, transplanted bay mussels, and resident bay mussels. These bioaccumulate at different rates (especially freshwater clams) and are hard to compare to each or to a guideline.

Primary Contact Recreation Use

One of the goals of the Clean Water Act is that all waterbodies of the nation be "swimmable." Many of the waterbodies of the Los Angeles region are designated as "swimmable" or usable for water-contact recreation. Some of these designated waterbodies, however, are inaccessible due to gates and fences installed for flood control or drinking water reservoir protection purposes. In spite of this, residents, homeless individuals and occasionally children often gain access and use these areas. Therefore, all waterbodies with a water-contact recreation use have been included in this report. On the 303(d) list table, access restrictions are indicated with a footnote.

Assessment of primary contact recreational uses is based on closure data for bathing areas, coliform bacteria data, hazardous substances and aesthetics. Bathing closure data was acquired from the Los Angeles and Ventura County Departments of Health Services. Guidelines for assessments and coliform bacteria standards and assessment guidelines are shown in Table 7. Inland surface waterbody coliform data is not collected on a frequent basis; only fecal coliform standards are used. Dry weather beach data are collected frequently, weekly or daily, in the surfzone by major ocean dischargers and by the Los Angeles County Department of Health Services. Wet weather coliform data is collected during storms. These data are compared to Ocean Plan standards and include both total and fecal coliform.

Hazardous substances in water and bottom sediment are evaluated on a case by case basis. Secondary Drinking water MCLs (table 8) related to contact recreation are also assessed. Additional factors such as persistent scum, oily films, excessive algae growth, significant trash, and persistent observations of non-natural foam and/or odor were also considered (tables 2 and 9).

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Table 7. Indicator Bacteria Criteria for Primary and Secondary contact recreation use and Shellfish Consumption

Assessment designation	Assessment Guideline
Criterion	Primary Contact Recreation (Inland)
Criterion 1	Fecal coliform concentration shall not exceed a log mean of 200/100 ml (based on a minimum of not less than four samples for any 30-day period) *[Note for this Region, we do not have weekly data for most of the waterbodies so this criterion is not used]*
Criterion 2	No more than 10 percent of total samples during any 30-day period exceed 400/100 ml. *[Note: used entire data set for each reach rather than 30-day period]*
Criterion	Secondary Contact Recreation(Inland)
Criterion 1	Fecal coliform concentration shall not exceed a log mean of 2000/100 ml (based on a minimum of not less than four samples for any 30-day period) *[Note for this Region, we do not have weekly data for most of the waterbodies o this criterion is not used]*
Criterion 2	No more than 10 percent of total samples during any 30-day period exceed 4000/100 ml. *[Note: used entire data set for each reach rather than 30-day period]*
	Primary Contact Recreation (beaches)
Total coliform	Samples of water from each sampling station shall have a density of total coliform organisms less than 1000 per 100 ml; provided that not more than 20 percent of the samples at any sampling station, in any 30-day period, may exceed 1000 per 100 ml, and provided further that no single sample when verified by a repeat sample taken within 48 hours shall exceed 10,000 per 100 ml.
Fecal coliform	The fecal coliform density based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean 200 per 100 ml nor shall more than 10 percent of the total samples during any 60-day period exceed 400 per 100 ml.
Criterion	Shellfish consumption
Criterion 1	In all waters where shellfish can be harvested for human consumption, the median total coliform concentration throughout the water column for any 30-day period shall not exceed 70/100 ml. *[Note for this Region, we do not have weekly data so this criterion is not used]*
Criterion 2	No more than ten percent of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used.

Secondary Contact Recreation Use

Most of the waterbodies of the region are designated for non-contact recreational use. This use includes activities where water is not normally ingested. The assessment for this use includes many of the same factors as for primary contact recreation but to a somewhat less stringent standard for coliform bacteria. Chemical and physical data are assessed using guidelines in Table 2 and standards in Table 8. In addition, field observations at stations along many of the reaches were tabulated for aesthetic factors such as significant excessive algae growth, significant trash, persistent non-natural foam and odor (table 9). These observations were assessed using guidelines in Table 2.

Fish and Shellfish Consumption Use

Fish and shellfish consumption use is assessed based on status of fishing advisories and bioaccumulation data. Guidelines for use of advisory data are listed in Table 2. Bioaccumulation standards are described above under aquatic life use. Table 7 includes shellfish bacteria limits which were not used in this assessment due to lack of resources.

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Table 8. Aesthetics/taste and odor standards

Note: most stringent criteria is selected. Constituents are only listed if samples used for assessment had values above detection limits.

Constituent	Reference	Status	Criteria (ppm unless noted)	Comments
Aluminum	CA Department of Health Services	Secondary MCL	0.02	
Ammonia	McKee and Wolf, 1978		0.037	
Chloride	CA Department of Health Services	Secondary MCL	250	
Color	CA Department of Health Services	Secondary MCL	15 units	
Copper	CA Department of Health Services	Secondary MCL	1000 ppb	
Fluoride	US Environmental Protection Agency	Secondary MCL	2	
Foaming agents (MBAS)	CA Department of Health Services	Secondary MCL	0.5	
Iron	CA Department of Health Services	Secondary MCL	0.3	
Manganese	CA Department of Health Services	Secondary MCL	0.05	
Odor	CA Department of Health Services	Secondary MCL	3 threshold units	
pH	US Environmental Protection Agency	Secondary MCL	6.5 to 8.5 units	
Silver	CA Department of Health Services	Secondary MCL	100 ppb	
Specific conductance	CA Department of Health Services	Secondary MCL	900 µmhos/cm	
Sulfate	CA Department of Health Services	Secondary MCL	250	
Total dissolved solids	CA Department of Health Services	Secondary MCL	500	
Turbidity	CA Department of Health Services	Secondary MCL	5 units	
Organic Constituents				
Ethylbenzene	US Environmental Protection Agency	Secondary MCL	30	
Phenol	CA Department of Health Services	Taste and odor Action level	5.0	
Toluene	US Environmental Protection Agency	Secondary MCL	40	
Xylene(s)	US Environmental Protection Agency	Secondary MCL	20	

Table 9. Observation categories used for assessing field observations of aesthetic stressors

Stressor	Observation categories
Trash	None, trash observed, Significant amount of trash observed
Unnatural scum/flotsam/foam	None, observed
Algae	None, significant amount observed
Odors	None, presence
Color	Clear, light yellow to green, dark green to brown
Turbidity	None, slight to turbid, very turbid
Oil and grease	None, Oil sheen, heavy oil

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Drinking water use

Assessment of the use of waterbodies in the region for drinking water is based on concentrations of constituents that are regulated for drinking water. In this 305(b) report, ambient or raw (untreated) surface and ground waters are assessed (Note that such water would be treated and disinfected, in accordance with requirements from the State Department of Health Services, prior to distribution for potable use). Contaminants that are generally not source-water related (e.g., corrosion byproducts, lead or copper from distribution system, or TTHMs) are not considered. Assessment of waterbodies for drinking water use differs from other uses in that median rather than mean of data are considered. Table 2 lists the guidelines for assessment and Table 10 lists the standards and references.

Assessed under the "federal" drinking water use are two "state" beneficial uses, namely MUN (municipal supply) and GWR (ground water recharge). Currently, all waterbodies in the region are designated as MUN per the 1988 Sources of Drinking Water Policy. A large number of waterbodies, however, were footnoted in the 1994 Basin Plan as being eligible for review and possible exemption status during the Triennial Review (1994-1997). The Regional Board staff is currently reviewing these footnoted MUN waterbodies and later this year (1996), intend to bring forward a revised MUN policy more appropriate for this region as well as criteria specific to this region for possible exemptions from the MUN designation. Waterbodies that were designated MUN (Municipal Drinking Water Supply) with a footnote in the region's Basin Plan (1994) and did not have a groundwater recharge (GWR) use are not assessed in this 1996 305(b) assessment. As discussed above, these waterbodies will be considered for exception from MUN in a separate Board action later this year. After consultation with State Board and USEPA staff, Regional Board staff decided to not assess the drinking water use for those waterbodies that were footnoted MUN in the 1994 Basin Plan and do not have a GWR use. These waterbodies may be removed from our Basin Plan within this year and, if any of them are determined to have drinking water uses and are impaired, staff will revise the 303(d) accordingly.

Table 10. Drinking Water standards

Note: most stringent criteria is selected. Constituents are only listed if samples used for assessment had values above detection limits.

Constituent	Reference	Status	Criteria	Comments
Inorganic constituents (ppm unless noted)				
Aluminum	CA Department of Health Services	Primary MCL	1000 ppb	
Gross alpha particle activity	CA Department of Health Services	Primary MCL	15 pCi/L	
Antimony	CA Department of Health Services	Primary MCL	6 ppb	
Arsenic	CA Department of Health Services	Primary MCL	50 ppb	
Bacteria, coliform	1994 Basin Plan	groundwater	1.1/100 ml (any seven day period)	
Barium	CA Department of Health Services	Primary MCL	1000 ppb	
Gross beta particle activity	CA Department of Health Services	Primary MCL	50 pci/L	
Beryllium	CA Department of Health Services		4 ppb	
Boron	CA Department of Health Services	Toxicity Action Level	1	
Cadmium	CA Department of Health Services	Primary MCL	5 ppb	
Chlorine (Cl_2)	US Environmental Protection Agency	Primary MCL	4	Proposed
Chromium total	CA Department of Health Services	Primary MCL	50 ppb	
Copper	US Environmental Protection Agency	Primary MCL	1300 ppb	
Cyanide	CA Department of Health Services	Primary MCL	0.200	
Fluoride	CA Department of Health Services	Primary MCL	*	
Lead	US Environmental Protection Agency	Primary MCL	15 ppb	
Mercury	CA Department of Health Services	Primary MCL	2 ppb	

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Nickel	CA Department of Health Services	Primary MCL	100 ppb	
Nitrate	CA Department of Health Services	Primary MCL	45	
Nitrite-N	CA Department of Health Services	Primary MCL	1	
Nitrate-N + Nitrite-N	CA Department of Health Services	Primary MCL	10	
Selenium	CA Department of Health Services	Primary MCL	50 ppb	
Sulfate	US Environmental Protection Agency	Primary MCL	400	Proposed
Thallium	CA Department of Health Services	Primary MCL	2 ppb	
Organic Constituents (ppb unless noted)				
Aldrin	CA Department of Health Services	Toxicity Action Level	0.05	
Benzene	CA Department of Health Services	Primary MCL	1	
Benzene hexachloride (a-BHC)	CA Department of Health Services	Toxicity Action Level	0.7	
Benzene hexachloride (b-BHC)	CA Department of Health Services	Toxicity Action Level	0.3	
Benzene hexachloride (g-BHC; Lindane)	CA Department of Health Services	Primary MCL	0.2	
Bromodichloromethane†	CA Department of Health Services	Primary MCL	100	Sum of trihalomethanes
Bromoform†	CA Department of Health Services	Primary MCL	100	Sum of trihalomethanes
n-Butylbenzene	CA Department of Health Services	Toxicity Action Level	45	
n-Butyl benzyl phthalate	US Environmental Protection Agency	Primary MCL	100	Proposed
Carbon tetrachloride	CA Department of Health Services	Primary MCL	0.5	
Chlordane	CA Department of Health Services	Primary MCL	0.1	
Chloroform†	CA Department of Health Services	Primary MCL	100	Sum of trihalomethanes
2,4-D	CA Department of Health Services	Primary MCL	70	
Dibromochloromethane†	CA Department of Health Services	Primary MCL	100	Sum of trihalomethanes
3,3'-Dichlorobenzidine (DCB)	none			
1,1-Dichloroethylene (1,1-DCE)	CA Department of Health Services	Primary MCL	6	
cis-1,2-Dichloroethylene	CA Department of Health Services	Primary MCL	6	
trans- 1,2-Dichloroethylene	CA Department of Health Services	Primary MCL	10	
1,3-Dichloropropene (cis and trans)	CA Department of Health Services	Primary MCL	0.5	
Di(2-ethylhexyl)phthalate	CA Department of Health Services	Primary MCL	4	
Di(n-octyl) phthalate	none			
Endrin	CA Department of Health Services	Primary MCL	2	
Ethylbenzene	CA Department of Health Services	Primary MCL	700	
Heptachlor	CA Department of Health Services	Primary MCL	0.01	

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Heptachlor epoxide	CA Department of Health Services	Primary MCL	0.01	
Methyl ethyl ketone (MEK)	none			
Methylene chloride (Dichloromethane)	CA Department of Health Services	Primary MCL	5	
Tetrachloroethylene (PCE)	CA Department of Health Services	Primary MCL	5	
Toluene	CA Department of Health Services	Primary MCL	150	
1,1,1-Trichloroethane (1,1,1-TCA)	CA Department of Health Services	Primary MCL	200	
Trichloroethylene (TCE)	CA Department of Health Services	Primary MCL	5	
Vinyl chloride	CA Department of Health Services	Primary MCL	0.5	
Xylene(s)	CA Department of Health Services	Primary MCL	1750	

* Fluoride criteria is based on annual average of maximum daily air temperature: MCL at 58.4 to 63.8 °F: 2.0 mg/L; 63.9 to 70.6 °F: 1.8 mg/L; and 70.7 to 79.2 °F: 1.6 mg/L.
† 100 ppb is total trihalomethanes (sum of bromoform, bromodichloromethane, chloroform, and dibromochloromethane)

Agriculture use

Water quality standards can vary by area and by crop. Due to a lack of state or federal standards, assessment of water quality for agricultural use is based upon local guidelines (table 11).

Table 11. Agriculture standards

Note: most stringent criteria is selected. Constituents are only listed if samples used for assessment had values above detection limits.

Constituent	Reference	Criteria	Comments
Aluminum	Ayers and Westcot, 1985	5 ppm	
Arsenic	Ayers and Westcot, 1985	100 ppb	
Boron	USEPA Quality Criteria for Water, 1986	0.75 ppm	
Cadmium	Ayers and Westcot, 1985	10 ppb	
Chloride	Ayers and Westcot, 1985	106 ppm	
Chromium VI	Ayers and Westcot, 1985	100 ppb	
Cobalt	Ayers and Westcot, 1985	50 ppb	
Copper	Ayers and Westcot, 1985	200 ppb	
Total dissolved solids	Bucy, 1995	750 ppm	Ayers and Westcot recommend 450 but locally that is not used
Fluoride	Ayers and Westcot, 1985	1 ppm	
Iron	Ayers and Westcot, 1985	5 ppm	
Lead	Ayers and Westcot, 1985	5000 ppb	
Manganese	Ayers and Westcot, 1985	0.2 ppm	
Nickel	Ayers and Westcot, 1985	200 ppb	
Selenium	Ayers and Westcot, 1985	20 ppb	
Specific conductance	Bucy, S. 1995. Fruit Growers Laboratory, Santa Paula, CA. Personal communication, November 14, 1995.	750 umhos/cm	Ayers and Westcot recommend 700 but locally that is not used
Vanadium	Ayers and Westcot, 1985	100 ppb	
Zinc	Ayers and Westcot, 1985	2000 ppb	

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Criteria used for assessing lakes

Although the general guidelines for surface waters apply to lakes of the region, special consideration is given to urban lakes. The Regional Board contracted with University of California, Riverside to assess urban lakes. Twenty three urban and non-urban lakes of the region were studied over a year period and this information and data are used in this Water Quality 305(b) Assessment.

For lakes, trophic status is assessed. Assessment is additionally based on, where available, the following factors: total phosphorus, chlorophyll a, secchi transparency, frequency of algal blooms, surface scum and mat, turbidity, reduction of water depth due to sediment, extent of nuisance macrophyte growth, and aesthetics.

Criteria used for assessing Nearshore, Open Bays, Estuaries, and Ocean

Due to lack of staff resources at this time, the assessment of nearshore areas, open bays, estuaries, and ocean areas is mostly limited to the review of published reports. Fish consumption advisories and some bioaccumulation data are also used.

Criteria used for assessing Ground Water

Neither the US EPA nor State Board has established a set methodology for assessing the quality of ground waters. Staff at the USEPA recognize that such assessments are monumental tasks. Accordingly, the USEPA Guidance document suggests that agencies do what is practicable during the 1996 reporting period, focussing on demand for and vulnerability of ground waters.

Regional Board staff did not compile a database on the quality of ground water, due to limited staff resources. Nor did Regional Board staff assess the quality of ground water based upon numbers of known contaminated sites. These data would not accurately reflect water quality, since the data (from monitoring wells) are inherently skewed toward water quality problems. Regional Board staff also rejected the idea of assessing the quality of ground water based upon data from production wells, as such data might inherently overstate water quality.

Assessments of the quality of ground waters in the Los Angeles Region, therefore, are based upon the extent to which beneficial uses have been, or are threatened to be, impaired. Beneficial use categories that were assessed include drinking water and industrial uses, which were lumped together (since industrial users in the Region typically require ground water that meets Title 22 standards (Table 10). The quality of ground waters to support agricultural uses was not assessed in most areas; exceptions were made in certain areas of Ventura County, where agriculture is an important industry.

Table 12. Assessment guidelines for groundwater basins

Assessment classification	Guideline
Fully supporting	No known contamination
Fully supporting but threatened	Evidence of contamination, but beneficial use has not been affected.
Partially supporting	Contamination has significantly affected production of ground water. For example, over 10% of production capacity in a basin has been shut down, or over 10% of production in a basin requires wellhead treatment/dilution prior to beneficial use. For those basins where production capacity is not easily available (perhaps due to widespread contamination), staff evaluated trends to determine the degree to which water quality had been degraded from background.
Not supporting	Contamination has impaired production of ground water. For example, over 25% of production capacity in a basin has been shut down, or over 25% of production in a basin requires wellhead treatment/dilution prior to beneficial use. Again, for those basins where production capacity is not readily available (perhaps due to widespread contamination), staff evaluated trends to determine the degree to which water quality had been degraded from background.

In order to determine impairments to ground waters, Regional Board staff gathered information on the extent to which production had been curtailed or cut back due to water quality problems. Ground waters that were pumped in spite of contamination, and then treated at wellhead or blended to meet water quality standards, also were considered impaired.

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Assessment classifications are summarized in Table 12. Production data for the assessments were obtained from many sources, including published reports and communications with water purveyors, wholesalers, and watermasters.

The attached Data Summary Tables present the results of the Regional Board's assessments. Ground waters in the "partially supporting" or "not supporting categories" are considered impaired with regard to respective beneficial uses; however, these ground waters are not entered on the 303(d) list, as the scope of the 303(d) list is limited to surface waters.

Ground waters in this assessment are generally considered to be single units with the exception of two basins, the Central Basin and the West Coast Basin that were divided into upper and lower, or production, aquifers. The total area given in square miles is the same for both the upper and lower aquifers, therefore, care needs to be taken to not double count these areas when looking at total square miles of impaired groundwater basins for the Los Angeles Region.

303(d) list

Impaired surface waterbodies included in the 305(b) assessment are also listed on the region's updated 303(d) list. Under Section 303 of the Clean Water Act, each state must submit a list of those waters that do not, or are not expected to, attain water quality standards after application of required technology-based controls. This list, known as the 303(d) list, serves to focus water quality efforts and resources toward the most significant water quality problems.

Waterbodies are placed on the 303(d) list if any uses were either "not" supported or "partially" supported for any beneficial use with the following exceptions:

1. Waterbodies where the sources of elevated constituents are most likely natural (i.e., chlorides, sulfates, and boron in areas where natural levels of these constituents are high).

2. Waterbodies for which color and/or turbidity (aesthetic constituents) for contact and non-contact recreation uses are the only elevated constituents. We did not separate wet weather sampling from dry weather sampling and these two constituents should be sampled on a more frequent and consistent basis in order to be sure that they are problems. They are noted, however, in the general 305(b) assessment.

3. Waterbodies that had only trash and/or algae impairing contact or non-contact recreation. Staff felt that these problems alone, did not make a waterbody eligible for listing given the more serious nature of other water quality problems in the Los Angeles area. Only a few waterbodies were exempted from the 303(d) list for this reason. The East Fork San Gabriel River, however, *was* included on the 303(d) list because removing the trash (and graffiti) problem from this waterbody would significantly enhance this otherwise pristine area.

The Regional Board will use a variety of approaches to address water quality problems affecting waters on the 303(d) list. In addition to water quality controls in Waste Discharge Requirements, these approaches may include: new watershed-based management efforts, enhanced stormwater programs for releases from municipal, industrial, and construction sources, and estimates of total maximum daily loads (TMDLs) of pollutants. TMDLs are a way to quantify pollutants loads from point and nonpoint sources, and can be used to allocate allowable loads in order to meet water quality standards.

TMDL priorities (high, medium, or low) on the draft 303(d) list, sent to the public in December, 1995, were based on a combination of many factors, including the severity of the problems, the value of the resources, the watershed schedule, staff resources and practicality/availability of solutions. As a result of discussions with staff from dischargers and members of the public, all TMDL priorities were downgraded to low with the exception of the targeted high priority efforts (Los Angeles River-nitrate and Malibu Creek- nutrients) already underway on two watersheds. The priority of all future TMDLs will be discussed and evaluated by stakeholder groups under the Watershed Approach. Staff and stakeholder resources will be key factors in determining the number of TMDLs we can undertake in the future.

As mentioned above,TMDL efforts are already underway for the Los Angeles River and Malibu Creek watersheds. Other efforts to estimate and reduce pollutant loadings will be initiated as the Watershed Initiative in the Los Angeles Region proceeds and as Regional Board resources allow.

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Additional lists in the assessment

The 305(b) report includes a number of state lists that are or have been mandated by the Clean Water Act. As part of the assessment for 1996, the 303(d) list is updated but previous lists were not updated. The lists in this assessment include:

§303(d) This list is updated in this assessment and is described above.

§314: This is a list from 1992 of publicly owned lakes that were nominated for restoration. This list is not updated in this report.

§319: This is a one time state-wide list that was compiled in the 1980's of nonpoint source pollution problems due to both toxic and nontoxic pollutants. This list is not updated in this report.

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WBS Input - Causes and sources (February 1996)

Degree codes

High	1 constituent leads to nonsupport
Moderate	1 constituent leads to partial support *or* Multiple constituents lead to nonsupport
Slight	Multiple constituents lead to nonsupport (and this one is slight, i.e., color) *or* Multiple constituents lead to partial support *or* Multiple constituents lead to fully supporting but threatened

Use codes

72	Agriculture
50	Drinking water
20	Aquatic life
42	Swimming (recreation contact)
44	Secondary (recreation non cont)
21	Fish consumption
23	Shellfishing

Cause codes

0000	Causes unknown
0100	Unknown toxicity (sediment or water)
0200	Pesticides Aldrin, Chlordane, DDT, DDE, DDD, Endrin, PCBs, Toxaphene
0300	Priority organic chemicals Phenol, Benzene, BTEX, Petroleum
0400	Non-priority organic chemicals (PAHs)
0500	Metals Ag, As, Ba, Be, Cr, CrVI, Cu, Fe, Pb, Mn, Hg, Se, Th, Zn, Ni, and B (boron)
0600	Ammonia
0700	Chlorine
0800	Other inorganic chemicals
0900	Nutrients (N+N)
1000	pH
1100	Siltation NONE
1200	Organic enrichment/low DO (eutrophication)
1300	Salinity/TDS/chlorides & sulfate (& SC)
1400	Thermal modifications-temp
1500	Flow alterations
1600	Other habitat alterations (benthic community)
1700	Pathogens (human enteric viruses, coliform)
1800	Radiation NONE
1900	Oil and grease
2000	Taste and odor
2100	Suspended solids NONE
2200	Noxious aquatic plants (algae)
2300	Filling and draining NONE
2400	Total toxics
2500	Turbidity
2600	Exotic species
3300	Fish barriers
3400	Trash
3500	Color
3600	Scum/foam
3700	Fish consumption advisory

Source Codes

0100	Industrial point sources (refinery, RCRA sites, etc)
0200	Municipal point sources
0400	Combined sewer overflows
1000	Agriculture
1300	Nurseries
1520	Upland grazing (grazing)
1600	Animal operations
1640	Confined animal operations
3000	Construction
4000	Urban runoff/storm sewers
5000	Resource extraction
5500	Petroleum activities
6300	landfills
6700	Septic disposal (septic washouts)
7200	Dredging
7300	Dam construction
7400	Flow regulation/modification
7550	Habitat modification other than hydrom.
7800	Draining/filling of wetlands
7900	Anti-fouling paints, naval activities
8100	Atmospheric deposition
8400	Spills
8500	Contaminated sediments
8600	Natural sources
8700	Recreational activities
8910	Groundwater loadings
8920	Groundwater withdrawal
8930	Leaking underground tanks
8950	Other (algal treatment, rising contaminated groundwater)
9000	Source unknown
9010	Transient encampments
9020	Illegal dumping
9030	Erosion/siltation

TMDLs Codes

3300	Fish barriers
3400	Trash
3540	Scum/foam

Note: for TMDLs, TRASH is always low priority irregardless of TMDL priority for reach.

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Regional Water Quality Control Board - Los Angeles Region

1996 Water Quality Assessment Data Summaries

Explanatory notes for interpreting the tables

Units are in ppm unless noted below.

Most of the data in this table are water column data. To conserve space, the descriptive terms have been eliminated. For each constituent, the top row is number of samples, second row is range of values (minimum to maximum), and third row is mean plus or minus standard deviation. Means are not given for pH and fecal coliform. For some constituents a "#" next to the mean indicates that no standard deviation has been calculated because there is not a normal distribution or there are less than 3 samples.. Water Column data: top row is number of samples, second row is range of values (minimum to maximum) and third row is mean plus or minus standard deviation.

* Between 3 and 20 samples and greater than 40% of the values are higher than the standard

† Older data was combined with recent data for conventional constituents such as TDS, B, and SO4. This older data was only used for tributaries in relatively undeveloped areas.

▼ Although ground water is semi-perched and shallow aquifers may not be directly used for drinking, industrial, or agriculture purposes, it can migrate to and partially recharge deeper aquifers

References:

1. Tissue data: California State Water Resources Board. State Mussel Watch Program. Elevated metals or organic chemicals are listed. Maximum concentrations are shown in parentheses.
2. California State Water Resources Board. Bay Protection and Toxic Cleanup Program. For sediment chemistry, elevated metals or organic chemicals are listed. Maximum concentrations are shown in parenthesis. For sediment or water toxicity tests, survival rates of test organisms are described as "low", "poor", or "good".
3. California State Water Resources Board. Toxic Substance Monitoring Program. Elevated constituents are shown with standard exceeded in parenthesis.
4. California Department of Fish and Game, 1994-1996. California Sport Fishing Regulations.
5. Regional Water Quality Control Board. 1995. Draft Final Report: Toxicity Study of the Santa Clara River, San Gabriel River, and Calleguas Creek. For water toxicity tests, survival rates of test organisms are described as "poor", or "good".
6. Santa Monica Bay Restoration Project. 1994. State of the Bay, 1993: Characterization study of the Santa Monica Bay Restoration Plan. Includes Gold, et. al., 1990, 1991,1992; Thompson et. al., 1987a; SCCWRP et. al., 1992; Greene, 1992.
7. Simi Valley County Sanitation District. 1995 (September). Report on Arroyo Simi Characterization.
8. Regional Water Quality Control Board. 1994 (December). Evaluation of Water Quality for Selected Lakes in the Los Angeles Hydrologic Basin. Final Report.
9. Los Angeles, County of. Department of Beaches and Harbors. 1992. Marine Studies of San Pedro Bay, California Part 20H. The Marine Environment of Marina Del Rey: October 1991-June 1992.
10. Los Angeles, County of. Department of Beaches and Harbors. 1995. Results of chemical and physical testing of sediments from Marina del Rey - October 1991-1992.
11. United States Army Corps of Engineers. 1995. Marina del Rey and Ballona Creek: Final reconnaissance report - Marina del Rey sediment chemistry.
12. Las Virgenes Municipal Water District. 1995. Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek. Used STSM standards from reference 3 above as well as Meanns Fish Tissue Standards (MFS)
13. California Department of Fish and Game. 1995. Draft Steelhead restoration and management plan for California.
14. California Department of Fish and Game. 1990. Preliminary report on the ecology of the Light-Footed Clapper Rail at Mugu Lagoon, Ventura County, California.

ABBREVIATIONS and Units in *Main Header* (1st Row of header):

Reach/location	Segment of waterbody that is assessed. Some waterbodies are combined. Waterbodies that are on lists are noted.
Hydro. Unit	Hydrologic unit as designated by the state.
Size	Length or area of waterbody (miles or acreage respectively).
Code	Code that has been assigned to the reach by the Regional Board. CA (California) 4 (Region 4) xx (watersheds 01 to 14). xxxx (segment number) waterbody type (O: oceans, nearshore, and offshore areas; C: beaches; H: bays and harbors; R: rivers and streams; L: lakes and reservoirs, E estuaries; and T tidal wetlands)
Previous WQA	Status of waterbody in 1992 and 1994 Water Quality Assessment Reports. Length or acreage is also shown.
WQA	1996 cycle status of each beneficial use for each assessed waterbody. Abbreviations for this column are: Fully supporting (F), Fully supporting but threatened (FT), Partially supporting (P), and Unassessed (U). Contact and non-contact recreational use was considered "Unassessed" if there was no water quality data (i.e., secondary MCL data) or no field observations (i.e., trash, odors, etc.); if there is an assessment noted then field observations were made but are not included in any columns on this table due to lack of space (see files).

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Use	As appropriate, USEPA's beneficial uses are listed for each waterbody. These uses are assessed in this report. Some uses are struck-out ; these are uses that are listed in the Basin Plan but are not assessed in this phase (see responsiveness summary). For uses listed as "Basin Plan", minerals constituents were compared to Basin Plan objectives. These Basin Plan comparisons are not included in the Waterbody System database.
Not Supporting	For each beneficial use (read across for each use), constituents that are "not supporting" that particular use. Number of exceedences was determined for each use; for many uses, >25% exceedences was used as the trigger to place a constituent or stressor in this column.
Partially supporting	For each beneficial use (read across for each use), constituents that are "partially supporting" that particular use. Number of exceedences was determined for each use; for many uses, >10% exceedences was the trigger used to place a constituent or stressor in this column. In some cases, constituents or stressors that are "fully supporting but threatened" are listed in this column.
Potential Sources	Potential sources for constituents or stressors . These sources are not linked specifically to any constituent. In parentheses, magnitude of sources are indicated: H (high), M (moderate) and S (slight).

ABBREVIATIONS and units in *Water Column Header* row (2nd row of header):

Temp	Temperature values in table are in Centigrade.
pH	Hydrogen ion activity (stnd units)
DO	Dissolved oxygen (depleted levels) (parts per million: ppm).
TDS	Total dissolved solids (ppm).
SC	Specific conductance (ppm).
Hard	Hardness (ppm).
B	Boron (ppm).
CHL	Chloride (ppm).
SO4	Sulfate (ppm).
Tissue, sediment and toxicity	See references and descriptions #1, 2 ,3, etc. above.
AMM	Ammonia-N (ppm).
N+N	Nitrate-N + Nitrite-N (ppm).
Fec Col.	Fecal coliform for inland surface waterbodies.
Fecal Col.	(Coastal Features) Fecal Coliform: dry weather and wet weather: the numbers in these columns are average number of exceedences for surfzone sampling events. Most of these areas are sampled weekly.
Total Col.	(Coastal features) see Fecal coliform above.
Metals	Ag (Silver), Ba (Barium), Cd (Cadmium), Cr (Chromium), CrVI (Chromium VI), Cu (Copper), Pb (Lead), Se (Selenium), TBT (Tributyl Tin), Zn (Zinc), and Hg (Mercury). Be (Beryllium) was scanned by only a few agencies. The number of sampling events or scans for metals is at the top of column. Individual metals are listed if they were detected at levels above the detection limit . Maximum concentration found for each metal is shown to the right of each metal. In some cases only one or two metals were scanned (usually a large number of times) and these are indicated in the column (e.g., all 11 metals were scanned 1 or 2 times but copper and zinc were scanned 67 times) (ppb).
Org Chem	See Organic chemicals on next page.
Beach Closures	Bathing areas closures issued by county departments of health.
Fish Consumption	Fish consumption advisories.

ADDITIONAL ABBREVIATIONS in *Not Supporting* and *Partially Supporting* columns:

ND	Non-detect. The constituent was not detected at or above the equipment's detection limitation.
Temp	Temperature of effluent is greater than 5°F above ambient temperature in waterbody.
COLIFORM	Coliform bacteria: fecal coliform for inland surface waterbodies; total and fecal coliform for beaches.
PAHs	Polycyclic aromatic hydrocarbons.
TRASH	Significant trash and debris observed.
ODORS	Significant odors noted.
COLOR	Green, yellow or brownish water color observed.
ALGAE	Significant algal growth observed.
OIL	Oily film observed on surface of water.
SCUM	Nonnatural foam, scum material or other flotsam observed.
Turb	Turbidity.
EUT	Eutrophic.
Sed(x)	Level of constituent in sediment is elevated.
HIST	Abnormal fish histology observed.
TIS(x)	Fish or mussel data from State Mussel Watch and State Toxic Substances Monitoring programs. The constituent in parenthesis exceeds the standard(s).
TOX	Tests or studies of chronic or acute toxicity of species (water column).
SED TOX	Tests or studies of chronic or acute toxicity of species (sediment).
ChemA	Toxic Substances Monitoring Program combination of pesticides: Aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, HCH (including lindane), endosulfan, and toxaphene.
Org Chem	Organic chemicals. These chemicals are usually analyzed in water samples (in general, the number of sampling events is shown at top of column). If sediment samples are analyzed, the terms H2O and Sed are used to distinguish the analyses (number of samples are shown in parenthesis). Organic chemicals that are detected above detection limits are indicated by the following abbreviations:

Water Column organic chemicals

- a benzene
- b bromodichloromethane
- c bromoform
- d chloroform
- e dibromochloromethane
- f o-DCB (1,2-Dichlorobenzene)
- g p-DCB (1,4-Dichlorobenzene)
- h 1,1-DCE (1,1-Dichloroethylene)
- i cis-1,2-dichloroethylene
- j trans-1,2-dichloroethylene
- k Carbon tetrachloride
- l cis and trans-1,3-dichloroprop
- m ethyl benzene
- n methylene chloride
- o methyl ethyl ketone
- p naphthalene
- q n-propylbenzene
- r PCE (Tetrachloroethylene)
- s toluene

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t 1,1,1-TCA (1,1,1-Trichloroethane)
u TCE (Trichloroethylene)
v 1,2,4-trimethylbenzene
w 1,3,5-trimethylbenzene
x vinyl chloride
y m,p-xylenes
z o-xylenes
aa alpha-BHC
ab beta-BHC
ac delta-BHC
ad gamma-BHC (Lindane)
ae phenol (ppm)
af cyanide (ppm)
ag p-IPT
ah 2,4-Dichlorophenol
ai 4-Nitrophenol
aj 2,6-Dichlorophenol
ak 2,3,4,6-Tetrachlorophenol
al DNBP
am 4-Chloro-3-methylphenol
an 2,4,6-Trichlorophenol
ao Pentachlorophenol
ap 2-Chlorophenol
aq 2-Nitrophenol
ar 2,4-Dinitrophenol
as 2,4-Dimethylphenol
at 4-Methylphenol
au Heptachlor
av Aldrin
aw Heptachlor epoxide
ax Dieldrin
ay Endrin Aldehyde
az Endosulfan I
ba Endosulfan II
bb 4,4'-DDD
bc 4,4'-DDE
bd 4,4'-DDT
be TPH
bf 1,1-DCA
bg 1,1-dichloroethylene
bh 1,2-DCA
bi 1,2,3-Trichlorobenzene
bj 1,2,3-Trichloropropane
bk 1,3,5-Trochlorobenzene
bl Dibromethane
bm Methyl-t-butyl ether
bn Trichlorotrifluoroethane (F113)
bo 2,4,5-Trich
bp Endrin

Sediment organic chemicals:
aa Lead
ab 4,4'-DDD
ac 4,4'-DDE
ad 4,4'-DDT
ae Copper
af Dieldrin

ag Mercury
ah Gamma-BHC (Lindane)
ai Cadmium
aj Barium
ak Zinc

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Islands

Reach/location (Islands)	Hydro Unit	Size (acres)	Code	Previous WQA acres status	WQA	Assessed Use	Not Supporting	Partially Supporting	Potential Sources
Fecal Coliform (Wet and Dry Weather)	Total Coliform (Wet and Dry weather)			Beach Closures		Fish Consumption	Tissue, Sediment, and Toxicity Data		
Anacapa Island: nearshore (Area of Special Biological Significance)	408.10	21280	CA414.61000	21280 good	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
San Nicolas Island and Begg Rock nearshore (Area of Special Biological Significance)	408.30	102528	CA414.63000	102528 good	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			Threat of military impacts
Santa Barbara Island: nearshore (Area of Special Biological Significance)	408.20	14000	CA414.64000	14000 good	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
Santa Catalina Island: nearshore (Areas of Special Biological Significance 1-6)	408.40	17936	CA414.66000	17936 good	F F F F F F	Drinking Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
							West side and at Ribbon Rock: Tissue-low to nondetectable levels of metals and pesticides *		
San Clemente Island: nearshore (Area of Special Biological Significance)	408.50	60912	CA414.68000	60912 good	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			Threat of military impacts

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Ventura County Coastal streams, lakes and estuaries

Reach/location (Ventura County Coastal streams, lakes and estuaries)		Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Las Saucos Creek		401.00	4.7	CA401.0030R					Unassessed					
no data	2 7.9-8.0	no data	2	2 1780-1950	no data	no data	2 78-126	2 841-883		no data	no data	no data	no data	2 fec
Javon Cyn		401.00	2.8	CA401.0050R					Unassessed					
Padre Juan Cyn		401.00	3.6	CA401.0070R					Unassessed					
A Lasse Cyn (Duluth West)		401.00	1.9	CA401.0080R					Unassessed					
Prince Barranca		402.10	1.4	CA401.0120R					Unassessed					
Hall Canyon		402.10	7.1	CA401.0130R					Unassessed					
Arundell Barranca †		403.11	4.38	CA401.0160R		N N U U	Agriculture Drinking--Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c		TDS*,SC*,CHL*,B* SO4* TDS*,SC*,SO4* CHL*,				Natural sources (m) Agricultural runoff (m) Urban runoff (m)	
7 15-35 19 ± 3	11 6.9-8.4 7.7 ± 0.5	no data	10 160-5200 2736 ± 1710	11 253-7870 3405 ± 2089	6 90-1605 747 ± 535	no data	11 13-1800 488 ± 520	11 42-2480 1082 ± 819		11 0.4-38.7 8.10	11 0.2-1.2 0.8 ± 0.4	no data	1 ND	1 ND
McGrath Lake Ag Drain		403.11	0.8	CA401.0200R					Unassessed					
McGrath Lake (Estuary) † 303(d)-low		403.11	18.7 ac	CA401.0210E	40 ac Intermed	N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		Sed/DDT,chlordane, total pesticides) SED TOX				Natural sources (m) Agricultural runoff (m) Oil spills(m) (Significant oil spill in December 1993)	
2 20-38	4 7.4-8.7 8.1 ± 0.5	no data	4 1810-8340	4 2293-12800 6197 ± 4199	2 845-1220	4 0.6-1.8 0.9 ± 0.4	4 238-3830 1488 ± 1434	4 640-1180 908 ± 191	Sed Chem: DDT (3ppm), chlordane (160ppb), other pesticides (3ppm) * Sed tox: low survival rates *	no data	3 1.8-11.8 7.8 ± 4.3	no data	no data	no data
West 6th Street Drain		403.11	2.14	CA401.0250R					Unassessed					
Conrad Drain 01		403.11	NEED	CA401.0270R					Unassessed					

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Reach/Location (Ventura County Coastal streams, lakes and estuaries)	Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp / pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Oxnard West Drain †	403.11	3.3	CA401.0260R					Unassessed					
1 10 / 3 7.0-7.8 7.5 ± 0.4	no data	3 584-11200 4864 ± 4571	3 848-15600 6546	no data	3 0.4-2.5 1.5 ± 0.9	3 60-4660 1640	3 223-1720 1120 ± 650	no data	no data	3 1.9-4.3 2.7 ± 1.1	no data	no data	no data
Hueneme Drain	403.11	1.17	CA401.0300R					Unassessed					
J Street Drain	403.11	2.41	CA401.0310R					Unassessed					
Oxnard Industrial Drain	403.11	4.31	CA401.0320R					Unassessed					
Rice Pond Drain	403.11	3.88	CA401.0330R					Unassessed					
La Jolla cyn	404.48	2.7	CA401.0340R					Unassessed					
Big Sycamore Cyn †	404.47	10.3	CA401.0350R		F F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c							
1 10 / 3 7.1-8.2 7.6 ± 0.4	no data	3 660-708 688 ± 27	2 980-1020	no data	3 0.1-0.3 0.2 ± 0.1	3 62-88 75 ± 10	3 138-223 180 ± 35	no data	1 0.2	3 0.4-1.1 0.8 ± 0.3	no data	no data	no data
Deer Cyn †	404.48	2.2	CA401.0360R		N F F F	Agriculture Drinking--Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c		TDS*,SC*,CHL* TDS,SC,SO4*				Natural sources (N)	
2 17 / 3 7.8-8.3 7.7 ± 0.5	no data	3 960-1180 1038 ± 83	3 1301-1460 1374 ± 61	no data	3 0.1-0.2 0.17 ± 0.05	3 114-130 122 ± 7	3 258-284 272 ± 12	no data	no data	3 ND-0.4 0.22 ± 0.10	no data	no data	no data
Little Sycamore Cyn †	404.48	4.8	CA401.0400R		F F F	Drinking--Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,SO4*					

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Reach/location (Ventura County Coastal streams, lakes and estuaries)		Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
1 17	3 7.0-8.3 7.7 ± 0.5	no data	3 700-1000 844 ± 123	3 1050-1140 1090 ± 37	1 685	3 ND-0.1 0.07 ± 0.05	3 47-80 63 ± 13	3 210-316 263 ± 43	no data	no data	2 0.5-2.1	1 179	no data	no data

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Ventura River Watershed

Reach/location (Ventura River Watershed)/Uses	Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses	Not supporting	Partially supporting	Sources
Temp / pH	DO	TDS	SC	Hard	B	Chl / SO4	Tissue, Sediment and Toxicity Data / NH3	N+N / Fec Col	metals / Org Chem
Ventura River Estuary 303(d)-low 319	402.10	0.38 mi	CA402 0000E	10 acres impaired	N P P	Aquatic life Recreation: cont. Recreation: non-c Fish consumption	AMM*,TIS(DDT), ELIT AMM*,COLOR, ALGAE COLOR, ALGAE TIS(DDT)	pH,TRASH TRASH	Urban runoff (m) Oil fields (o) Municipal Effluent (m) Transient encampments (m) Natural sources (m) Recreational use (n)
86 / 63 10-23 / 7.2-8.6 16 ± 4 / 8.3 ± 0.4	82 5.4-22 9.9 ± 2.7	1 25600	no data	no data	no data	no data / no data	Tissue('93): DDT(MTRLs) * Sed chem: low pesticide levels * Sed tox: good survival rates * Water tox: 100% normal * / 4 ND-1.7 0.8 ± 0.7	6 0.5-2.6 1.8 ± 0.7 / 3 220-1600	1-2 Se 50 / H2O(1): All ND Sed(1): All ND
Ventura River R1 (Estuary to Main St) and R2 (Main St. to Weldon Cyn) 303(d)-low 319	402.10	0.10 and 4.84	CA402 0010R and CA402 0020R	6 impaired	N FT N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan	TDS*,SC*,CHL*,B* TDS*,SC*,CHL*,SO4*,AMM CHL*,AMM,DO AMM,ALGAE, COLOR ALGAE, COLOR	TIS(Cu,Se,As,Zn) Turb Turb	Urban runoff (m) Oil fields (o) Municipal Effluent (m) Transient encampments (m) Natural sources (m) Agriculture (a) Recreational use (n) Industrial sources (n) Spills (o)
262 / 269 9-38 / 7.1-8.9 17 ± 4 / 7.9 ± 0.3	269 2.0-14.8 7.9 ± 2.6	13 680-1480 1087 ± 339	7 827-1800 1388 ± 325	9 377-824 623 ± 66	9 0.3-1.3 0.8 ± 0.4	10 24-304 202 ± 104 / 10 340-430 388 ± 66	Tissue('90): no organic chemicals at elevated levels * Tissue('91): Zn(EDL85) * Tissue('93): Cu(EDL85), Se(EDL85), Ag(EDL85), Zn(EDL85) * / 469 ND-6.2 1.4 ± 0.8	13 1.8-27.8 8.1 ± 6.4 / 1 120	7 Se 1700 Cd 16 Cr 98 Cu 191 Pb 140 Zn 883 / H2O(9) [illegible] Sed(1) ND
Canada del Diablo	402.10	0.8	CA402 0030R				Unassessed		Spills Oil field operations
Canada Large	402.10	0.01	CA402 0080R	5 unknown	N N F N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan	TDS*,SC*,CHL*,B* SO4*,B* TDS*,SC*,SO4* ALGAE ALGAE TDS*,SO4*,B*	TRASH TRASH	Natural sources (m) Oil field operations (o) Agriculture (m) Grazing (m)
8 / 8 10-29 / 6.9-8.9 20 ± 8 / 8.1 ± 0.8	no data	8 84-2820 2225 ± 891	7 147-3000 2846 ± 1016	4 784-1134 888 ± 138	7 0.1-1.7 1.2 ± 0.5	8 6-216 138 ± 67 / 8 6-1800 1000 ± 683	no data / 1 ND	7 0-2.6 0.88 / no data	1 Se 40 Se 0 / no data
Ventura River R3 (Weldon Cyn to conf. with Coyote Creek (Centex Vista/Bonita Ave Rd)) 303(d)-low 319	402.10	0.76	CA402 0100R	6 impaired	N FT N P F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan	SC* TDS*,SC*,SO4*AMM Water diversion and pumping AMM	pH	Natural sources (m) Urban runoff (m) Diversions/flow alteration (m) Agriculture (a) Recreational use (n) Grazing (a)

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Reach/location (Ventura River Watershed/Lake		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	NO3	N+N	Fec Col	metals	Org Chem
130 9-23 16 ± 4	109 7.2-8.9 8.2 ± 0.3	107-3.3- 14.4 10.4 ± 1.7	9 575-812 689 ± 72	9 844- 1088 953 ± 93	9 350-510 440 ± 62	2 0.3- 0.3 0.38 ± 0.08	9 15-62 44 ± 13	9 230-280 253 ± 9	no data	478 0.1-4.8 0.4 ± 0.3	2 1.2-1.4 1.3 ± 0.09	no data	no data	no data
Weldon Cyn		402.10	6.3	CA402. 0170R					Unassessed					
Ventura River R4 (Coyote Creek to Casitas Lake Rd) 303(d)-low		402.20	14.84	CA402. 0180R	9 good	N FT N F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC TDS,SC Water diversion and pumping				Natural sources (ns) Urban runoff (us) Diversions/flow alteration (ds) Agriculture (a) Recreational use (d) Groundwater withdrawal (ds)	
66 13-39 21 ± 3	41 7.3-8.5 8.2 ± 0.2	no data	41 640-884 689 ± 67	41 720- 1100 980 ± 81	1 338	41 0.3- 0.6 0.4 ± 0.1	19 8-58 41 ± 13	19 216-291 247 ± 20	no data Robles Diversion by-pass flows [1]	2 0.3-0.3	19 0.09-2.3 1.2 ± 0.6	no data	1 Se 62	1 ND
Coyote Creek R1 (cont) Ventura to Lake Casitas Dam)		402.20	2.69	CA402. 0180R	3 good	FT F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,SO4* TDS*,CHL*,SO4*				Natural sources (ns) Recreational use (d) Urban runoff (u) Flow alterations (ds) Agriculture (a) Animal operations (a)	
3 10-22 17 ± 5	5 7.4-8.5 7.7 ± 0.4	no data	5 410- 1320 667 ± 307	4 895- 1480 1193 ± 348	3 305-920 603 ± 220	4 ND- 0.7 0.5 ± 0.3	5 17-128 76 ± 35	5 84-445 328 ± 139	no data	2 ND-0.4 0.2 ± 0.2	5 0.5-0.9 0.7 ± 0.2	no data	1 Se 110 Hg 0.4	1 ND
Lake Casitas 303(d) low 314 319		402.30	2708 ac	CA402. 0230L	2739 Intake	F F FT F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c				TIS(As): Fully but threatened		Natural sources (ns) Urban runoff (us) Aerial deposition (ad)	
113 10-39 16 ± 5	113 7.3-8.5 7.8 ± 0.4	113 0.3-10.9 6.9 ± 3.5	42 283-479 369 ± 35	42 857-908 891 ± 16	no data	no data	42 148-190 169 ± 11	47 165-381 219 ± 34	Tissue (ug): As(EDL69) [1]	42 ND	42 ND-0.27 0.19	no data	no data	34+ a,m,s,v,w,y,aa,ad,af, ao,ap,bi,av,au,ay,ba ,be
Coyote Creek R2 (above lake)		402.30	7.69	CA402. 0290R					Unassessed				Grazing Groundwater pumping	
Santa Ana Creek 1		402.30	3.69	CA402. 0040R	10 good	N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC* TDS*				Natural sources (ns) Agriculture (a) Grazing (g) Diversions/flow alteration (ds)	

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COMMENT VOL 12

Reach/location (Ventura River Watershed Units		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQ A	Assessed Uses		Not supporting		Partially supporting		Sources	
Temp	pH	DO	TDS	SC	Hard	S	Chl	SO4	Tissue, Sediment and Toxicity Data	NHB	N+N	Fecs Col	metals	Org Chem
3 12-19 14 ± 4	4 7.9-8.5 8.2 ± 0.3	no data	4 420- 1078 662 ± 242	4 630- 1327 884 ± 280	1 430	4 ND- 0.7 0.3 ± 0.3	4 8-124 41#	4 129-393 199 ± 86	no data	1 ND	1 0.2	no data	no data	no data
San Antonio Creek R1 (cont. Ventura to Ojai Valley Country Club) and San Antonio Creek R2 (abv Ojai Valley Country Club)		402.30 402.32	8.42 and 8.02	CA402. 0410R and CA402. 0510R	16 good	N FT F P P	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC TDS,SC,SO4 TDS,CHL,SO4		ALGAE, Turb ALGAE, Turb		Natural sources (ns) Urban runoff (ns) Agriculture (ns) Grazing (s) Diversions/flow alteration (s)	
23 13-38 19 ± 4	27 7.7-8.4 8.1 ± 0.2	no data	27 663- 1000 847 ± 67	28 973- 1560 1227 ± 147	3 466-629 485 ± 32	28 nd- 0.6 0.3 ± 0.1	8 38-120 67 ± 29	8 220-338 309 ± 17	no data	2 ND-0.3	8 1.2-6.9 3.2 ± 1.4	no data	1 Be 70 Be 6	1 ND
Lion Canyon R1 (cont. SA to Reservoir) and Lion Canyon R2 (abv reservoir)		402.30 402.31	4.66 and 4.84	CA402. 0430R and CA402. 0470R	9 good	N F P P	Agriculture Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* TDS*,SC*,SO4* COLOR COLOR TDS*,SO4*		Turb Turb		Natural sources (ns) Grazing (s) Agriculture (s) Urban runoff (s)	
2 12-32	4 7.4-8.2 7.9 ± 0.3	no data	4 708-974 888 ± 101	3 1080- 1270 1180 ± 86	3 519-691 538 ± 14	3 0.3- 0.6 0.4 ± 0.1	4 46-80 59 ± 13	4 200-338 276 ± 63	no data	1 0.0	6 ND-6.3 2.3 ± 2.1	no data	1 Be 60 Be 16	1 ND
Stewart Cyn		402.32	2.66	CA402. 0530R					Unassessed					
Fox Cyn		402.32	0.3	CA402. 0540R		N FT F U U	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL* TDS*,SC*,SO4* TDS*,CHL*				Natural sources (ns) Urban runoff (ns)	
1 12	3 6.8-8.6 7.9 ± 0.8	no data	3 88-820 629 ± 383	3 134- 1460 881 ± 668	2 623-693	3 ND- 0.1 0.07 ± 0.04	3 7-116 79 ± 61	3 7-289 199 ± 135	no data	no data	3 0.3-6.9 3.8 ± 2.4	no data	1-2 ND	no data

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Reach/location (Ventura River Watershed)/Date		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
Ventura River R6 (Camino Cielo Rd to Jct Matilija)		402.20	0.23	CA402.0790R	9 good	N FT U P F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		B* TDS*,AMM* AMM* CHL*				Natural sources (m) Mine drainage (s) Recreational use (s) Agriculture (s) Grazing (s)	
3 11-19 16 ± 4	4 7.8-8.3 8.0 ± 0.2	no data	6 534-791 629 ± 91	4 760-849 810 ± 28	6 356-433 391 ± 34	6 ND- 1.2 0.69	6 9-150 86 ± 52	6 205-275 246 ± 24	no data	3 ND-0.7 0.39	6 ND	no data	2-4 Be 101 Cd 1	3 ND
Matilija Creek R1 (jct with north fork to reservoir) and R2 (abv reservoir) 303(d)-low		402.20 402.20	1.8 and 16.6	CA402.0800R and CA402.0820R	7 good	N FT N F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC,B TDS Fish harder B		TDS,CHL		Natural sources (m) Diversion/flow alteration (m) Agriculture (s) Grazing (s) Recreational use (s)	
25 9-28 16 ± 5	29 7.7-8.6 8.1 ± 0.2	21 5.9-13.2 8.5 ± 1.8	29 356-776 607 ± 76	28 545-2015 938 ± 317	19 184-488 288 ± 80	27 ND- 1.8 0.7 ± 0.5	29 4-63 38 ± 34	29 83-294 240 ± 37	Matilija Dam removal issues **	1 8.6	27 ND-0.7 0.19	no data	1 Be 90	1 ND
Matilija Reservoir 303(d)-low 310		402.20	198 acres	CA402.0810L	124 interm	N FT N F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC,B TDS Fish harder B		TDS,CHL		Natural sources (m) Flow modification (m) Agriculture (s) Recreational use (s) Grazing (s)	
Matilija Creek Upper North Fork		402.20	7.02	CA402.0840R	9 unknow n				Unassessed					
Matilija Creek North Fork and Bear Creek		402.20 402.20	7.71 and 7.75	CA402.0860R and CA402.0870R	6 good	N FT U F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC* TDS*,SO4*				Natural sources (m) Recreational use (s) Grazing (s)	
3 13-39 16 ± 3	6 7.8-8.4 8.1 ± 0.2	no data	6 530-918 639 ± 100	7 780-1188 888 ± 136	4 400-457 416 ± 28	7 ND- 1 0.49	8 6-48 30 ± 15	8 215-310 280 ± 34	no data	no data	7 0-1.4 0.39	no data	1 Be 88	no data

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Reach Location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tmxs, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
Santa Clara River Estuary 303(d)-low		403.11	2.67	CA403.0 030E	60 as unknown	F N U	Aquatic life Recreation: cont. Recreation: non-c		COLIFORM				Urban runoff (m) Agricultural (o) Oil spills (o) Municipal effluent (m) Transient encampments (m) Bird droppings (m)	
									Sed tox: good survival rates [1] Sed chem: low pesticide levels [1] Wet tox: 100% normal [1]			75-93% exceedances		
Santa Clara River R1 (Estuary to Hwy 101 bridge) and R2 (Hwy 101 bridge to Freeman Diversion)		403.11 and 403.11	6.79 and 6.99	CA403.0 020R and CA403.0 030R	79 biasm	N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* SO4* TDS*,SO4* (Exotic vegetation)				Natural sources (m) Diversion/flow alteration (m) Agriculture (m) Urban runoff (m) Resource extract'n (m) Municipal effluent (m)	
10 9-38 16 ± 8	8 7.7-8.3 8.0 ± 0.2	no data	5 710-1383 877 ± 228	5 790-1700 1344 ± 317	2 420-780 600 ± 166	5 0.1-0.7 0.5 ± 0.2	5 24-74 49 ± 17	5 290-620 434 ± 114	no data	no data	2 0.8-0.9 0.9 ± 0.1	no data	1-2 Ba 65 Cd 2 Se 6	H2O(4) ND Sed (1) ND
Brown Barranca/Long Canyon †		403.11	3.79	CA403.0 080R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL* SO4* TDS*,SC*,SO4* TDS,SO4*				Natural sources (m) Agriculture (m) Urban runoff (m)	
3 15-17 16 ± 1	8 7.4-8.4 7.9 ± 0.3	no data	6 872-5772 2387 ± 1667	6 826-3480 2164 ± 883	6 213-1910 833 ± 604	6 0.14-1.4 0.6 ± 0.5	6 32-256 118 ± 89	6 101-3300 1112 ± 1081	no data	no data	6 2.5-8.9 4.8 ± 2.7	no data	1 Se 6	H2O(1) of Sed(2) sb,se,ed Sed
Ellsworth Barranca/Miles Cyn †		403.21	7.1	CA403.0 110R	0 unknown	N N F U U	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL*,B* SO4* TDS*,SC*,SO4* TDS,SO4*, CHL*,B*				Natural sources (m) Urban runoff (m) Agriculture (m)	
6 2-38 13 ± 7	no data	no data	10 880-3671 1986 ± 749	9 785-3712 2169 ± 1081	9 243-1168 614 ± 304	9 0.3-2.2 1.0 ± 0.7	11 38-860 221 ± 188	10 231-1039 682 ± 311	no data	no data	no data	no data	no data	H2O (1) ND Sed(2) sb,se,ed

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Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	CH	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
Wheeler Cyn/Todd Reservoir 1		403.21	4.17	CA403.0 140R	6 Interm	N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL*,B* SO4* TDS*,SO4* TDS,SO4*, CHL*				Natural source (ns) Urban runoff (us) Petroleum operations (o) Agriculture (a)	
7 3-31 19 ± 9	12 7.3-8.1 7.7 ± 0.2	no data	13 880-2980 1991 ± 613	11 676-3382 2311 ± 671	11 237-1388 908 ± 297	12 0.08-1.7 0.8 ± 0.4	14 40-215 144 ± 51	12 238-1412 875 ± 309	no data	no data	12 0.8-25.8 8.89	no data	0-1 Zn 70	H2O (1) ex,sf Sed (2) ec
Santa Clara River R3 (Diversion to abv SP Crossfeder Timber Cyn)		403.21	13.24	CA403.0 160R	79 Interm	N N FT P F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,B* SO4* TDS*,SC*,SO4*,AMM* (Exotic vegetation) AMM* SO4*,CHL*		CHL* TOX: Fully bio treatment		Natural sources (ns) Urban runoff (us) Resource extraction (m) Municipal effluent (c) Industrial point source (c)	
20 13-38 19 ± 3	3 8.2-8.3 8.2 ± 0.05	no data	5 832-1380 1049 ± 241	23 1120-2180 1484 ± 304	5 410-760 588 ± 131	5 0.6-0.9 0.7 ± 0.2	27 34-110 79 ± 21	28 320-760 565 ± 162	Tissue('91): no organic chemicals at elevated levels * Tissue('92): no organic chemicals at elevated levels * Wet Bio Toxicity: reproduction affected, low level chronic toxicity found *	5 0.02-0.45 0.28 ± 0.19	5 1.6-3.2 2.5 ± 0.7	no data	no data	no data
Fagan Cyn 1		403.21	4.69	CA403.0 260R		N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* TDS*,Fe*,Mn*				Natural sources (ns) Agricultural (a) Urban runoff (us)	
2 11	5 6.8-8.4 7.3 ± 0.6	no data	4 132-1070 625 ± 364	5 199-1380 731 ± 471	1 287	4 0.1-0.9 0.4 ± 0.3	5 9-79 38 ± 28	5 ND-618 209 ± 192	no data	no data	5 1.1-3.6 2.1 ± 0.9	no data	no data	no data
Santa Paula Creek R1 (confluence with SC to Diversion Dam)		403.21	2.0	CA403.0 280R	14 good	N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC TDS,SC		CHL		Natural sources (ns) Resource extraction (m) Urban runoff (u) Agriculture (a)	
22 8-23 16 ± 4	21 7.9-8.6 8.1 ± 0.2	17 7.1-14.0 10.2 ± 1.7	21 410-912 676 ± 169	21 540-1414 977 ± 267	10 164-414 316 ± 91	4 0.1-0.6 0.3 ± 0.2	21 11-189 67 ± 49	21 88-364 228 ± 60	no data	2 0.09-0.55	5 0-0.5 0.2 ± 0.2	no data	no data	1 MD

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Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC [1]	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
Santa Paula Creek R2 (Abv Diversion Dam) [1]		403.21	12.41	CA403.0 310R	14 good	F FT FT N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		Turb* Turb*,oil		TOX: Fully but threatened COLOR		Natural sources (ns) Urban runoff (u) Agriculture (a)	
10 10-22 15 ± 4	17 7.2-8.4 7.9 ± 0.4	1 10.6	15 189-791 417 ± 146	16 214-1000 578 ± 146	13 110-660 267 ± 113	16 ND-0.2 0.059	16 4-34 9 ± 7	16 38-300 153 ± 68	no data	no data	9 0-1.1 0.4 ± 0.3	no data	1 Be 59	2 be
Sisar Creek R1 and R21		403.21 403.22	1.22 and 0.65	CA403.0 340R and CA403.0 360R	2 Impaired and 5 good	N FT F N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC* Turb*, TDS* Turb* SO4*				Natural sources (ns) Urban runoff (u) Agriculture (a)	
8 8-16 12 ± 2	12 6.9-8.2 7.8 ± 0.4	1 8.2	12 328-638 500 ± 198	11 484-1275 845 ± 285	11 198-627 379 ± 122	12 ND-0.5 0.19	12 3-110 32 ± 29	12 118-307 205 ± 65	no data	no data	9 0-1.5 0.8 ± 0.5	no data	1 Be 60 Cd 2	1 ND
Santa Clara River R4 (below Timber Cyn to abv Grimes Cyn) [1]		403.31	9.63	CA403.0 430R	79 trauma	N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,B* SO4 TDS*,SC (Exotic vegetation) TDS*,SO4		CHL		Natural sources (ns) Oil spills (o) Industrial point sources (c) POTW effluent (ps) Agriculture (a) Urban runoff (u)	
21 7-29 17 ± 6	17 7.9-8.4 8.0 ± 0.2	16 7.0-10.7 8.1 ± 1.1	17 858-1615 1179 ± 309	22 737-1980 1461 ± 351	11 316-776 564 ± 139	16 0.1-1.1 0.7 ± 0.3	21 25-110 68 ± 22	21 232-741 530 ± 176	no data	no data	17 0.9-3.5 2.2 ± 1.0	no data	no data	3 ND
Timber Cyn		403.31	0.12	CA403.0 440R					Unassessed					
Balsam Cyn		403.31	2.69	CA403.0 460R					Unassessed					
Sespe Creek R1 (sect. u/SC to 8/97 abv Little Sespe)		403.31	7.9	CA403.0 540R	46 good	N N FT P P	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC*,F*,B* B* TDS*,SO4* COLOR B*		TOX: Fully but threatened ALGAE ALGAE		Natural sources (ns) Agriculture (a) Urban runoff (u)	
4 16-35 23 ± 3	6 8.0-8.6 8.2 ± 0.2	1 10.6	6 510-769 648 ± 101	6 720-1009 801 ± 105	3 345-380 365 ± 18	4 ND-2.1 1.4 ± 0.8	6 10-69 51 ± 33	6 220-325 263 ± 40	Wat Bio Toxicity: reproduction affected, low level chronic toxicity found *	no data	4 ND-1.3 0.49	no data	1 Be 79 Cd 2	1 ND

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Reach/Area (Santa Clara River Watershed)		Hydro Unit	Site	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NHB	N+N	Fee Oil	metals	VOCs
Sespe Creek R2 (abv 5007 dis Little Sespe)		403.32	33.80	CA403.0 620R	45 good	N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,B TDS,SC,SO4 TDS,CHL,SO4,B				Natural sources (n)	
22 9-27 17 ± 6	39 7.9-8.6 8.2 ± 0.2	19 8.9-13.1 10.5 ± 1.2	39 484-1021 761 ± 136	26 674-1489 1078 ± 218	14 320-483 399 ± 47	22 0.1-4.2 1.4 ± 1.3	26 12-198 83 ± 64	26 190-432 304 ± 82	no data	2 0.01-0.05 0.03 ± 0.02	18 ND-0.4 0.19	no data	Bs(2) Be 91	1 ND
Pole Cyn ↑		403.31	8.6	CA403.0 940R	7 biasm	N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* SO4* TDS*,SC*,SO4* TDS*,SO4*				Natural sources (n) Industrial point source (n) Agriculture (n)	
4 10-13 11 ± 1	8 7.6-8.3 7.9 ± 0.2	no data	8 880-1794 1372 ± 277	8 1027-2036 1643 ± 292	5 669-1016 816 ± 162	8 0.1-0.4 0.3 ± 0.1	9 9-32 19 ± 8	8 452-861 717 ± 149	no data	no data	8 0.3-1.3 0.7 ± 0.4	no data	1 Be 49 Se 16	2 ND
Santa Clara River R5 (abv Grimes Cyn to Propane Rd) and R6 (Propane Rd to Blue Cut)		403.31 403.41	2.10 and 11.10	CA403.0 930R and CA403.0 980R	79 biasm	N FT FT N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* TDS*,SC*,SO4*,AMM* (Exotic vegetation) AMM*, Turb,COLOR		TOX and Bed Chem(DDT): Both fully but threatened		Natural sources (n) Agriculture (m) Urban runoff (u)	
15 17-39 22 ± 3	11 7.5-8.6 8.1 ± 0.3	no data	8 653-1080 874 ± 267	19 986-1980 1162 ± 202	6 310-640 438 ± 73	7 0.6-0.8 0.6 ± 0.1	14 15-120 81 ± 27	14 64-680 312 ± 131	Wat Bio Toxicity: reproduction affected, low level chronic toxicity found * Bed chem: DDE(300ppb), DDT(180 ppb) [RWQCB data]	3 0.11-0.8 0.5 ± 0.3	9 0.6-22.6 5.89	no data	2-4 Be 133 Cu 10	H2O(9) ND Sed(2) ac,ed,sf
Hopper Cyn ↑		403.41	13.86	CA403.1 010R	10 biasm	N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC SO4 Turb*,TDS,SC,SO4 SO4 TDS,SO4		CHL,B CHL		Natural sources (n) Agriculture (m) Urban runoff (u) Municipal effluent (m)	
33 9-31 18 ± 7	66 6.9-8.5 7.9 ± 0.4	1 9.5	64 274-5749 1880 ± 1407	66 370-8000 1918 ± 1418	54 183-1370 883 ± 282	64 ND-8.3 0.89	66 2-643 169	66 6-1440 578 ± 327	no data	no data	43 ND-2.9 0.89	no data	1 Be 40 Se 16	1 ND
Tessy Cyn ↑		403.41	1.7	CA403.1 060R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,B* SO4* TDS*,SC*,SO4* TDS*,SO4*				Natural sources (n) Agriculture (m)	

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Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
2 12-14	4 7.1-8.2 7.6 ± 0.5	no data	4 2068-6160 3460 ± 1151	4 2203-6260 3421 ± 1185	3 1194-2810 1993 ± 660	4 0.4-1.8 1.0 ± 0.6	4 1-103 42 ± 40	4 1222-3020 2020 ± 645	no data	no data	3 1.3-17.7 7.09	no data	0-1 ND	no data
Reel Wash/Canyon/Drain		403.41	2.42	CA403.1 070R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* SO4* TDS*,SC*,SO4* TDS*,SO4*				Natural sources (m) Urban runoff (u)	
2 10-11	3 7.1-8.8 7.8 ± 0.8	no data	3 165-4880 2259 ± 1858	3 233-4910 2600 ± 1912	2 111-2338	3 0.2-1.8 0.7 ± 0.8	3 3-44 27 ± 17	3 86-2570 1460 ± 1193	no data	no data	3 ND-7.2 3.09	no data	1 Se 12	no data
Smith Cyn		403.41	2.27	CA403.1 080R					Unassessed					
1 12	2 8.0-8.1	no data	2 3610-4873	2 3800-6120	1 2108	2 1.4-13.3	2 119-480	2 1210-2110	no data	no data	1 6.38	no data	1 ND (Cu and Zn only metals scanned)	1 ND
Piru Creek R1 (cont. Santa Clara to stw gaging station below Santa Felicia Dam)		403.41	6.09	CA403.1 130R	86 good	N FT FT N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC* TDS*,SC*,SO4* ODOR ODOR		TOX: Fully but threatened Turb		Imported water (m) Natural sources (m) Agriculture (m) Urban runoff (u)	
6 16-23 19 ± 2	7 7.7-8.6 8.1 ± 0.3	1 11.7	6 880-1057 784 ± 151	6 800-1400 888 ± 208	4 308-688 417 ± 91	6 0.3-0.8 0.6 ± 0.1	7 47-114 76 ± 23	7 210-442 316 ± 88	Wet Bio Toxicity: reproduction affected, low level chronic toxicity found *	no data	5 ND-0.6 0.2 ± 0.1	no data	0-3 Se 64 Cd 22	1 ND
Piru Creek R2 (gage to Santa Fe. Dam)		403.41	STILL NEED	CA403.1 160R	86 good	N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC* TDS*,SC*,SO4* CHL*				Natural sources (m) Imported water (m)	
19 7-27 16 ± 4	16 7.9-8.9 8.3 ± 0.3	16 7.8-14.7 11.9 ± 2.0	18 630-888 729 ± 116	19 822-2208 1089 ± 284	13 273-434 371 ± 91	17 0.14-2.4 0.7 ± 0.5	16 61-113 88 ± 16	16 200-370 273 ± 42	no data	2 0.02-0.04 0.03 ± 0.01	17 ND-0.7 0.3 ± 0.3	no data	2 Se 34 Se only metal scanned.	no data

R0033680

COPY VOL 12

Reach/Rx... (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
Lake Piru (lower and upper areas)		403.41 403.42	1439 ac	CA403.1 190L and CA403.1 260L	1240 good	N FT N F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		SC TDS DO				Natural sources (ns) Aerial deposition (ad) Imported water (iw)	
105 10-26 18 ± 5	105 7.1-8.2 7.9 ± 0.3	105 0.3-10.1 6.0 ± 3.3	47 785-840 678 ± 43	47 785-840 678 ± 43	no data	no data	47 40-74 58 ± 9	42 80-159 112 ± 29	no data	47 ND-0.1 0.0079	105 0.3-10.1 6.0 ±3.3	no data	no data	no data
Piru Creek R3 (Lake Piru to Pyramid Lake)		403.42	8.70	CA403.1 290R	65 good	F F F P F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		CHL*		ALGAE		Imported water (iw) Natural sources (ns) Recreational uses (ru)	
2 11-21 16 ± 5	6 8.7-8.7 7.8 ± 0.6	6 10.3-13.0 11.3 ± 0.9	6 346-637 407 ± 68	6 622-800 668 ± 65	6 138-349 165 ± 39	6 0.2-0.6 0.3 ± 0.1	6 100-130 114 ± 10	6 69-134 79 ± 38	no data	no data	6 ND-0.9 0.6 ± 0.3	6 100-120	no data	no data
Pyramid Lake		403.42	1620 ac	CA403.1 430L	1380 good	F F F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c						Natural sources (ns) Aerial deposition (ad) Imported water (iw)	
90 6-34 17 ± 6	90 7.2-8.9 8.0 ± 0.5	90 4.0-13.1 8.6 ± 2.6	42 662-718 691 ± 18	42 662-718 691 ± 18	no data	no data	42 86-111 90 ± 18	43 89-156 122 ± 17	no data	42 ND-0.2 0.010	90 4.0-13.1 8.6 ± 2.6	no data	no data	no data
Canada de las Alamos ↑		403.43	7.84	CA403.1 480R	6 unknown	F FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		Turb* CHL*				Natural sources (ns) Grazing (g)	
12 6-27 16 ± 7	16 7.4-8.2 8.3 ± 0.3	11 7.8-11.9 8.3 ± 1.2	13 162-1282 667 ± 382	13 305-1761 672 ± 533	13 83-480 217 ± 122	13 0.13-2.5 0.8 ± 0.7	13 16-104 75 ± 40	13 22-629 163 ± 180	no data	no data	12 0.07-0.9 0.3 ± 0.2	no data	no data	no data
Gorman Creek		403.43	12.21	CA403.1 510R	12 biomn				Unassessed					
Piru Creek Reach 4 (blw Pyramid Lake) ↑		403.42	34.23	CA403.1 560R		N N F N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC*,B* B* Turb*,TDS*,SC*,SO4* Turb*,SO4* B*				Natural sources (ns) Grazing (g) Agriculture (a) Recreation (r)	

R0033681

COMCS VOL 12

Reach/Location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	NNB	N+N	Fec Col	metals	VOCs
13 6-30 17 ± 7	8 8.2-8.2 8.6 ± 0.3	10 7.9-11.8 9.6 ± 1.1	15 404-1160 754 ± 249	15 519-1381 960 ± 236	13 387-800 406 ± 143	15 0.2-3.7 1.5 ± 0.98	15 5-26 11 ± 6	15 182-672 386 ± 158	no data	no data	9 ND-1.3 0.29	no data	no data	1 ND
Lechuza Creek R1 and R2 ↑		403.42 403.44	4.10 and 7.68	CA403.1 710R and CA403.1 720R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC*,B* B* TDS*,SO4* B*				Natural sources (m) Grazing (s) Agriculture (s) Recreation (s)	
4 16-18 16 ± 1	7 7.2-8.4 8.0 ± 0.4	1 10.6	7 420-7135 15289	7 894-801 788 ± 103	3 311-380 369 ± 34	7 1.6-8.1 5.3 ± 2.9	7 6-11 9 ± 2	7 175-373 240 ± 39	no data	no data	4 0.4-2.7 1.3 ± 0.9	no data	1 As 7 Se 60	no data
Seymour Creek ↑		403.44	7.2	CA403.1 730R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		B* B* B*				Natural sources (m) Grazing (s) Agriculture (s) Recreation (s)	
1 16	3 7.8-8.4 8.2 ± 0.3	no data	3 320-546 435 ± 92	3 430-760 623 ± 146	no data	3 0.5-3.7 1.8 ± 1.4	3 5-10 7 ± 2	3 59-192 123 ± 54	no data	no data	1 ND	no data	no data	no data
Aliso Creek ↑		403.44	4.92	CA403.1 740R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		B* B* B*				Natural sources (m) Grazing (s) Agriculture (s) Recreation (s)	
1 11	4 7.9-8.4 8.0 ± 0.4	no data	4 373-612 464 ± 93	4 630-917 828 ± 111	no data	4 8.1-13.4 8.6 ± 3.0	4 4-6 5.5 ± 1	4 116-259 186 ± 42	no data	no data	3 ND-0.4 0.29	no data	no data	no data
Lechuza Creek Middle Fork ↑		403.44	1.2	CA403.1 760R		N N F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		B* B* Fe*,Mn* B*				Natural sources (m) Grazing (s) Agriculture (s) Recreation (s)	
8 10-19 16 ± 4	7 8.0-8.4 8.3 ± 0.2	no data	7 195-839 437 ± 198	7 439-1010 603 ± 207	1 300	7 0.1-2.4 1.4 ± 0.9	7 4-8 7 ± 2	7 ND-483 171 ± 139	no data	no data	2 ND	no data	no data	no data
Tapo Cyn		403.41	1.82	CA403.1 830R	16 Intens				Unassessed					

R0033682

COMPO VOL 12

Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Pos Cal	metals	VOCs
Santa Clara River R7 (Blue cut (west of Sell) to West Pier Hwy 99)		403.51	9.21	CA403.1 940R	79 Interm	N FT FT N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL* TDS*,SC*,SO4*,AMM* (Exotic vegetation) Turb* CHL*		TIS(Ag,Zn)-Fully supporting but threatened		Grazing - riparian (m) Agriculture (m) Natural sources (m) Urban runoff (m) Industrial point source (s)	
14 21-27 23 ± 2	13 7.3-8.5 8.2 ± 0.4	9 8.1-8.9 8.2 ± 0.4	9 660-938 879 ± 80	15 984-1482 1336 ± 107	6 360-470 425 ± 27	5 0.4-0.7 0.6 ± 0.1	9 54-139 109 ± 22	9 188-370 308 ± 60	Tissue('91): no organic chemicals at elevated levels * Tissue('92): Ag(EDL85), Zn(EDL85) *	4 0.07-0.44 0.20 ± 0.13	8 1.3-7.5 4.5 ± 1.9	3 20-880	no data	3 ND
Castaic Creek R1 (confl SC to Castaic Lagoon)		403.51	4.3	CA403.1 990R	6 good				Unassessed					
Castaic Lagoon 314 310		403.51	160 ac	CA403.2 240L	197 Interm	N F F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		SC, CHL				Natural sources (m) Urban runoff (m) Aerial deposition (s) Recreational use (m) Bird droppings (m)	
116 8-39 19 ± 6	109 7.1-8.7 8.2 ± 0.4	116 0.2-13.7 6.1 ± 3.2	43 744-798 769 ± 13	43 744-798 769 ± 13	no data	no data	43 88-114 103 ± 10	62 80-134 113 ± 7	no data	43 ND-0.13 0.039	116 0.3-13.7 6.1 ± 3.2	no data (sources reported due to sediment)	no data	no data
Castaic Creek R2 (lagoon to lake)		403.51	0.71	CA403.2 270R					Unassessed					
Castaic Lake		403.51	4109 ac	CA403.2 260L	2630 good	F F F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c						Imported water (m) Natural sources (m) Oil spills (s) Aerial deposition (s)	
141 7.2-8.7 7.9 ± 0.4	141 0.5-14.6 8.8 ± 3.3	62 668-739 703 ± 7	62 668-739 703 ± 7	no data	no data	62 79-105 93 ± 7	15 24-82 50 ± 20	no data	62 ND-0.1 0.0039	141 0.15-14.6 8.8 ± 3.3	no data	no data	no data	
Elderberry Forebay		403.51	380 ac	CA403.2 300L					Unassessed					
Castaic Creek R3 (abv Castaic Lake) ?		403.51	11.2	CA403.2 320R		N FT N F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC* TDS*				Natural sources (m)	
1 37	4 0.0-0.4 0.2 ± 0.1	1 0.0	7 480-710 610 ± 84	4 990-1109 015 ± 309	4 280-380 348 ± 61	no data	4 13-43 30 ± 11	4 140-320 233 ± 69	no data	no data	4 0.09-0.8 0.4 ± 0.3	2 3-6	0-4 Ba 37	no data

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COMPT VOL 12

Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	VOCs
Elizabeth Lake Cyn ↑		403.51	19.09	CA403.2 470R		N FT F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SC*,F* TDS*				Natural sources (m) Urban runoff (m)	
2 28	9 8.0-8.5 8.3 ± 0.2	2 8.2-8.8	12 380-660 557 ± 159	9 450-1500 893 ± 300	9 210-440 320 ± 75	no data	9 18-190 73 ± 48	9 62-250 152 ± 56	no data	no data	9 ND-0.8 0.2#	2 ND-3	1 Be 65 Cu 50 Zn 250	1 ND
Lake Hughes 303(d) - low 314 319		403.51	34 ac	CA403.2 610L	40 Impaired	N FT N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		TDS*,SC* TDS*,SC*,SO4* EUT, Fish kills TRASH,ODORS, ALGAE TRASH,ODORS, ALGAE				Natural sources (m) Urban runoff (m) Aerial deposition (d) Septic systems (m) Recreational use (m)	
15 10-21 16 ± 5	15 7.7-8.1 8.0 ± 0.1	15 4.5-11.0 8.8 ± 2.1	10 231-1100 769 ± 222	10 1105- 6230 1732 ± 1508	no data	no data	9 78-262 103 ± 57	10 217-2914 544#		9 ND	9 ND	no data	no data	no data
Munz Lake 303(d)-low		403.61	18 ac	CA403.2 620L		N F N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		SC* EUT TRASH TRASH				Natural sources (m) Urban runoff (m) Aerial deposition (d) Nutrient-rich sediments (m) Septic systems (m) Recreational use (m)	
22 6-24 15 ± 7	22 6.5-8.1 7.5 ± 0.4	22 6.5-10.4 8.3 ± 1.3	15 382-822 638 ± 174	15 382-822 638 ± 174	no data	no data	15 32-73 55 ± 17	15 24-82 50 ± 20	no data	15 ND-0.23 0.04#	22 6.5-10.4 8.3 ± 1.3	no data	no data	no data
Elizabeth Lake 303(d)-low 314 319		403.61	194 ac	CA403.2 640L	80 Impaired	N N N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,CHL SO4* pH,TDS,SC,CHL,SO4,AMM CHL,pH,EUT AMM,pH,TRASH TRASH		DO		Natural sources (m) Urban runoff (m) Aerial deposition (d) Nutrient-rich sediments (m) Septic systems (m) Recreational use (m)	
30 6-22 14 ± 6	30 7.3-9.6 8.6 ± 0.7	30 0.8-11.0 7.7 ± 2.5	20 722-4000 2986 ± 1774	20 1152- 6330 4141 ± 2323	no data	no data	20 128-1069 653 ± 412	20 153-1789 956 ± 636		20 ND-0.45 0.12#	20 ND-0.88 0.2#	no data	no data	no data

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VOL 12
CM3-00

Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N-N	Fec Col	metals	VOCs
Santa Clara River R9 (W Pier Hwy 99 to Bouquet Cyn Rd Bridge) 303(d)-low		403.51	3.42	CA403.2 690R	79 Interim	N FT N N F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,CHL,B TDS,SC,AMM AMM AMM,COLIFORM CHL		TOX-Fully but threatened COLOR		Natural sources (m) Oil spills (s) POTW effluent (m) Urban runoff (m) Industrial point source s(s)	
88 10-27 18 ± 4	91 6.8-8.4 7.6 ± 0.3	20 4.2-10.6 7.4 ± 2.0	90 78-1138 754 ± 109	91 120-1412 1131 ± 148	82 32-608 366 ± 67	69 ND-1.4 0.7 ± 0.2	69 10-138 105 ± 21	90 20-513 201 ± 60	Wat Bio Toxicity: reproduction affected, low level chronic toxicity found *	69 ND-4.9 1.4 ± 1.3	69 0.3-15.4 5.7 ± 2.4	69 20-34000	69 As 12 Be 280 Cd 11 Cr 10 CrVI 29 Cu 60 Pb 100 Se 19 Zn 190 Ni 60	3-4 ND be scanned 67 times and detected above detectio n limit
San Francisquito Cyn		403.51	25.42	CA403.2 710R		F F FT F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan				TOX: Fully but threatened COLOR		Natural sources (m) Urban runoff (m) Agriculture (s)	
2 18-21	9 7.8-8.3 8.2 ± 0.2	1 8.2	9 217-787 448 ± 192	8 350-818 585 ± 230	7 82-440 249 ± 144	3 0.1-0.7 0.3 ± 0.28	9 14-44 28 ± 8	9 19-280 122 ± 95	Wat Bio Toxicity: reproduction affected, low level chronic toxicity found *	no data	9 ND-1.1 0.39	3 ND	0-4 Ag 160 As 35 Be 52 Cu 30 Pb 4	1 ND
Santa Clara River South Fork		403.51	8.09	CA403.2 790R					Unassessed					
Newhall Creek		403.51	4.2	CA403.2 800R					Unassessed					
Santa Clara River R9 (Bouquet Cyn Rd to abv Lang gaging station) and R10 (abv Lang gaging station) †		403.51 and 403.56	12.69 and 3.0	CA403.2 990R and CA403.3 380R	79 Interim	F F F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan						Resource extraction	
3 18-30 25 ± 5	16 7.9-8.6 8.1 ± 0.2	6 6.7-8.6 7.6 ± 1.2	18 310-677 440 ± 117	18 380-1600 701 ± 216	14 180-288 251 ± 29	1 ND	15 6-47 32 ± 10	15 20-100 69 ± 20	no data	no data	18 ND-4.5 0.69	10 3-62	0-2 Be 62 Pb 63 Cu 8 Zn(14) Zn 20	4 ND

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COMPO VOL 12

Reach/location (Santa Clara River Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NNS	H+N	Fec Col	metals	VOCs
Bouquet Cyn R1		403.51	11.16	CA403.2 970R	17 good	F F FT F F	Agriculture Drinking: Primary Drinking: Second Aquatic life Recreation: cont. Recreation: non-c Basin Plan				TOX: Fully but threatened		Toxicity may be from copper sulfate treatments in reservoir (m) Natural sources (m) Imported water (m) Recreational use (m)	
4 11-13 12 ± 1	12 7.6-8.6 8.2 ± 0.3	1 12	11 229-414 288 ± 45	11 341-654 440 ± 84	9 86-275 147 ± 61	5 0.5-0.6 0.56 ± 0.05	11 19-33 24 ± 4	11 28-77 38 ± 13	Wet Bio Toxicity: reproduction affected, low level chronic toxicity found [4]	no data	10 ND-1.2 0.49	3 2-13	0-4 As 10 Be 40 Cr 16 Zn 80	1 ND
Bouquet Reservoir		403.52	1208 ac	CA403.3 090L	628 good	F F F F F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c							
Mint Cyn R1 (confl to Rowler Cyn)		403.51	8.16	CA403.3 180R					Unassessed					
Mint Cyn Creek R2 (abv Rowler Cyn)		403.53	7.36	CA403.3 230R					Unassessed					
Agua Dulce Cyn R1 (confl SC to Hwy 14)		403.56	2.88	CA403.3 410R					Unassessed					
Agua Dulce Cyn R2 (abv Hwy 14)		403.54	6.61	CA403.3 430R					Unassessed					
Soledad Cyn		403.55	2.69	CA403.3 760R					Unassessed					
Aliso Cyn		403.55	7.06	CA403.3 780R					Unassessed					

R0033686

COMMCO VOL 12

Reach/location (Calleguas Creek Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	BC	Hard	S	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
Mugu Lagoon 303(d)-low 319		403.11	805 ac	CA404.0000E	1900 Impaired	N U U N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		Cu, Hg, Ni, Zn, Bird reproductivity(DDT), TIS(Chlordane, DDT, endosulfan, dieldrin, toxaphene, PCBs), Sed(DDT,toxaphene), SED TOX,Nitrogen, Excessive sediment TIS(DDT, PCBs, toxaphene)		TIS(As,Cd,Ag)		Natural sources (m) Agriculture runoff (m) Naval base activities (m) Construction (s) Landfill runoff (s) Industrial sites (m) Urban runoff (m)	
									Wat Chem: Cu, Hg, Ni, Zn exceedences [US Navy data] *Bird reproductivity* : DDT** *Tissue('90)*: no organic chemicals at elevated levels [9] *Tissue('91)*: As(EDL95), Cd(EDL95), Ag(EDL95) [9] *Tissue('92)*: DDT(MTRLs), PCBs(MTRLs), As(EDL95), Cd(EDL95), Ag(EDL95) [9] *Tissue('93)*: DDT(MTRLs), Ag(EDL95) [9] *Sed Chem('88,'89,'91,'92)*: DDE(200 ppb), DDD,toxaphene(1900ppb),DDT(30ppb) [1] *Sed Toxicity('93)*: poor survival rates [9] *Tissue('88,'93)*: toxaphene (NAS), DDT(NAS),chlordane,endosulfan,dieldrin [9]					
Rio de Santa Clara/Oxnard Drain #3 303(d)-low		403.11	2.49	CA404.0008R		N U U N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TIS(chlordane, DDT, toxaphene, ChemA, PCBs), SED TOX,Nitrogen TIS(chlordane, DDT, toxaphene, ChemA, PCBs)				Natural sources (m) Agriculture runoff (m) Urban runoff (m)	
									Tissue('90): chlordane(NAS), DDT(NAS), toxaphene(NAS), ChemA(NAS) [1] *Tissue('91)*: chlordane(NAS), DDT(NAS), PCBs(NAS), toxaphene(NAS), ChemA(NAS) [1] *Tissue('93)*: no organic chemicals at elevated levels [9] *Sed toxicity ('93,'94)*: poor survival rates [1] *Tissue('90-'91)*: toxaphene (NAS), PCBs(NAS), chlordane(NAS) [1]					
Duck Pond Ag Drain &Mugu Drain/Oxnard Dr #2 303(d)-low		403.11	13.8	CA404.0010R		N F F N	Agriculture Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TDS1,-CHL1 SO41,-N+N1 TDS1 TOX, SED TOX, Sed(DDT),TIS(Chlordane, toxaphene, DDT, ChemA), Nitrogen TIS(Chlordane, toxaphene, DDT, ChemA)		TIS(Dieldrin): Fully supporting bu threatened COLOR		Natural sources (m) Agriculture runoff (m) Urban runoff (m) Municipal effluent (m)	
2 20-22 21 ± 1	4 7.3-7.8 7.4 ± 0.1	no data	3 3388-5380 4086 ± 916	2 3120-3700 3410 ± 280	2 1515-1850 1683 ± 168	2 1.9-2.2 2.1 ± 0.1	3 176-580 334 ± 182	3 1538-2300 1918 ± 383	*Tissue('93)*: chlordane(MTRLs,FDA), DDT(MTRLs,FDA), toxaphene(MTRLs, NAS), dieldrin(EDL95), ChemA(NAS) [9] *Sed Chem('88,'89,'90)*: DDT (500ppb) [1] *Wat toxicity*: poor survival rates [9] *Sed toxicity*: poor survival rates [1]	no data	3 54-110 69 ± 29	no data	1 ND	H2O (2): a,s,y,o e,sf Sed (5): sb,sc,s d
Calleguas Creek Estuary 303(d)-low		403.11	0.8	CA404.0000E		N F F N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		AMM, TOX, SED TOX, Sed(DDT), TIS(chlordane, endosulfan,DDT,toxaphene), Nitrogen TIS(chlordane, DDT,toxaphene)		COLOR		Natural sources (m) Agriculture runoff (m) Urban runoff (m)	

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COMP
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Reach/location (Calleguas Creek Watershed)		Hydro Unit	Site	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
9 10-29 19 ± 5	28 6.6-8.6 7.7 ± 0.5	3 5.7-8.3 7.3 ± 1.1	26 636-7072 1719 ± 1391	21 1085-9000 2704 ± 1738	20 305-1380 705 ± 236	1 0.8	19 105-2820 551#	20 142-857 438 ± 183	*Wat toxicity:* poor survival rates * *Sed toxicity (93):* poor survival rates * *Sed chem:* DDT * *Tissue:* chlordane (283 ppb), DDT (4264 ppb), endosulfan (860 ppb), toxaphene(3600 ppb) *	28 0.1-30.2 2.7 ± 3.8	9 1.12-28.9 14.8 ± 8.0	no data	Cu and Zn (19) Cu ND Zn 40 no other metals scanned	H2O no data Sed(1) ND
Revolon Slough main branch: Mugu Lagoon to Central Avenue 303(d)-low 319		403.11	6.90	CA404.0080R	9 Impaired	N N N N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TDS,SC,CHL,B SO4,B,N+N TDS,SC,SO4,AMM Se* TOX,S[illegible] toxaphene,chlordane, DDT, endosulfan, [illegible] chlordane, toxaphene, DDT,Chem[illegible] PCB's), Nitrogen AMM*, ALGAE, COLOR, TRASH, Turb ALGAE, TRASH TIS[illegible] chlordane, toxaphene, DDT,ChemA,dieldrin,PCBs)		[GROSS ALPHA (N=3) ABOVE STND] TIS(Chlorpyrifos, hexachlorobenzene,dacthal)		Natural sources (m) Agriculture runoff (m) Urban runoff (m)	
15 14-34 19 ± 3	23 5.2-8.8 7.9 ± 0.6	1 7	22 2160-4600 3653 ± 694	20 2600-6160 4363 ± 989	18 1012-2140 1682 ± 305	20 0.6-2.8 1.9 ± 0.8	22 131-276 185 ± 35	22 1083-2460 1840 ± 354	*Tissue(90):* dacthal(EDL85), DDT(NAS), endosulfan(NAS), toxaphene(NAS), ChemA(NAS) * *Tissue(91):* chlordane(MTRLs), DDT(MTRLs), dieldrin(MTRLs), toxaphene(MTRLs,NAS), dacthal(EDL85), ChemA(NAS) * *Tissue(93):* chlordane(NAS), chloropyrifos(EDL85), dacthal(EDL85), DDT(NAS)< hexachlorobenzene(EDL85), toxaphene(NAS), ChemA(NAS) * *Wat toxicity:* poor survival rates * *Sed chem(88-90):* DDT(1648 ppb), toxaphene, chlordane, endosulfan, dacthal * *Tissue(86-88):* DDT(NAS), PCBs(NAS) *	12 ND-1.2 0.8 ± 0.4	22 11.9-70.0 48.5 ± 13	no data	2-4 Se 62 Cu 11 Pb 9 Se 11	H2O (6): h,c,d,e, ed,bo Sed (13): sb,sc,s d,sg
Beardsley Channel (abv Central Ave) 303(d)-low 319		403.61	6.16	CA404.0160R	5 Impaired	N P P	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4*,N+N* TDS*,SC*,SO4* TOX, Sed(DDT)		Sed pest. are very high ALGAE, COLOR ALGAE		Natural sources (m) Agriculture runoff (m) Urban runoff (m) Illegal dumping (e) Excessive sediment (m)	
6 17-34 21 ± 2	6 7.3-8.9 7.9 ± 0.6	no data	6 1170-3300 1988 ± 741	6 1320-4600 2315 ± 1370	2 680-940 800 ± 140	6 0.5-2 1.0 ± 0.6	5 75-177 124 ± 32	5 470-1780 985 ± 467	Wat toxicity: poor survival rates * Sed chem: DDD(1460ppb), DDE(173ppb), DDT(18ppb) [RWQCB]	no data	6 3.6-38.8 16.1 ± 13.0	no data	no data	H2O(1) ND Sed(4) sb,sc,s d,sh
Calleguas Creek R1 (estuary to 0.5 mi u of Broome Rd) and R2 (0.5 mi u of Broome Rd to Potrero Rd) 303(d)-low 319		403.11 403.12	2.2 and 2.3	CA404.0200R and CA404.0220R	11 Impaired	N N N FT F N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TDS, SC,CHL N+N TURB*, TDS,SC,SO4,AMM AMM, TIS/DDT,toxaphene, ChemA, chlordane/Hitrazine TURB*,AMM TIS(DDT,toxaphene, ChemA, chlordane)		TIS(dacthal): Fully but threatened		Natural sources (m) Agriculture runoff (m) Urban runoff (m) Excessive sediment (m) POTW effluent (m)	

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Reach/location (Calleguas Creek Watershed)		Hydro Unit	Site	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
3 10-31 20 ± 8.6	22 7.8-9 7.7 ± 0.6	no data	28 464-2772 918 ± 411	21 908-4995 1650 ± 795	19 230-1972 568 ± 353	1 0.5	19 92-400 204 ± 65	20 114-1266 347 ± 231	Tissue('90): dacthal(EDL85), DDT(NAS), toxaphene(NAS), ChemA(NAS) [5] Tissue('91): chlordane(MTRLs), DDT(MTRLs,NAS), toxaphene(NAS), ChemA(NAS), dacthal(EDL85), ChemA(NAS) [5] Tissue('92): DDT(NAS), toxaphene(NAS), ChemA(NAS) 3 Tissue('93): chlordane(NAS), DDT(NAS), toxaphene(NAS), ChemA(NAS) [5]	25 0.25-21.4 3.64 ± 4.2	28 4.6-30.1 14.1 ± 6.5	no data	Cu and Zn(19) Cu 30 Zn 50 no other metals scanned	no data
Calleguas Creek R3 (Potrero to Somis Rd) 303(d)-low		NEED	7.7	CA404.0260R		N FT N FT F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,CHL TURB*,TDS,SC,SO4,AMM AMM, TOX, Sed(toxaphene, DDT) TURB,AMM TDS,CHL,SO4,N+N				Natural sources (m) Agriculture runoff (m) Urban runoff (m) Excessive sediment (m) POTW effluent (m)	
18 11-30 21 ± 6	60 6.7-8.5 7.6 ± 0.4	no data	63 544-1340 860 ± 159	53 943-1850 1451 ± 226	44 240-852 464 ± 112	12 0.3-0.6 0.4 ± 0.1	49 101-264 185 ± 29	51 100-660 272 ± 85	Sed chem: toxaphene, DDT [1] Wat toxicity: poor survival rates [5]	89 ND-30 4.6 ± 4.0	67 1.9-38 12.1 ± 6.8	no data	2-41 Be 89 Cu 70 Zn 30 Al 80	H2O(4): d,f Sed(5): ec,ed,s g
Conejo Creek R1 (cont/ Call to Santa Rosa Rd) and R2 (Santa Rosa Rd to ~Thousand Oaks city limit) and R3 (~Thousand Oaks city limit to Lynn Rd.) and R4 (abv Lynn Rd) 303(d)-low		403.12 403.63 403.64 403.66	5.6 and 2.67 and 5.6 and 4.98	CA404.0270R and CA404.0340R and CA404.0400R and CA404.0500R	10 Interm	N FT N N N N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption Basin Plan		TDS,SC,CHL TURB*,TDS,SC,SO4,AMM DO, AMM, TOX, TIS(endosulfan, toxaphene, DDT, ChemA), Sed(toxaphene) TURB,AMM, ALGAE, COLOR ALGAE TIS(endosulfan, toxaphene, DDT, ChemA) TDS,CHL,SO4,N+N		TIS/Dacthal, As, Cd, Cr, Ni		Natural sources (m) Agriculture runoff (m) Urban runoff (m) Sediment (m) POTW effluent (m) Grazing (n)	
R1: 13 13-29 21 ± 5 R2: 5 13-25 19 ± 6 R3: 107 12-38 19 ± 3	53 6.6-8.7 7.5 ± 0.4 27 7.0-8.1 7.5 ± 0.3 223 6.6-8.6 7.6 ± 0.3	no data no data 173 2.6-10.9 7.0 ± 1.8	80 560-1210 825 ± 129 31 408-1210 819 ± 164 80 538-1240 888 ± 89	49 980-1825 1400 ± 195 20 250-608 482 ± 93 43 980-2080 1527 ± 273	44 260-608 458 ± 102 20 250-608 482 ± 93 39 240-782 546 ± 143	9 0.2-0.5 0.4 ± 10.1 6 0.2-0.6 0.4 ± 0.1 3 0.4-0.6 0.5 ± 0.04	47 108-238 181 ± 125 25 78-230 173 ± 31 41 70-242 172 ± 38	48 88-414 261 ± 178 25 99-388 284 ± 79 41 143-671 288 ± 86	Wat toxicity: poor survival rates [5] Sed chem: toxaphene [1] Tissue('91): Ag(EDL85), dacthal(EDL85), DDT(NAS), endosulfan(NAS), toxaphene(NAS), ChemA(NAS) [5] Tissue('92): Cd(EDL85), Cr(EDL85), Ni(EDL85), Ag(EDL85), DDT(NAS), toxaphene(NAS), ChemA(NAS) [5]	60 0.75-28.0 6.89 ± 5.01 28 0.5-28.1 9.2 ± 7.0 88 ND-34.4 6.469	60 2.6-33.6 11.0 ± 16.8 31 1.6-25.0 9.4 ± 5.1 60 0.2-22.1 3.76	no data no data no data	2-77 Be 168 Cd 1 Zn 100	H2O (9): b,d Sed(2): sb,ec,s d
Arroyo Santa Rosa R1 (cont/ Conejo to Krisb Lane) and R2 (abv Krisb Lane)		403.63 403.66	4.09 and 4.86	CA404.0370R and CA404.0380R	8 Impaire d				Unassessed					

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Reach/Location (Calleguas Creek Watershed)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
Trib from Olsen Rd POTW		403.65	2.74	CA404 0390R		U F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan							
350 7-24 18 ± 3	350 7.0-8.4 7.9 ± 0.3	348 3.2-11.6 7.5 ± 1.2	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Conejo Creek/Arroyo Conejo North Fork 303(d)-low		403.64	6.51	CA404 0420R		N FT N F F N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption Basin Plan		TDS,SC,CHL TDS,SC,SO4,AMM CHL, AMM,TISI(chlordane,DDT) TISI(chlordane,DDT) TDS,CHL,SO4		TIB(C4, Ag): Fully but threatened		Natural sources (m) Agriculture runoff (m) Urban runoff (m) Sediment (m) POTW effluent (m) Grazing (o) Sewage spills (o)	
262 8-28 17 ± 5	301 6.6-8.8 7.9 ± 0.6	267 4.5-12.9 8.9 ± 1.7	42 460-1470 1023 ± 248	23 789-2240 1766 ± 316	19 236-884 649 ± 152	3 0.2-0.5 0.4 ± 0.1	22 75-324 231 ± 14	22 43-456 298 ± 106	Tissue('90) no organic chemicals at elevated levels Tissue('91): Cd(EDL85) * Tissue('93): chlordane(MTRLs), DDT(MTRLs), Ag(EDL85) *	40 ND-34.8 4.2 ± 7.5	35 0.2-4.5 2.1 ± 1.2	no data	Cu and Zn (19) Zn 20 no other metals scanned	1 ND
Arroyo Conejo South Branch		403.94	6.25	CA404 0450R					Unassessed					
2 19-19	no data	no data	2 1720-2200	2 2620-3310	no data	2 0.2	2 187-208	2 669-682	no data	no data	2 1.5-2.5	no data	no data	no data
Arroyo Las Posas R1 (Lewis-Somis Rd to Fox Barrance) and R2 (Fox Barrance to ~Moorpark Frwy (23)) 303(d)-low 319		403.12 403.62	1.99 and 9.62	CA404 0560R and CA404 0600R	8 Intens	N N N FT F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,CHL*,B* SO4* TDS*,SC*,SO4*,AMM* AMM*, Bed(DDT) AMM* TDS*,CHL*,SO4*,N+N				Natural sources (m) Agriculture runoff (m) Urban runoff (m) Sediment (m) POTW effluent (m) Grazing (o) Fuel spills (o)	
4 16.9-28 22 ± 3	4 7.5-8.0 7.9 ± 0.2	no data	5 1120-1280 1194 ± 62	4 1630-1800 1728 ± 62	3 480-580 513 ± 60	4 0.7-0.9 0.8 ± 0.1	4 142-190 171 ± 18	4 401-600 438 ± 39	Sed Chem('88): DDD(204ppb), DDE(1084ppb), DDT(2338ppb)[RWQCB data]	4 2.3-4.6 3.65 ± 0.68	5 9.0-12.3 11.3 ± 1.2	no data	Al 30 no other metals scanned	H2O (1): ND Sed(1): sb,sc,s d
Fox Barrance		403.62	3.09	CA404 0610R					Unassessed					
Mahon Barrance		403.62	4.4	CA404 0660R					Unassessed					

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Reach/location (Calleguas Creek Watershed)		Hydro Unit	Bias	Code	Previous WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	NH3	N+N	Fec Col	metals	Org Chem
Arroyo Simi R1 (~Moorpark Frwy (23) to Brea cyn) 303(d)-low		403.62	7.58	CA404.0710R	15 Interim	N P H N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SO4*,B* TDS*,SO4*,AMM* SO4*,AMM*,ALGAE ALGAE TDS*,CHL*,SO4*,B*		TIS(Cr, Ni, As, Se,Zn); AMM*, Temp, TOX (3 are FT) COLOR		Natural sources (m) Agriculture runoff (m) Urban runoff (m) POTW effluent (m) Grazing (s) Spills (s)	
218 9-32 19 ± 4	213 6.9-8.9 8.0 ± 0.3	208 5.2-12.4 8.5 ± 1.2	7 1120-2600 1751 ± 470	10 1620-4550 2402 ± 827	3 535-1000 838 ± 215	10 0.4-1.4 1.1 ± 0.3	10 133-1180 277#	7 185-1000 642 ± 278	Tissue(*91) Cr(EDL85), Ni(EDL85), Se(EDL85), Ag(EDL85), Zn(EDL85) * Wet toxicity: poor survival rates * Temperature *	7 0.03-16.1 6.11#	10 1.4-14.8 4.7 ± 3.8	no data	no data	no data
Arroyo Simi R2 (abv Brea Cyn)		403.67	11.12	CA404.0770R	15 Interim	N F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SO4*,B* TDS*,SC*,SO4*, TDS*,CHL*,SO4*,B*				Ground water de-watering (m) Natural sources (m) Agriculture runoff (m) Urban runoff (m) Grazing (s)	
4 12-29 22 ± 7	7 7.7-8.0 8.3 ± 0.4	no data See Simi Report	7 482-2380 1664 ± 819	7 825-2700 2121 ± 670	2 1000-1030 1015#	7 0.2-1.5 0.9 ± 0.5	7 53-180 130 ± 80	7 222-1040 800 ± 307	no data	2 0.08-0.1 0.09 ± 1.5	7 0.05-6.2 3.3 ± 1.5	no data	0-1 As 2 Se 100	1 ND
Tapo Cyn R1		403.67	6.23	CA404.0880R					Unassessed					

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Reach/location (LA Co. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Lachusa Cyn		404.42	2.9	CA407.0070R					Unassessed					
Zuma Cyn		404.38	8.9	CA407.0140R					Unassessed					
Corral Cyn		404.31	4.1	CA407.0220R		F FT F	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4 TDS,SC,SO4		AMM		Natural sources (m) Unknown sources (m) Septic systems (s) Horse corals (m) Urban runoff (m)	
35 10-24 17 ± 4	34 7.7-8.5 8.1 ± 0.2	no data	36 120-2510 1110 ± 446	34 189-4385 1553 ± 886	36 75-1528 669 ± 243	36 ND-0.6 0.2 ± 0.1	36 7-143 74 ± 26	34 46-1280 482 ± 210		35 ND-2.02 0.078	36 ND-6.6 0.39	36 ND-760	2 Be 382 Cu 41	34 be (be only chemical scanned)
Malibu Lagoon 303(d)-low 319		404.21	32.6 ac	CA405.0000E	29 ac impaired	N N F N N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption Shellfish Harvesting		Benthic community, TBI(As,Ni,Se,Pb) COLIFORM, Enteric viruses, swimming restriction TBI(As, Se, Pb) Advisory		TBI(Ag,Cr), BUT; Excessive freshwater -Fully but threatened		Natural sources (m) Unknown sources (m) Septic systems (s) Horse corals (m) Urban runoff (m) POTW effluent (m) Transient encampments (m) Artificial breaching of lagoon sandbar (m) Recreational use (m) Fires (m)	
									Tissue ('93): no elevated constituents [a] *Tissue*: no elevated constituents [a] *Sed tox*: good survival [a] *Wat tox*: possible impairment during storms [a] *Benthic community* [a] *Tissue ('93)*: As(MFS,MIS), Ni(MFS), Se(MFS,MIS), Pb(MFS,MIS), Ag(EDLSS), Cr(EDLSS) [a] *Enteric viruses* [a]			Coliform [a]		

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Reach/location (LA Co. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Malibu Creek (lagoon to Malibu Lake) 303(d)-low except targeted for nutrients)		404.21	9.5	CA405.0010R	6 Interm 3 unknown	N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4 TDS,SC,SO4 Fish barrier, TSI(As,Se,Cr,Ni) AMM,TRASH,ALGAE TRASH,ALGAE		TSI(Cd,Cu,Pb,Ag) COLIFORM,SCUM,COLOR SCUM		Natural sources (m) Unknown sources (m) Septic systems (s) Horse corals (m) Urban runoff (m) POTW effluent (m) Transient encampments (m) Artificial breaching of lagoon sandbar (m) Recreational use (m) Fires (m) Fish barrier (m)	
101 6-30 16 ± 4	108 7.2-8.9 8.1 ± 0.3	19 6.2-12.9 8.5 ± 1.8	95 800-2314 1356 ± 361	81 903-3340 1839 ± 454	93 7-1300 751 ± 209	94 ND-1 0.4 ± 0.2	96 47-225 143 ± 32	96 298-1246 623 ± 216	Tissue ('92): Cd(EDL95), Se(EDL95), Ag(EDL95) [a] Tissue('93): As(MFS,MIS), Se(MFS,MIS), Cr(MIS), Ni (MFS), Ag(EDL95), Cu(EDL95), Pb(EDL95) [a]	109 ND-1.1 0.19	113 ND-11.9 3.6 ± 3.0	83 ND-14000	66-78 As 32 Be 55 Cd 20 Cr 50 CrVI 20 Cu 240 Pb 300 Se 65 Zn 270 Hg 1 Ni 80	H2O (d) d,bio Sed (1): ss
Cold Creek		404.21	8.16	CA405.0030R		F FT F	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS*,SC* AMM*,COLOR				Natural sources (m) Septic systems (s) Horse corals (m) Urban runoff (m) Grazing (s)	
18 11-30 17 ± 2	18 7.7-8.4 8.0 ± 0.2	8 8-10.2 9.9 ± 0.7	10 425-1060 759 ± 169	6 1070-1330 1138 ± 89	10 315-620 481 ± 89	10 0.3-3.6 1.19	10 32-110 74 ± 22	10 62-734 257 ± 177	no data	19 ND-1 0.19	22 ND-2.3 0.69	7 ND-80000	0-2 As 3 Be 770 Cd 10 Cr 380 Cu 180 Pb 100 Se 1 Zn 730 Hg 0.1 Ni 90	H2O no data Sed (1) ss
Las Virgenes Creek 303(d)-low except targeted for nutrients)		404.22	11.47	CA405.0070R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4* TDS*,SC*,SO4* Se*, DO AMM,COLIFORM*,SCUM,ALGAE,TRASH,COLOR,Turb SCUM,ALGAE,TRASH				Natural sources (m) Septic systems (s) Horse corals (m) Urban runoff (m) Grazing (s) POTW effluent (m) Aerial deposition (m)	

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Reach/location (LA Co Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
22 10-26 18 ± 4	24 7.5-8.1 7.9 ± 0.2	12 3.1-15.6 7.9 ± 3.8	16 2560-3520 3042 ± 274	10 2660-4690 3776 ± 720	16 1200-1912 1570 ± 148	16 ND-0.8 0.5 ± 0.2	16 114-197 161 ± 27	16 1290-1919 1595 ± 191	no data	23 ND-1.4 0.19	28 ND-4.7 2.0 ± 1.8	10 40-17000	4-6 Ag 3 As 3 Ba 60 Cd 10 Cr 2 Cu 10 Pb 100 Se 38 Zn 50 Hg 0.1	no data
Stokes Creek 303(d)-low except targeted for nutrients)		404.22	5.33	CA405.0080R		F P F	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4*		COLIFORM*		Natural sources (m) Septic systems (s) Horse corals (m) Urban runoff (m) Aerial deposition (s)	
8 12-23 17 ± 3	7 7.6-7.9 7.7 ± 0.1	5 7.6-16.6 11.1 ± 3.8	4 234-1150 891 ± 382	2 1880	4 103-680 478 ± 227	4 ND-0.5 0.3 ± 0.2	4 15-115 79 ± 40	4 148-321 269 ± 71	no data	12 ND-0.16 0.039	12 0.7-8.8 3.7 ± 2.8	4 80-14000	1 Ag 3 Zn 140 Hg 0.5	no data
Malibu Lake 303(d)-low 314		404.24	69 ac	CA405.0190L	56 Interim	N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4 TDS,SC,SO4 DO,EUT,TIS(PCBs,chlordane) AMM,ALGAE ALGAE		TIS(Cd,Cu,Zn)		Algae treatment (m) Natural sources (m) Urban runoff (m) Aerial deposition (s) Septic systems (m)	
112 10-30 19 ± 6	101 7.0-8.0 7.7 ± 0.3	112 0.1-20.4 6.9 ± 5.1	42 347-2287 1631 ± 481	42 834-3650 2105 ± 662	no data (1060)	no data	42 28-274 165 ± 64	42 115-1623 767 ± 364	Tissue ('91): PCBs (MTRLs), Cd(EDL85), Cu(EDL85), Zn(EDL85) [a] Tissue ('92): Chlordane(MTRLs), Cd(EDL85), Cu(EDL85), Zn(EDL85) [a]	42 ND-0.68 0.19	42 ND-2.2 0.449	no data	42 Cu 62 Pb 88 Se 42 Zn 31 Ag 2.4 Ni 48	27+ a,m,p,s,t,u,w,y,z,ag,al,cl,as,e,b,ac,cd,au,dy,ex,fdp,ay,ba,bc
Medea Creek R1 (tiba to confl with Lindero) and R2 (abv confl with Lindero) 303(d)-low (except targeted for nutrients) 319		404.24 404.23	3.01 and 6.44	CA405.0180R and CA405.0200R	7 Interim	N N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		SO4* TDS*,SC*,SO4*,AMM* Se* AMM, COLIFORM,COLOR COLIFORM*		ALGAE,TRASH,Turb ALGAE,TRASH		Natural sources (m) Horse corals (m) Urban runoff (m) Grazing (s) Aerial deposition (s)	

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Reach/Location (LA Co. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
R1: 14 12-27 19 ± 4 R2: 4 11-21 17 ± 4	15 7.4-8.2 7.9 ± 0.2 8 7.0-8.1 7.6 ± 0.4	2 7.6-7.7 no data	15 607- 2908 2236 ± 668 8 295- 2930 1979 ± 778	8 2380- 4200 3353 ± 670 7 1800- 4350 3029 ± 871	14 298- 1600 1217 ± 382 8 172- 1820 1268 ± 484	15 0.04 - 0.71 0.37 ± 0.21 8 ND- 265 33#	15 54-298 209 ± 61 8 37-950 258 ± 271	15 235-1522 1130 ± 360 8 134-1339 890 ± 378	no data no data	11 ND-2.0 0.36# 5 ND-0.50 0.22 ± 0.20	16 0.3-3.8 1.3 ± 0.9 8 ND-1.1 0.6 ± 0.4	8 23-60000 4 300-60000	0-8 As 4.2 Ba 68 Cd 10 Cr 3 Cu 20 Pb 100 Se 8 Zn 187 Hg 0.5	H2O: no data Sed(1): ss
Undere Creek R1 (Medse to Lake Lindero) and R2 (abv lake) 303(d)-low		404.23 404.23	2.2 and 4.8	CA405. 0210R and CA405. 0230R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		SO4: ~~TDS?, SC?, CHL?, SO4?, AMM?~~ CHL*, Se* AMM*, COLIFORM, TRASH, ALGAE, COLOR COLIFORM, TRASH, ALGAE		SCUM SCUM		Natural sources (m) Horse corals (m) Urban runoff (m) Grazing (a) Aerial deposition (a)	
7 11-21 16 ± 4	12 7.5-8.2 7.8 ± 0.2	no data	12 326- 3460 2549 ± 1029	9 2830- 4730 3884 ± 882	12 156- 2140 1501 ± 653	12 ND- 0.5 0.17 ± 0.16	12 61-310 233 ± 81	12 79-1987 1295 ± 669	no data	7 ND-1.60 0.38#	12 0.3-4.2 1.0#	9 1700-60000	0-5 As 4 Ba 77 Cd 4 Cr 10 Cu 27 Ba 10 Zn 131 Hg 0.6	no data
Lake Lindere 303(d)-low		404.23	13.68	CA405. 0220L	77 unknown	N N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		SO4 ~~TDS,SC,CHL,SO4~~ CHL,SC,Se,EUT,TIS(Se) AMM DDOR3,TRASH,ALGAE ODOR3,TRASH,ALGAE TIS(Se)		TIS(sediment)		Natural sources (m) Urban runoff (m) Aerial deposition (a) Algae treatment (m) Nutrient-rich sediments (m) Recreational use (m)	
81 10-31 21 ± 6	76 7.5-8.4 8.4 ± 0.2	81 1.1-18.2 11.0 ± 3.6	30 929- 3448 2477 ± 726	30 1325- 3530 2937 ± 747	no data (1480)	no data	30 88-330 244 ± 76	30 374-1610 1148 ± 388	Tissue('91): Se(MIS), Oxadiazon(EDL88) * Tissue('92): Se(MIS) *	30 ND-0.49 0.109	30 ND-1.3 0.49	no data	30 Cu 68 Pb 69 Se 19 Ni 14	no data
Pale Cornada 303(d)-low		404.23	7.78	CA405. 0240R		N N N P	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		SO4* TDS*,SC*,SO4*,AMM* CHL* AMM*,COLIFORM*		COLIFORM*		Natural sources (m) Horse corals (m) Urban runoff (m) Grazing (a) Aerial deposition (a)	
5 13-22 18 ± 3	5 7.2-8.0 7.8 ± 0.3	no data	5 488- 3602 2300 ± 1070	4 2380- 4800 3608 ± 1153	5 169- 1830 1270 ± 678	5 ND- 1.0 0.49	5 28-283 164 ± 94	5 174-1932 1198 ± 634	no data	13 ND-1.8 0.7 ± 0.6	16 0.8-8.4 4.3 ± 3.0	4 220-30000	0-1 Ba 150 Cr 40 Pb 50 Zn 210 Hg 0.7	no data

R00033695

COMMO VOL 12

Reach/location (LA Ca. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Triunfo Cyn Creek R1 and R2 303(d)-low 319 (for 404.24 only)		404.24 404.25	4.08 and 1.98	CA405.0260R and CA405.0320R	7 Interm	FT N FT F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		TDS*,SC*,SO4* Hg*,Pb*		COLOR		Natural sources (ns) Horse corals (m) Urban runoff (m) Grazing (a) Aerial deposition (a)	
6 13-24 19 ± 4	6 7.3-8.6 7.7 ± 0.4	1 4.5	8 430-1014 778 ± 173	6 982-1660 1269 ± 282	7 382-640 481 ± 81	8 ND-0.2 0.04 8	6 40-130 94 ± 28	6 115-361 257 ± 72	no data	3 ND-0.17 0.089	6 ND-1.4 0.49	4 ND-2300	0-3 As 3.7 Ba 230 Cd 10 Cr 190 Cu 60 Pb 100 Zn 160 Hg 1	no data
Westlake Lake 303(d)-low 314 319		404.25	169 ac	CA405.0330L	198 Interm	N N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TDS,SC,SO4,AMM AMM,DO,Cu,Pb,EUT,TIS(chlordane) AMM,ALGAE ALGAE TIS(chlordane)		TIS(Cd,Cu,Zn)		Natural sources (ns) Urban runoff (m) Aerial deposition (a) Algae treatment (m) Nutrient-rich sediments (m)	
135 10-30 20 ± 6	119 6.7-8.7 7.7 ± 0.4	135 0.1-19.3 4.9 ± 4.5	52 290-1479 814 ± 276	52 378-1480 1151 ± 344	no data (300)	no data	52 22-150 104 ± 41	52 66-391 251 ± 93	Tissue ('91): Chlordane(MTRLs), Cd(EDL85) * Tissue ('92): Cu(EDL85), Zn(EDL85) *	52 ND-1.34 0.35 ± 0.33	52 ND-1.7 0.39	no data	52 Cu 58 Pb 91 Ba 15 Zn 12	31+ a,m,s,v,w,y,z,e g,d,st,sp,aa,o b,ad,au,av,aw, ao,bb,bc,ay,az
Potrero Cyn		404.25	2.99	CA405.0380R					Unassessed					
Eleanor Trib R1 (blw Lake)		404.25	1.68	CA405.0390R					Unassessed					
Lake Eleanor 314 319		404.25	8.17 ac	CA405.0400L	8 Interm	U U U U	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c						Natural sources (ns) Aerial deposition (a)	
Lake Sherwood 314 319		404.28	213 ac	CA405.0430L	194 Interm	FT N N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		AMM AMM,DO,EUT,TIS(Hg) AMM,ALGAE ALGAE TIS(Hg)				Natural sources (ns) Urban runoff (m) Aerial deposition (a) Golf course runoff (m)	
170 9-32 17 ± 5	159 6.6-9.0 7.5 ± 0.6	170 0.1-16.3 4.09	77 203-494 349 ± 66	77 280-666 541 ± 96	no data	no data	77 16-48 32 ± 9	77 8-140 63 ± 35	Tissue ('91): Hg(MRS) * Tissue ('92): Hg(MTRLs,FDA) *	77 ND-0.67 0.019	77 ND-1.4 0.49	no data	77 As 6 Cu 179 Pb 98 Se 3 Zn 20 Ni 16	37+ a,m,s,v,w,y,z,e g,sn,sp,st,aa,o b,ac,ad,au,av, aw,ax,bp,ay,az ,bb,bs,bc
Hidden Valley Creek		404.28	4.75	CA405.0460R					Unassessed					

R0033696

COMCO VOL 12

Reach/location (LA Co. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	CN	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Tuna Cyn		404.12	2.4	CA407.0300R					Unassessed					
Topanga Cyn 303(d)-low		404.11	8.6	CA407.0310R		N FT F	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,SO4 Pb		AMM		Natural sources (m) Horse corals (m) Urban runoff (m) Grazing (s) Aerial deposition (s)	
66 6-24 17 ± 4	66 7.4-8.7	1 7	66 660-1800 1039 ± 169	66 967-2006 1476 ± 193	66 468-792 600 ± 87	66 ND-1 0.6 ± 0.2	66 12-175 108 ± 24	66 272-687 411 ± 104	no data	67 ND-0.48 0.039	65 ND-4.3 0.59	66 ND-1300	67-68 As 23 Ba 248 Cd 20 Cr 20 CrVI 13 Cu 40 Pb 230 Se 7 Zn 100 Hg 0.1 Ni 60	H2O(1) All ND be scanned 67 times and detected above detection limit Sed(1) sc
Santa Monica Cyn 303(d)-low		406.13	2.9	CA407.0480R		N N P	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,SO4 Pb AMM,COLIFORM		pH COLIFORM		Natural sources (m) Horse corals (m) Urban runoff (m)	
65 3-27 14 ± 6	66 7.7-8.9 8.2 ± 0.2	no data	66 562-1254 911 ± 110	66 810-1636 1324 ± 149	66 360-723 560 ± 69	66 ND-0.8 0.2 ± 0.1	66 46-166 108 ± 25	66 10-512 304 ± 77	no data	66 ND-1.22 0.069	67 0.7-8.1 3.2 ± 1.5	66 ND-16000	66 As 40 Ba 288 Cd 20 Cr 20 CrVI 12 Cu 40 Pb 240 Se 3 Zn 320 Hg 5 Ni 60	1 All ND TPH scanned 66 times and detected above detection limit
Pico Kenter Drain 303(d)-low		406.13	4.77	CA407.0560R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,AMM CHL,AMM,Cu,Pb,TOX,PAHs AMM,COLIFORM,Enteric viruses COLIFORM		COLOR,TRASH TRASH		Natural sources (m) Urban runoff (m)	
60 9-34 16 ± 5	64 7.4-8.9 8.0 ± 0.3	no data	64 352-20024 2841#	63 80-38200 4018#	63 104-3853 638 ± 759	64 ND-3.2 0.46	64 61-10403 1130#	64 67-1744 290#	Enteric viruses, PAHs, water toxicity*	63 ND-4.67 0.66#	64 ND-13.3 2.0 ± 1.7	63 ND-160000	63-64 Ag 100 As 112 Ba 420 Cd 110 Cr 90 CrVI 20 Cu 293 Pb 460 Se 7 Zn 370 Ni 110	1-63 b,d,be

R0033697

COMO
VOL 12

Reach/location (LA Co. Coastal watersheds)	Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp / pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Ashland Avenue Drain 303(d)-low	405.13	0.87	CA407.0570R		N N U	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS DO,TOX COLIFORM				Urban runoff (m) Natural sources (m)	
								TDS, DO, coliform, and toxicity data [a]					
Ballona Creek Estuary 303(d)-low	405.13	2.5	CA408.0000E		N N N N	Aquatic life Recreation: cont. Recreation: non-c Shellfish		SED TOX,Sed(Pb,Zn, DDT, aroclor, PCB's,PAHs,chlordane),TIS(chlordane,PCBs) COLIFORM Advisory				Urban runoff (m) Natural sources (m) Spills (m) POTW effluent (m) Industrial point sources (m) Combined sewer overflow (m)	
								Tissue ('86): chlordane (~200 ppb), PCBs (550 ppb) [b] Sed tox: low survival [b] Sed chem: PCBs (200 ppb), PAHs (5 ppb), chlordane (~100 ppb) [b] Sed Chem ('91-92): Pb, Zn, chlordane, DDT,DDE,DDT,aroclor) [c] Sed chem('95): PAHs (6508ppb), PCBs, Pb(306ppb) [m]					
Ballona Wetland 303(d)-low 319	405.13	86 degrade 151 total	CA408.0040T		N(B 6) N N N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		TIS(As) habitat alteration, exotic vegetation, reduced tidal flushing, hydromodification TRASH TRASH TIS(As)		TIS(Pb, Cr)		Urban runoff (m) Natural sources (m) Flow modification (m) Habitat alteration (m) Construction runoff (m) Hydromodification (m) Periodic stagnation(m) Recreation (o)	
								Tissue ('93): As (MTRLs), Cr (EDL95), Pb (EDL95) [d] Habitat alteration, exotic vegetation, reduced tidal flushing, trash [n]					
Ballona Creek 303(d)-low	405.13	4.3	CA408.0050R	180 as impaired	N N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c fish consumption		TDS,AMM Pb,SED TOX,TOX,TIS(As,chlordane,DDT,dieldrin,PCBs,ChemA) Sed(Cd,TBT, Cu,Pb,Ag) AMM,COLIFORM COLIFORM TIS(chlordane, DDE, dieldrin, PCBs, ChemA)		CHL,TIS(Cr,Cu,Pb,Ag,Zn) pH,TRASH TRASH		Urban runoff (m) Natural sources (m) Fuel spills (m) POTW effluent (m) Industrial point sources (m) Sewage overflow(m) RCRA sites (m)	
210 4-29 16 ± 5	217 7.1-8.6 8.2 ± 0.4		216 176-5810 824 ± 429	216 420-8270 1236 ± 880	216 67-1280 382 ± 141	216 ND-1.1 0.4 ± 0.2	217 13-3020 1616	217 1-487 210 ± 102	Tissue ('93): As(MTRLs), Cr(EDL95), Cu(EDL95), Pb(EDL95), Ag(EDL95), Zn(EDL95), chlordane(MTRLs, NAS), DDT(MTRLs), dieldrin(MTRLs), PCBs(MTRLs,NAS), ChemA(NAS) [o] Sed chem ('96): Cd,TBT, Cu,Pb,Ag [m]	214 ND-4.48 0.209	216 ND-16.9	214 20-160000	213-216 Ag 10 As 80 Be 1200 Cd 30 Cr 60 CrVI 28 Cu 117 Pb 280 Se 27 Zn 1310 Hg 1 Ni 110	2-213 tox,sf

R0033698

COMPO VOL 12

Reach/Watershed (LA Co Coastal watersheds)	Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp / pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
Sepulveda Canyon/Channel 303(d)-low	405.13	6.8	CA408.0070R		N N N	Drinking-Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c		CHL,AMM,Pb AMM,COLIFORM COLIFORM		pH,COLOR		Urban runoff (m) Natural sources (m) Industrial point sources (m)	
66 6-26 17 ± 4 / 71 7.4-8.6 8.3 ± 0.4	no data	71 714-7800 2986 ± 1644	70 1100-10800 4740 ± 2838	70 360-3400 1376 ± 815	71 0.1-1.2 0.6 ± 0.3	71 1-4775 1311 ± 1040	71 114-784 357 ± 140	no data	69 ND-4.3 0.39	70 ND-13.7 3.4 ± 2.1	69 20-60000	69-70 Ag 10 As 52 Be 449 Cd 70 Cr 64 Cu 160 Pb 260 Se 2500 Zn 480 Hg 2 Ni 240	3-4 All ND TPH scanned 66 times and detected above detection limit
Pollywog Park Lake	405.12	3	CA407.0650L	2 ac unknown				Unassessed					
Dominguez Channel estuary (to Vermont) and Dominguez Channel above Vermont 303(d)-low 319	405.12 405.12	6.4 and 9	CA408.0120E and CA408.0180R	7 Interm.	N N N N	Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		AMM, Sed(Cr,Zn,DDT,PAHs), Benthic community, CHL, Cu, Pb, TIS(aldrin,chlordane,DDT,dieldrin,PCBs) AMM,pH,COLIFORM,COLOR COLIFORM TIS(chlordane, DDT, dieldrin, PCBs)		pH, TIS(ChemA,Pb); Sed Chem(Pb, Zn)-Fully but threatened		Urban runoff (m) Natural sources (m) Oil/waste spills (m) POTW effluent (m) Industrial point sources (m) Historic DDT releases (m) Refinery discharges (m)	
73 6-27 19 ± 6 / 74 6.6-8.7 8.4 ± 0.6	no data	74 170-20768 15789	74 273-26800 23849	74 67-4080 4316	74 ND-2.0 0.4 ± 0.3	74 50-13874 6888	74 27-1822 2039	NPDES monitoring-Sed chem: Cr(120ppm), Zn(260 ppm), DDT(1.5ppm), PAHs(2ppm) See also LA Harbor- Consolidated Slip below. Tissue (92): aldrin(MTRLs), chlordane(MTRLs,EDL95), DDT(MTRLS,EDL95), dieldrin(MTRLs), PCBs(MTRLs,EDL95), ChemA(EDL95), Pb (EDL95) * Sed chem (91): Pb(122 ppm), Cu(90 ppm), Zn(746 ppm) [RWQCB data]	71 ND-10.6 0.39	73 ND-6.2 0.89	70 2-48000	75 Ag 20 As 6 Be 274 Cd 20 Cr 108 Cu 80 Pb 780 Se 29 Zn 2370 Ni 101 Hg 2	H2O (7) U,U,,s be scanned 72 times and detected above detection limit Sed(1-2): su,su,su,u,u,,s s
Harbor Park Lake 303(d)-low 314 319	405.12	46.2 ac	CA408.0140L	80 Impaired	N N N N	Drinking--Primary Drinking-Second. Aquatic life Recreation: cont. Recreation: non-c Fish Consumption		TDS AMM,FUT,TIS(chlordane, ChemA,DDT,dieldrin, PCBs) AMM,ODORS,TRASH,ALGAE ODORS,TRASH,ALGAE ADVISORY(DDT,chlordane), TIS(chlordane, ChemA,DDT,dieldrin, PCBs)				Urban runoff (m) Natural sources (m) Aerial deposition (s) Golf course runoff (m) Nutrient-rich sediments (m) Recreational use (m)	

R00033699

COMPS VOL 12

Reach/location (LA Co Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
40 11-29 22 ± 6	40 6.7-8.1 7.6 ± 0.6	40 4.9-15.0 8.2 ± 2.4	37 125- 1050 476 ± 288	37 204- 1383 752 ± 420	no data (440)	no data	37 15-173 82 ± 56	37 30-195 117 ± 68	Tissue('90): chlordane(NAS), ChemA(MAS) * Tissue ('910: chlordane(MTRLs, NAS), DDT(MTRLs), dieldrin(MTRLs), PCBs(MTRLs,NAS), oxadiazon(EDL95), ChemA(NAS) * Tissue ('92): chlordane(MTRLs), DDT(MTRLs) * Tissue ('93): chlordane (MTRLs, FDA), DDT(MTRLs), dieldrin(MTRLs), PCBs(MTRLs, NAS), oxadiazon (EDL95), ChemA(NAS) * Fish consumption advisory: DDT,chlordane-Goldfish or carp *	37 ND-0.6 0.16	37 ND-0.5 0.16	no data	37 As 7 Cu 61 Pb 158 Zn 17	23+ a,m,n,r,v,w,y,z, aa,ab,ac,ad,ag ,au,av,aw,ax,b e
Wilmington Drain 303(d)-low		405.12	4.9	CA405. 0160R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,SO4,AMM AMM,Cu,Pb AMM,COLIFORM COLIFORM		CHL		Urban runoff (m) Natural sources (m) Oil/fuel/waste spills (m) Industrial point sources (m)	
67 7-29 18 ± 6	66 6.7-8.6	no data	66 108- 1750 883 ± 409	66 189- 2650 1310 ± 588	66 40-600 438 ± 223	66 ND- 3.6 0.6 ± 0.7	66 16-388 169 ± 93	66 39-687 293 ± 197	no data	66 ND-16 1.09	63 ND-7.6	67 33-160000	67 As 21 Ba 450 Cd 13 Cr 60 CrVI 12 Cu 140 Pb 290 Se 67 Zn 980 Hg 1.3 Ni 197	1 bo
Torrance Carson Channel 303(d)-low		405.12	12.6	CA405. 0160R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC CHL,Cu,Pb AMM,COLIFORM COLIFORM		pH		Urban runoff (m) Natural sources (m) Fuel/oil spills (m) Industrial point sources (m)	
66 6-39 19 ± 6	66 6.7-8.3 8.2 ± 0.6	no data	66 326- 1174 788 ± 140	66 467- 1798 1280 ± 252	66 99-620 364 ± 66	66 ND- 1.3 0.4 ± 0.2	66 69-416 228 ± 79	66 33-321 101 ± 65	no data	66 ND-0.03 0.349	66 ND-4.2 0.39	66 130-630000	66 As 35 Ba 300 Cd 10 Cr 210 CrVI 74 Cu 60 Pb 90 Se 62 Zn 370 Hg 1.2 Ni 40	66 bo [bo only chem assessed]
Colorado Lagoon 303(d)-low 319		405.12	13.6 ac	CA405. 0260T	13 Impaired	N U U N	Aquatic life Recreation: cont. Recreation: non-c Fish consumption		Sed/Pb,Zn,chlordane,PAHs),TBt/Cu, ChemA,chlordane,DDT,dieldrin,PCBs), SED TOX TBt/chlordane,DDT,dieldrin,PCBs)		TBt(dechlor),Chem A, Cu, Pb,Cd,Cr,Ni,Ag)		Urban runoff (m) Natural sources (m)	

R0033700

COMOT

VOL 12

Reach/location (LA Co. Coastal watersheds)		Hydro Unit	Size (miles / acres)	Code	Previous WQA	WQA	Assessed Uses		Not Supporting		Partially Supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	Org Chem
									Tissue ('92) chlordane(MTRLs,EDL95), DDT(MTRLs), dieldrin(MTRLS, EDL95), PCBs(MTRLs,EDL85), ChemA(EDL95), Cu(EDL85), Pb(EDL85), Ag(EDL85) [5] *Tissue('86)* chlordane (320ppb) [1] *Sed chem:* Pb(510 ppm), Zn(660 ppm), chlordane(140 ppb), PAHs(10ppm) [3] *Sed toxicity:* poor survival rates [3] *Water toxicity:* impairment unlikely [3]					
Stine Pond		405.15	3.2	CA408.0265T		FT U U	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c				TB(coliform):Fully but threatened		Urban runoff (m) Natural sources (m) Spills (s)	
									Tissue: chlordane (320 ppb) [1] Sed chem: Pb(510ppm), Zn(660ppm), chlordane(140 ppb), PAHs(10ppm)[3] Sed tox: low survival[3] Wat tox: slight toxicity[3] Tissue('93): Oxadason(EDL95)[5]					
Los Cerritos Estuary		405.15	54 ac	CA408.0270E		F U U	Aquatic life Recreation: cont. Recreation: non-c						Urban runoff (m) Natural sources (m) Spills (s) Industrial point sources (m)	
Los Cerritos Channel 303(d)-low			16	CA408.0260R		N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,AMM AMM,Cu,Pb,Zn AMM,COLIFORM COLIFORM		pH		Urban runoff (m) Natural sources (m) Fuel spills (s) Industrial point sources (m)	
66 7-30 19 ± 5	69 3.3-8.1 6.2 ± 0.7	no data	69 300-2456 694 ± 275	69 408-3540 1040 ± 394	69 110-865 240 ± 66	69 ND-0.9 0.3 ± 0.2	69 43-1278 164#	69 40-327 138 ± 61	no data	69 ND-2.19 0.34 ± 0.41	67 ND-16.0 0.69	69 3-170000	70	2-3 all nd ho scanned 69 times and detected above detection limit
Palos Verdes Channel		405.15	10.9	CA408.0910R					Unassessed					

R0033701

COMO VOL 12

Los Angeles River watershed

Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Los Angeles River Estuary (Queensway Bay)		405.12	3.71	CA409.0 000E		FT U U	Aquatic life Recreation: cont. Recreation: non-c Basin Plan				TIS(Chlordane,DDT),Sed(PAHs,Chlordane): Fully but threatened		Urban runoff (m) Dredging activities (m) POTW effluent (m) Spills (o) Industrial point sources (m) Illegal dumping (m)	
									Sed tox: good survival rates [1] Sed Chem: PAH (2ppm), chlordane (15 ppb) [1] Benthic community: slightly impaired [1] Tissue ('88): chlordane (150ppb), DDT(250ppb) [1]					
Los Angeles River R1 (Estuary to upstream Carson Bl) 303(d) list		405.12	2.01	CA409.0 010R		FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		(NO2) pH,TDS,SC,AMM pH,AMM,Pb pH,TURB*,AMM,COLIFORM,TRASH,SCUM,ALGAE,COLOR COLIFORM, TRASH, SCUM, ALGAE		CHL		Natural sources (m) POTW effluent (m) Illegal dumping (o) Transient encampments (o) Offsite spills (m) Urban runoff (m) Horse corrals (o)	
146 7-34 22±8	148 7-10.6 9.2±0.9	80 9.1-34 19.2±2.4	95 389-628 483±68	141 624-1310 1081±89	87 153-484 276±68	88 ND-0.93 0.5±0.2	94 44-205 131±28	93 115-307 188±42	no data	94 ND-8.2 2.7±2.4	94 0.01-13.16 4.6±2.4	91 ND-93000	88-87 As 37 Be 630 Cd 42 Cr 20 CrVI 16 Cu 40 Pb 120 Se 3 Zn 340 Ba 0.5 Ni 88	H2O(11): s,af (88)be
Los Angeles River R2 (Upstream Carson Bl to Figueroa Bl) 303(d) list		408.16	19.37	CA409.0 020R	28 Interim	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,AMM AMM,Pb AMM,COLIFORM,TRASH, SCUM,ALGAE,COLOR COLIFORM,TRASH, SCUM,ALGAE		pH,ODOR,OIL,Turb ODOR, OIL CHL,N+N		Natural sources (m) POTW effluent (m) Illegal dumping (o) Transient encampments (o) Spills (o) Urban runoff (m) Horse corrals (o)	
188 7-32 19±8	183 6.7-8.7 8.1±0.6	21 9-19 13.2±2.8	152 300-672 672±62	142 427-1318 1088±12 7	142 180-488 271±62	142 ND-1.8 0.5±0.2	183 37-228 125±30	180 68-370 180±49	no data	182 ND-29.8 6±4.5	180 0-19.2 6.2±3.8	188 ND-230000	84-142 As 180 Be 280 Cd 2 Cr 70 CrVI 17 Cu 210 Pb 140 Se 15 Zn 2300 Hg 1 Ni 70	H2O(11): d,f,g,j,k, s,y,ev, ba(139)

R0033702

VOL 12

Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	TC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Compton Creek 303(d) low		405.15	8.52	CA409.0 040R	8 trisem	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS, AMM Cu,Pb AMM,COLIFORM COLIFORM		pH pH		Natural sources (m) POTW effluent (m) Illegal dumping (s) Fuel spills (s) Urban runoff (m) Horse stables (s)	
58 8-20 20±6	58 6.9-8.9 8.1±0.6	8 1.8-7 5.5±1.7	58 180-1380 531±152	52 270-2230 851±234	52 85-348 229±60	52 ND-1.1 0.3±0.2	58 19-520 99±62	58 28-283 120±44	no data	58 ND-12.1 0.7±1.7	57 ND-7.8 0.4±1.1	57 ND-130000	51 As 28 Be 312 Cd 10 Cr 40 CrVI 15 Cu 230 Pb 200 Se 7 Zn 1000 Ni 50	H2O (1) ND (51)be
Rio Hondo R1 (Confluence LA River to Santa Ana Freyr) 303(d) -low		405.15	4.19	CA409.0 080R		FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,AMM AMM,Cu,Pb,Zn AMM,COLIFORM,TRASH TRASH CHL		CHL,pH COLIFORM SO4		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m)	
58 6-38 21±8	57 7.3-8.9 8.3±0.6	1 12	57 138-2020 786±331	58 200-2650 1194±48 4	58 60-653 282±102	58 ND-0.8 0.3±0.2	57 12-559 184±107	57 22-861 208±108	no data	57 ND-2.6 0.34±0.47	57 ND-6 0.7±1.1	60 ND-28000	58 As 67 Be 333 Cd 10 Cr 30 CrVI 42 Cu 63 Pb 110 Se 14 Zn 1340 Hg 1 Ni 30	H2O(2) c,e be scanne d 56 times and detecte d above detectio n limit
Rio Hondo R2 (at Spreading Grounds) and R3 (Spreading Grounds to Whittier Narrows Dam) and R4 at Whittier Narrows Flood Control Basin 303(d) -low		405.15 405.15 405.41	2.71 and 1.38 and 3.10	CA409.0 090R and CA409.0 100R and CA409.0 110R	20 trisem	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,AMM AMM COLIFORM, AMM		DO: fully but threatened Turb COLIFORM N+N		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m)	
R2: 60 6-38 18±4 R3: 28 10-27 16±4 R4: 118 6-29 18±4	65 6.7-10.7 7.8±0.6 28 7-8.9 8±0.3 124 6.9-8.9 7.8±0.4	no data 28 4.9-19.8 10.7±3.1 89 1.8-19 7.9±3.3	65 104-669 306±134 28 283-730 538±117 124 ND-653 498±139	64 129-1084 604±215 28 394-1080 842±160 124 273-1086 789±169	65 48-324 230±61 27 152-348 227±41 124 12-389 221±68	64 ND-0.5 0.2±0.1 no data 68 ND-0.6 0.2±0.1	65 11-178 85±33 28 5-138 78±35 124 1-52 71±28	65 17-297 142±63 28 50-229 142±43 124 3-291 137±61	no data no data no data	65 ND-18.2 4.4±4.6 no data 65 ND-22.3 6.7±6.9	64 0.2-14.6 2.7±3.2 1 5.73 65 0.2-21 3.4±4.2	61 ND-60000 no data 65 ND->160000	61-130 Ag 30 As 44 Be 430 Cd 20 Cr 20 CrVI 48 Cu 57 Pb 80 Se 13 Zn 240 Ni 46	H2O(7): b,d,e,f,g ,j,l,ad (65)be

R0033703

COMPT

VOL 12

Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	BC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Garvey Reservoir		405.41	33 ac	CA409.0 150L	1610 unlin				Unassessed					
Rio Hondo R5 (Whittier Narrows Flood Control Basin to Peck Road Park Lake) and R6 (Peck Road Park Lake to Santa Fe Flood Control Basin)		405.41 405.33	5.16 and 2.82	CA409.0 190R and CA409.0 670R	20 Interm				Unassessed				Urban runoff (m)	
no data	no data	no data	2 241-518 380±139	no data	1 204	1 ND	2 32-138 84±53	2 26-39 33±7	no data	no data	1 3.6	no data	3 Ba 48 Cd 2 Cr 47 Cu 27 Pb 12 Zn 82	H2O(4): y
Eaton Wash R1 (confluence Rio Hondo to Huntington Drive) and R2 (Huntington Drive to Eaton Canyon Reservoir Dam)		405.41 405.31	4.98 and 2.84	CA409.0 220R and CA409.0 240R					Unassessed				Urban runoff (m)	
no data	1 9.1	no data	2 213-271	no data	1 104	1 ND	2 26-38	2 38-55	no data	no data	1 0.6	no data	no data	H2O(1) ND
Eaton Canyon Reservoir		405.31	0.086	CA409.0 320L										
Eaton Canyon Creek R3 (upstream of Reservoir)		405.31	6.96	CA409.0 330R					Unassessed				Urban runoff (m)	
no data	1 7.8	no data	2 212-213 212±1	no data	1 168	1 0.2	2 7-8 8±1	2 18-20 19±1	no data	no data	no data	no data	no data	no data
Peck Road Park Lake 303(d)-low		405.41	166 ac	CA409.0 480L	80 Interm	F N N N N	Drinking: Primary Drinking: Second Aquatic life Recreation: cont. Recreation: non-c Fish consumption		DO Pb TIS(DDT,chlordane) AMM ODORS TRASH ODORS TRASH TIS(DDT,chlordane)				Natural sources (m) Urban runoff (m) Aerial deposition (n) Recreational use (m)	
166 10-39 17 ± 6	161 6.9-8.8 7.7 ± 0.6	166 0.3-15.2 6.0 ± 4.0	80 116-271 175 ± 32	80 169-427 276 ± 52	no data (220)	no data	80 6-39 9.2 ± 8	80 8-44 20 ± 8	Tissue ('91): chlordane(MTRLs), DDT(MTRLs) [a] Tissue ('92): No organic chemicals at elevated levels [a]	80 ND-1.2 0.1-69	80 ND-1.1 0.5 ± 0.4	no data	80 Ag 1.1 As 6 Cu 69 Pb 73 Ba 2 Zn 47 Ni 23	41+ a,m,s,t, v,w,y,z, aa,ad,af, aa,ad,a a,av,aw ,aa,ad,b a,bp

R0033704

COMBO VOL 12

Reach/Location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Source	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Santa Anita Wash R1 (Peck Road Park Lake to Foothill Blvd) and R2 (Foothill Blvd to Dam at Carolwood Dr) and R3 (Debris Basin at Carolwood Dr to Santa Anita Reservoir)		405.41 405.33 405.33	1.33 and 3.5 and 1.08	CA409.0 500R and CA409.0 510R and CA409.0 550R		F F FT F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		COLOR				Natural sources (n) Urban runoff (m)	
no data	2 8.4 8.4±0	no data	3 230-381 283±70	no data	1 220	2 ND-0.1 0.05±0.0 5	3 12-32 19±9	3 16-41 25±11	no data	no data	1 4.4	no data	no data	no data
Santa Anita Reservoir		405.33	0.021 ac	CA409.0 560L	17 unknown				Unassessed					
Santa Anita Canyon Creek R4 (upstream of Reservoir)		405.33	4.84	CA409.0 580R					Unassessed					
3 15-26 18±4	15 7.9-8.6 8.1±0.2	3 8.1-8.3 8.2±0.1	18 130-320 205±48	15 170-530 348±79	14 100-208 158±27	no data	15 4-10 7±1	15 7-150 23±34	no data	no data	15 0.18-1.37 0.7±0.4	5 ND-300	1-15 Be 32 Cu and Zn (15) Cu 40 Zn 11	no data
Sawpit Wash R1 (Confluence Rio Hondo to Dam at Spanish Canyon) and R2 (Debris Basin at Spanish Canyon to Sawpit Dam)		405.41 405.33	5.46 and 0.38	CA409.0 690R and CA409.0 730R		F F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan						Urban runoff (m)	
no data	1 8	no data	3 83-231 170±83	1 256	2 107-180 129±22	2 ND	3 10-138 54±58	3 11-44 29±14	0	1 0.8	2 ND-0.8 0.4±0.4	no data	2 Be 58	H2O(1) ND
Monrovia Canyon Creek 303(d) - low		405.33	2.80	CA409.0 740R		F N FT F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		Di		AMM		Natural sources (n) Urban runoff (m) Unknown source (u)	
66 6-34 16±4	68 7.4-8.9 8.2±0.3	no data	68 200-638 278±67	68 331-882 480±74	68 160-380 213±23	68 ND-0.5 0.1±0.1	68 4-6720 138±104 9	68 14-209 30±23	no data	68 ND-4.3 0.1±0.5	68 0.18-8.54 1.5±1.6	67 ND-300	68 As 11 Be 182 Cd 18 Cr 10 Cu 40 Pb 40 Se 6 Zn 230 Hg 2 Ni 68	H20 no data (68)be
Sawpit Reservoir		405.33	10 ac	CA409.0 760L					Unassessed					

R0033705

COMPO
VOL 12

Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Sawpit Canyon Creek R3 (upstream of Reservoir)		405.33	3.51	CA409.0 770R					Unassessed					
Hollenbeck Park Lake		405.15	4.75 ac	CA409.0 870L	5 unknown				Unassessed					
Belvedere Park Lake 314		405.15	4 ac	CA409.0 880L	2 Intermediate	F F F	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		Lake was restored to Fish and Game specifications in 1986. pH pH,AMM,DO,Cu,Pb,EUT, TIS(chlordane, ChemA) AMM,pH,ODORS,TRASH,ALGAE ODORS,TRASH,ALGAE		TIS(Cu,Cu,Pb,Zn)		Natural sources (m) Urban runoff (m) Aerial deposition (s) Nutrient-rich sediments (m) Septic systems (m) Recreational use (m)	
34 12-38 21 ± 5	34 7.0-10.1 8.8 ± 0.6	34 0.5-19.5 6.2 ± 5.0	34 19-722 417 ± 216	34 100-1116 662 ± 327	no data (300)	no data	34 6-163 63 ± 53	34 10-155 102 ± 63	Tissue ('91): Cr(EDL95), Cu(EDL95), Pb(EDL95), Zn(EDL95), chlordane(NAS), ChemA(NAS) [a] Tissue ('92): Pb(EDL95), Zn(EDL95), chlordane(NAS), ChemA(NAS) [a]	34 ND-1.5 0.209	34 ND-0.16 0.049	no data	34 Cd 1 Cu 61 Pb 51 Se 3 Zn 31 Ni 16	no data
Lincoln Park Lake 303(d)-low 314		405.15	7 ac	CA409.0 890L	5 Intermediate	N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		TDS,SC,AMM AMM,Pb,EUT AMM,ODORS,TRASH ODORS,TRASH		DO;TIS(Cd)Fully but threatened pH		Natural sources (m) Urban runoff (m) Aerial deposition (s) Park runoff (m) Ducks (m) Recreational use (m)	
79 11-30 20 ± 6	68 7.2-8.1 8.1 ± 0.4	79 0.1-13.7 6.9 ± 3.3	28 419-701 619 ± 65	28 771-1046 962 ± 74	no data (300)	no data	28 57-93 76 ± 12	28 183-280 220 ± 28	Tissue ('91): No organic chemicals at elevated levels [a] Tissue ('92): Cd(EDL95) [a]	28 ND-1.14 0.34 ± 0.32	28 ND-0.33 0.089	no data	28 As 5.5 Cd 1.6 Cu 61 Pb 94 Zn 13	no data
Macarthur Park Lake		405.15	23 ac	CA409.0 900L					Unassessed					
Echo Park Lake 303(d)-low 314		405.15	2 ac	CA409.0 910L	15 Intermediate	N N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		AMM,Cu,Pb,EUT,TIS(PCBs) AMM,pH,ODORS,TRASH,ALGAE ODORS,TRASH,ALGAE TIS(PCBs)		nil		Natural sources (m) Urban runoff (m) Aerial deposition (s) Algae treatment (m) Recreational use (m)	
80 10-29 21 ± 6	69 7.0-8.4 8.5 ± 0.5	80 1.9-15.6 9.1 ± 2.6	31 249-483 346 ± 88	31 417-795 580 ± 105	no data (300)	no data	31 35-94 62 ± 16	31 51-144 88 ± 25	Tissue ('91): No organic chemicals at elevated levels [a] Tissue ('92): PCBs(MTRLs) [a]	31 ND-0.71 0.119	31 ND-0.2 0.049	no data	31 Cu 105 Pb 105 Se 3 Zn 14	16+ a,p,s,m, v,w,y,z, ag,ay,b a,al,al,a a,ah,au, av,aw,b a,bp
Elysian Park Lake		405.15	0.002	CA409.0 920L					Unassessed					

R0033706

COMCO VOL 12

Reach (Los Angeles River)		Hydro Unit	Site	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Arroyo Seco R1 (LA River to West Holly Ave) and R2 (West Holly Ave to Devils Gate Dam) 303(d) -low 319		405 15 405 31	7.02 and 2.83	CA408 0 930R and CA408 0 970R	1 Impaired 7 Intermediate 10 unknown	F N N	Drinking-Primary Drinking-Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,AMM* AMM*: COLIFORM*, TRASH,ALGAE,COLOR TRASH, ALGAE				Natural sources (m) Urban runoff (m) Transient encampments (m) Illegal dumping (s)	
9 11-29 19±8	11 6 8-8 8 8.1±0.5	7 7 9-13 9 7±1 6	11 301-788 582±151	4 552-1200 899±241	4 184-463 317±95	4 ND-0 1 0 03±0 0 4	11 32-114 80±28	10 55-270 175±69	no data	10 ND-3 .5±0.9	10 1 8-6 6 3 7±1 5	7 ND-30000	4 Be 178 Cd 3 Cu 20 Pb 43 Zn 133	H2O(4) ND (2)be
Eagle Rock Reservoir		405 25	0.012	CA408.0 960L					Unassessed					
Devils Gate Reservoir (empty)		405 32	0.183	CA409 0 990L					Unassessed					
Arroyo Seco R3 (upstream of Devils Gate Reservoir)		405 32	13 67	CA409 1 090R					Unassessed					
3 16-24 18±3	16 7 9-8 8 8.2±0 2	3 6 6-9 3 8 9±0 3	17 170-460 277±85	19 280-625 454±89	13 130-234 194±27	no data	14 5-18 13±4	14 1-160 35±38	no data	no data	15 0.1-2 0 8±0 6	6 ND-600	0-2 Be 47 Cu and Zn (14-15) Cu 30 Zn 30	no data
Silverlake Reservoir		405 18	0.118	CA408.1 340L	78 good				Unassessed					
Ivanhoe Reservoir		405 18	0.011	CA408 1 360L					Unassessed					
Los Angeles River R3 (Figueroa St. to Riverside Dr.) 303(d) -low 319		405.21	7.34	CA408.1 380R	19 Interm 7 Impaired	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC*,AMM AMM AMM,TRASH,ALGAE,ODOR, COLOR, TRASH,ALGAE,ODOR		TIS(Ag) Fully but threatened SCUM SCUM		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m)	
20 12-39 19±4	22 7.1-8.1 7.8±0.2	14 7.6-11 8.9±1	20 63-844 631±185	7 700-1239 1017±20 2	7 216-295 257±28	8 0.4-0.7 0.5±0.1	27 5-172 114±33	26 27-380 189±52	Tissue(*99): Ag(EDL95) *	20 2.2-14.9 8.1±2.7	20 3.1-7.6 4.6±1.1	12 110-600	7-17 As 7 Be 66 Cd 3 Cr 28 CrVI 29 Cu 10 Pb 22 Zn 74 Hg 0.7	H2O(24-28): b,c,d,e, g,h,i,j,l, n,o,r,s,t, u,v,x,bie ,bg,bh,b i,bj,bk

R0033707

COMP
VOL 12

Reach/Location (Los Angeles River)	Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp / pH	DO	TDS	SC	Hard	B	CHL	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Sycamore Canyon (South Branch)	405.21	7.75	CA409.1 370R		FT F N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,AMM* AMM*,COLIFORM* COLIFORM*				Natural sources (m) Illegal dumping (s) Urban runoff (m)	
8 7-23 14±5 / 8 7.3-8.8 7.8±0.4	no data	8 546-730 605±52	8 867-1023 936±46	8 237-358 297±33	8 0.04-0.13 0.1±0.04	8 72-99 84±8	8 145-220 184±22	no data	8 ND-0.3 0.12±0.09	8 1.2-4.6 2.4±1.1	8 280-8E5	8 As 3 Ba 80 Cu 20 Pb 40 Zn 250	H2O(8): a,bs
Verdugo Wash R1 (LA River to Verdugo Rd) and R2 (upstream of Verdugo Rd) 303(d) -low	405.21 405.24	3.41 and 5.56	CA409.1 360R and CA409.1 420R		FT F N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,AMM* AMM*,COLIFORM*,TRASH,ALGAE,COLOR COLIFORM*,TRASH,ALGAE				Natural sources (m) Illegal dumping (s) Urban runoff (m)	
6 10-34 18±5 / 9 7.3-8.2 8.2±0.6	7 9.6-11 9.4±0.8	7 468-726 600±86	2 800-1003 952±52	2 310-356 333±23	2 ND	9 60-133 91±22	9 101-191 149±31	no data	6 ND-1.3 0.3±0.4	6 1.1-3.8 2.6±0.6	6 ND-30000	2 Ba 224	H2O(2-ND)
Los Angeles River R4 (Riverside Dr. to Sepulveda Dam) 303(d) -low 319	405.21	11.64	CA409.1 620R		FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,AMM AMM,Pb AMM,COLIFORM,TRASH,SCUM,ALGAE,ODOR,COLOR COLIFORM,TRASH,SCUM,ALGAE,ODOR		CHL,SO4,N+N		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m) Spills (s)	
89 4-28 18±6 / 87 6.7-8.6 7.7±0.4	20 8-40 12.2±6.7	117 88-1148 632±195	74 604-1580 1078±16 3	74 118-560 280±80	77 ND-1 0.6±0.2	112 6-221 124±38	109 12-484 207±80	no data	95 ND-34.9 10.7±4.8	92 0.03-20.42 4.7±3.9	89 ND-80000	89-103 As 71 Ba 225 Cd 10 Cr 30 Cr/VI 14 Cu 70 Pb 120 Se 10 Zn 250 Hg 1 Ni 60	H2O(42): a,b,c,d,e,g,h,m,n,p,q,r,s,t,u,v,w,y,z,bl,bv,bl,bm (71) bs
Burbank Western Channel 303(d) -low	405.21	6.36	CA409.1 630R	6 Interm	N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,AMM* AMM*,Cd* AMM*,TRASH,SCUM,ALGAE TRASH,SCUM,ALGAE		ODOR,COLOR ODOR		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m) Spills (s)	
10 10-38 19±4 / 11 7.3-7.8 7.6±0.2	7 8-13 10.2±1.3	10 518-887 682±128	4 800-1191 1033±13 4	4 184-340 272±69	4 0.3-0.6 0.5±0.1	12 101-182 133±24	11 82-270 168±	no data	11 8.3-16.9 12±2.7	11 6.4-11.7 3.6±3.0	6 ND-10	3 Ag 3 Ba 125 Cd 3 Cr 15 Cu 28 Pb 31 Zn 60	H2O(3): b,c,d,e,f,g,bs

R0033708

COMP-2
VOL 12

Reach/Location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Tujunga Wash (LA River to Hansen Dam) 303(d) -low		405.21	9.68	CA409.1 820R	10 Interim	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		pH*,TDS*,AMM* AMM*,Cu* AMM*,COLIFORM*,TRASH,COLOR TRASH		SCUM,ODOR SCUM,ODOR		Natural sources (ns) Illegal dumping (s) Urban runoff (m)	
6 11-30 18±8	8 7.3-8.9 8.3±0.5	6 7-11 9.2±1.4	7 224-1358 663±322	2 1000-1766 1383±383	2 208-275 241±35	2 0.3-1.9 1.1±0.8	9 11-338 135±110	8 31-280 112±74	no data	7 ND-2.4 0.6±0.8	7 ND-0.22 0.08±0.1	5 ND-2300	3 As 21 Be 138 Cd 6 Cu 101 Zn 87	H2O(3) be
Pacoima Wash South Branch (downstream of Pacoima Spreading Grounds)		405.21	4.02	CA409.1 830R					Unassessed					
1 17	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	2 As 19 Be 65 Cu 22 Zn 88	H2O(3) d
Pacoima Wash R1 (Pacoima Spreading Grounds to Lopez Flood Control Basin) and R2 (Lopez Flood Control Basin to Pacoima Dam)		405.21 405.21	3.41 and 2.85	CA409.2 070R and CA409.2 110R	14 Interim .	F F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan							
2 27 27	4 8.1-8.2 8.1±0.1	1 8.1	13 220-880 345±98	10 300-880 612±103	10 160-320 238±45	no data	11 4-18 10±4	11 29-110 75±24	no data	no data	11 ND-0.5 0.18±0.19	6 ND-9	2 Be 98 Be 8 Cu and Zn(11) ND	no data
Pacoima Reservoir		405.22	0.082	CA409.2 180L	89 unknown				Unassessed				Urban runoff (m)	
Pacoima Canyon Creek R3 (upstream of Pacoima Reservoir)		405.22	19.02	CA409.2 210R					Unassessed				Urban runoff (m)	
Hansen Lake		405.21	0.184	CA409.2 440L					Unassessed					
Middle Lake		405.21	0.006	CA409.2 450L					Unassessed					
Little Tujunga Canyon Creek		405.23	7.16	CA409.2 490R		F F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,CHL*,SO4*					
2 27-39 38±1	no data	no data	10 410-823 497±78	7 600-843 783±147	7 253-408 328±58	no data	7 19-58 37±13	7 109-207 155±33	no data	no data	7 ND-1.13 0.38±0.37	2 11-105	Cu and Zn(7) Zn 11	no data

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Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Big Tujunga Canyon Creek R1 (Hansen Flood Control Basin to Big Tujunga Reservoir)		405.23	15.13	CA409.2 680R		F F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan						Resource extraction (o)	
3 16-29 23±5	9 8-9.1 8.4±0.3	3 7.6-8.8 8.7±0.9	15 208-680 315±98	11 270-650 467±105	10 130-254 194±38	1 ND	12 6-14 10±2	12 19-67 36±14	no data	no data	11 ND-1.28 0.38±0.37	6 ND-82	2-3 Ba 82 Pb 9 Cu and Zn(11) ND	no data
Big Tujunga Reservoir		405.23	0.141	CA409.3 090L	84 unknown				Unassessed					
Big Tujunga Canyon Creek R2 (upstream of Big Tujunga Reservoir)		405.23	7.88	CA409.3 140R					Unassessed					
Lucas Creek		405.23	2.12	CA409.3 180R		F F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan							
2 19-30 20±1	12 7.4-8.7 8.3±0.3	2 8.3-9.1 8.7±0.4	16 200-420 282±61	12 270-470 387±60	12 125-219 171±22	no data	12 7-18 11±3	12 15-33 23±6	no data	no data	12 ND-2 0.27±0.64	3 2-8	1 Ba 82 Pb 4 Cu and Zn (12) Zn 10	no data
Upper Big Tujunga Canyon Creek		405.23	6.35	CA409.3 600R					Unassessed					
Los Angeles River R5 (within Sepulveda Basin) 303(d) - tiw 319		405.21	1.93	CA409.3 650R	19 Interm 7 Impaired	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*,SC*,AMM*,SO4* AMM, TTS(ChemA) TRASH,SCUM,ALGAE,ODOR,COLOR TRASH,SCUM,ALGAE,ODOR SO4*		TTS(Aq Chlorinated) Oil Oil		Natural sources (m) POTW effluent (m) Illegal dumping (s) Urban runoff (m) Recreational use (o)	
8 7-34 18±8	11 6.5-7.8 7.4±0.5	7 7-8.4 8±1	8 611-1260 822±224	4 890-1169 1011±10 1	4 172-301 224±48	4 0.5-1.2 0.8±0.3	11 93-178 132±23	11 142-632 338±177	Tissue('91): no elevated levels of organic chemicals * Tissue('92): Ag(EDLSS), chlorpyrifos(EDLSS), ChemA(NAS) *	10 2.2-30.1 8.8±8	10 0.5-18.7 3.6±4.1	6 300-1700	4-6 As 10 Ba 72 Cd 2 Cu 10 Se 7 Zn 91	H2O(8): b,c,d,e,f ,g,h,i,j, u Sed(1) ND
Encino Reservoir		405.21	0.309	CA409.3 70CL					Unassessed					
Bull Creek		405.21	8.76	CA409.3 730R	10 Interm	FT F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*				Natural sources (m) Urban runoff (m)	

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Reach/location (Los Angeles River)	Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp / pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
1 14 / 3 7.6-8.5 8.1±0.4	no data	4 500-653 580±181	3 798-1047 881±117	3 253-484 342±101	3 0.2-0.9 0.5±0.3	4 76-116 97±18	4 134-370 209±85	no data	1 1.1	3 ND-2 1±0.8	no data	4 As 14 Be 117 Cd 2 Cu 15	H2O(1-5) n,y,z,bo Sed(1) bo
Los Angeles Reservoir	405.21	0.257	CA409.3 790L	448 good				Unassessed					
Los Angeles River R6 (upstream of Sepulveda Flood Control Basin) 303(d) -low 319	405.21	6.17	CA409.3 880R	18 Interm 7 Impaired	N F N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SO4 TDS,SC*,SO4,AMM*, 1,1-DCE,PCE,TCE AMM*,COLIFORM* COLIFORM* TDS,CHL,SO4				Rising contaminated groundwater (m) Natural sources (m) POTW effluent (m) Illegal dumping (m) Urban runoff (m) Transient encampments (m)	
17 10-33 21±8 / 21 7.8-7 8.1±0.4	14 9-18 13±3	28 123-1980 1213±46 8	4 1288-1700 1407±17 2	6 366-775 607±132	5 0.63-0.8 0.5±0.2	28 12-208 145±44	28 67-1030 586±228	no data	17 ND-2 0.3±0.6	18 0.8-8.8 3.4±2	13 170-8000	9-18 As 6 Be 115 Cd 16 Cu 22 Pb 13 Se 14 Zn 11 Hg 0.85	H2O(2-32) a,b,c,d,e,f,g,h,i,j,k,l,m,n,p,r,t,u,v,w,bo,br,jbn
Aliso Canyon Wash 303(d) -low	405.21	10.13	CA409.3 930R	18 Interm	FT N N N	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS* Se* SO4*		COLOR		Natural sources (m) Unknown sources (m) Urban runoff (m)	
2 13-25 19±8 / 4 7.9-8.6 8.3±0.2	no data	5 592-979 788±156	3 878-1114 994±108	4 308-486 378±81	3 0.3-0.8 0.5±0.2	5 76-198 128±42	5 183-324 245±61	no data	2 0.2-1.2 0.7±0.8	4 2.1-4.2 3.1±0.8	1 1600	4 As 10 Be 113 Cd 2 Cu 12 Se 8.3 Zn 65	H2O(2-3) bo
Browns Canyon Wash R1 (Confluence LA River to Reservoir) and R2 (upstream of Reservoir)	405.21 405.21	7.98 and 2.44	CA409.4 090R and CA409.4 190R	2 Interm	FT F F F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*				Natural sources (m) Urban runoff (m)	
2 14-34 19±8 / 3 7.8-8.8 8.3±0.5	0	4 305-1339 788±370	2 1100-1360 1225±12 8	3 138-830 421±294	2 0.3-0.4 0.4±0.1	4 82-200 114±56	4 72-800 248±168	no data	no data	3 ND-1.8 0.7±0.8	1 ND	3 Be 85 Cd 2 Cu 16 Se 8	H2O(4) r,s
Arroyo Calabasas	405.21	3.30	CA409.4 230R					Unassessed					

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Reach/location (Los Angeles River)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
2 16-25 20±5	2 8.2-8.3 8.3±0.1	1 17	2 1980- 2490 2225±26 5	no data	1 1010	no data	2 217-240 229±12	2 947-1270 1109±16 2	no data	2 0.1-0.3 0.2±0.1	2 0.2-1 0.6±0.4	2 800-1700	no data	H2O(1-ND)
Lake Calabasas 303(d)-low		405.21	28 ac	CA408.4 240L	21 Interm	FT N N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		pH AMM TIS(DDT),EUT AMM ODORS ODORS TIS(DDT)		DO,pH,TIS(Cd,Cu,Zn)		Natural sources (m) Urban runoff (m) Aerial deposition (s) Algae treatment (m) Ducks (m)	
92 9-32 21 ± 6	85 7.4-8.3 8.6 ± 0.4	92 0.2-15.7 8.7 ± 3.3	29 322-661 433 ± 79	28 565-868 759 ± 139	no data (1010)	no data	28 78-167 128 ± 32	28 51-116 83 ± 20	Tissue ('91): Cu(EDL85) * Tissue ('92): DDT(MTRLs), Cd(EDL85), Cu(EDL85), Zn(EDL85) *	28 ND-0.45 0.089	28 ND-0.1 08	no data	28 Cu 92 Pb 67 Se 2 Zn 11	no data
Bell Creek 303(d) -low		405.21	8.81	CA408.4 300R		N F N F	Drinking: Primary Drinking: Secondary Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SO4* TDS*,SO4* COLIFORM* TDS*,CHL*,SO4*		COLIFORM*		Industrial point source (m) Natural sources (m) Urban runoff (m)	
3 16-25 21±4	3 8.1-8.3 8.2±0.1	1 21	3 1320- 1470 1410±86	no data	2 686-760 723±58	no data	3 141-238 183±40	3 328-840 526±142	no data	2 0.1-0.2 0.2±0.1	3 0-3.8 2.1±1.8	3 ND-8000	no data	H2O(1-ND)
Chatsworth Creek R1 (downstream of Hidden Lake)		405.21	1.76	CA408.4 310R					Unassessed					
Chatsworth Reservoir		405.21	849 ac	CA408.4 360L					Unassessed					

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Reach/location (San Gabriel)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
San Gabriel River Estuary 303(d) low 319		405.15	2.95	CA410.0 000E		N N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		TIS(As) COLOR TIS(As)		TOX, TIS(Cu, As,Cr),HBIT Turb		POTW effluent (m) Urban runoff (m) Spills (s) Illegal dumping (s)	
									Tissue ('90): Cu(EDL95), Ag(EDL95)[a] Tissue ('91): Cr(EDL85), Ag(EDL85)[a] Tissue ('92): As(MTRLs), Cu (EDL85), Ag(EDL85)[a] Tissue ('93): Cu(EDL85), As(MTRLs)[a] Wat Bio Toxicity: poor survival rates[a]					
Coyote Creek 303(d)		405.15	13.45	CA410.0 010R	17 Inter	N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,AMM AMM,Pb,TOX,HBIT AMM,COLIFORM,ALGAE,COLOR COLIFORM, ALGAE NA		CHL,TIS(Cr,Cu,As) Turb		Natural sources (m) POTW effluent (m) Urban runoff (m) Spills (s) Illegal dumping (s)	
134 7-31 19 ± 6	144 7.1-8.9 8.0 ± 0.4	1 13.9	139 320-1922 925 ± 240	139 462-2600 1426 ± 299	139 134-632 331 ± 110	139 ND-3.7 0.49	139 53-405 182 ± 89	139 91-683 282 ± 100	Tissue ('92): Cr(EDL85), Cu (EDL85), Ag(EDL85)[a] Wat Bio Toxicity: poor survival rates[a]	143 ND-32 5.1±6	140 ND-17.8 3.6 ± 3.0	71 ND-340000	139- 143 Ag 30 As 74 Be 800 Cd 10 Cr 90 CrVI 20 Cu 90 Pb 310 Se 14 Zn 770 Ni 30	16 d,g,ad, be scanned 139 times and detected above detectio n limit
Fullerton Drain/Creek			12.88	CA410.0 050R					Unassessed					
Coyote Creek North Fork			3.75	CA410.0 080R					Unassessed					
San Gabriel River R1 (Estuary to Firestone) 303(D) low		405.15	6.73	CA410.0 230R	9 Impaired	N N P	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,AMM AMM,Pb,TOX,HBIT AMM,COLIFORM,COLOR		ALGAE,Turb COLIFORM, ALGAE, Turb		Natural sources (m) POTW effluent (m) Urban runoff (m) Spills (s) Illegal dumping (s)	

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Reach/location (San Gabriel)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	S	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
72 13-30 22 ± 4	76 6.6-8.9 7.9 ± 0.5	no data	70 204-1486 763 ± 134	70 351-2280 1238 ± 217	70 132-410 243 ± 38	70 ND-1.2 0.5 ± 0.2	70 22-291 167 ± 37	70 38-480 171 ± 47	Wet Bio Toxicity: poor survival rates *	77 ND-21.1 10.1 ± 4.1	69 0.79-28.5 6.9 ± 5.8	69 ND-60000	70-76 Ag 130 As 22 BA 219 Cd 20 Cr 20 CrVI 24 Cu 100 Pb 100 Se 17 Zn 340 Ni 30	17 b,d,f,g,k, n,r,t,v,y, z be scanned 69 times and detected above detectio n limit
El Dorado Lakes 303(d)-low 314		405.15	220 ac	CA410.0 230L	230 Interim	N N N	Drinking--Primary Drinking--Second. Aquatic life Recreation: cont. Recreation: non-c		pH,AMM AMM,Cu,Pb,EUT,TISO4tot AMM,pH,ALGAE ALGAE		pH,TIS(Cr)		Natural sources (n) Urban runoff (m) Aerial deposition (s) Nutrient-rich sediments (m) Algae treatment (m)	
126 12-30 22 ± 6	116 6.9-8.4 5.5 ± 0.6	126 0.2-25.6 7.0 ± 4.6	46 380-488 449 ± 26	45 673-832 753 ± 44	no data (240)	no data	46 65-83 76 ± 6	46 ND-70 40 ± 17		46 ND-1.92 0.309	45 ND-0.3 0.039	no data	46 As 28 Cu 69 Pb 108 Zn 21 Ni 11	29+ a,m,p,s,t ,v,w,y,z, aq,al,al, an,ao,ap ,ac,ad,a u,av,aw, ax,ay,az ,ba,bb,b o,bp
San Gabriel River R2 (Firestone to Whittier Narrows Dam) 303(d) low		405.15	9.69	CA410.0 250R	8 Interim	FT N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS, SC,AMM AMM,Pb AMM,COLIFORM COLIFORM		N+N		Natural sources (n) POTW effluent (m) Urban runoff (m) Spills (s) Illegal dumping (s)	
46 9-27 19 ± 5	50 6.2-8.6 7.8 ± 0.5	no data	50 164-760 664 ± 120	46 289-1196 918 ± 191	50 116-330 240 ± 60	49 ND-17 5 ± 4.6	50 7-180 102 ± 29	50 20-336 180 ± 82		49 ND-16.5 5.2 ± 4.8	50 0.38-12.6 4.2 ± 3.6	49 ND-13000	49-50 As 22 Be 169 Cd 10 Cr 10 CrVI 24 Cu 140 Pb 110 Se 20 Zn 120 Ni 103	2-9 f,g,r,v,af be scanned 47 times and detected above detectio n limit
Legg Lake 303(d)-low		405.41	40 ac	CA410.0 310L	70 good	FT N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		pH Cu,Pb ODORS,TRASH ODORS,TRASH		AMM,pH		Natural sources (n) Urban runoff (m) Aerial deposition (s) Algae treatment (m) Ducks (m) Recreational use (m)	

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Reach/Rec. (San Gabriel)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Cl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
91 11-29 21 ± 6	84 7.6-8.9 8.3 ± 0.3	91 5.6-14.6 11.1 ± 1.7	43 179-248 207 ± 16	43 295-368 327 ± 29	no data (240)	no data	43 18-29 22 ± 2	43 39-55 46 ± 4	Tissue ('91): No organic chemicals at elevated levels * Tissue ('92): No organic chemicals at elevated levels *	43 ND-0.36 0.059	43 ND-0.2 0.029	no data	43 Cu 87 Pb 70 Zn 134	13+ a,m,o,v,w,y,z,ac,av,aw,ay,az,ba,bb,bp
San Gabriel River R3 (Whittier Narrows to Ramona) 303(d) low		405.41	3.52	CA410.0 320R	(42)Interim	FT N P F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS, SC TOX		TURB		Natural sources (m) Urban runoff (m) Spills (s) Illegal dumping (s) Municipal effluent (m) Poultry farm (s)	
27 9-26 16 ± 4	28 7.3-8.6 8.0 ± 0.4	28 3.8-12.9 9.0 ± 2.1	27 201-888 572 ± 158	27 300-1240 878 ± 235	27 120-470 247 ± 74	1 0.2	27 4-224 95 ± 46	27 24-385 157 ± 68	Wat Bio Toxicity: reduced survival rates *	2 1.8-3.2 2.59	1 0.9	no data	2 Be 128 Cd 2	2 ND
San Jose Creek R1 (SG confl. to ~Temple Street) and R2 (~Temple to ~I-10 at White Ave) 303(d) low		405.41 and 405.51	13.12 and 4.93	CA410.0 330R and CA410.0 480R	(16) Interim	FT N N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS,SC,SO4,AMM AMM,Pb AMM,COLIFORM,COLOR COLIFORM TDS,SO4		TOX pH, ALGAE ALGAE CHL		Natural sources (m) POTW effluent (m) Urban runoff (m) Fuel/oil Spills (s) Illegal dumping (s)	
68 9-27 17 ± 4	73 6.9-8.1 8.1 ± 0.4	1 8.4	73 591-1120 840 ± 129	71 780-1810 1236 ± 182	72 288-610 438 ± 91	73 ND-1.2 0.25 ± 0.19	73 65-292 130 ± 39	73 180-435 282 ± 52	Wat Bio Toxicity: reduced survival rates *	74 ND-10.3 2.0 ± 3	72 ND-12.1 2.979	68 ND-16000	70-72 As 11 Ba 282 Cd 30 Cr 150 CrVI 28 Cu 80 Pb 170 Se 13 Zn 180 Hg 2 Ni 120	4 s ba scanned 69 times and detected above detectio n limit
Puente Creek		405.41	8.78	CA410.0 340R					Unassessed					
Walnut Creek Wash (goes to Puddingstone res) 303(d) low		405.41	13.9	CA410.0 880R	13 Interim	FT N N F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TDS*, AMM* pH*,TOX AMM*,pH*				Natural sources (m) POTW effluent (m) Urban runoff (m) Fuel/oil Spills (s) Illegal dumping (s)	
3 14-29 22 ± 6	4 8.0-10.6 9.2 ± 1.0	1 10.7	4 471-829 661 ± 64	2 759-933 844*	3 138-270 224 ± 62	4 ND-0.2 0.13 ± 0.08	4 62-108 84 ± 9	4 112-230 168 ± 46	Wat Bio Toxicity: poor survival rates *	3 0.2-1.8 1.03 ± 0.6	3 0.3-7 3.1 ± 2.9	no data	1-3 Ba 146 Cu 14	3 ND
Big Dalton Wash R1 (to lower reservoir)		405.41	10.42	CA410.0 600R					Unassessed				Urban runoff (m)	
Little Dalton Wash Creek R1 (below res)		405.41	8.99	CA410.0 630R					Unassessed				Urban runoff (m)	

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Reach/location (San Gabriel)		Hydro Unit	Size	Code	Prior WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	Chl	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Little Dalton Reservoir		405.41	6.6	CA410.0 670L					Unassessed				Urban runoff (m)	
Little Dalton Cyn Creek R2 (abv res)		405.41	3.96	CA410.0 660R					Unassessed				Urban runoff (m)	
San Dimas Wash R1 (Big Dalton to lower San Dimas Reservoir at ext of Oak Knoll)		405.41	7.93	CA410.0 680R					Unassessed				Urban runoff (m)	
San Dimas Creek R2 (Horn Cyn to San Dimas Reservoir)		405.44	3.30	CA410.0 720R					Unassessed				Urban runoff (m)	
San Dimas Reservoir		405.44	550 ac	CA410.0 760L	500 good				Unassessed				Urban runoff (m)	
San Dimas Wash R3 (abv res)		405.44	6.67	CA410.0 770R		F F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		FULLY SUPPORTING					
2 22-28 241	8 8.0-8.6	2 8.2-8.3	11 280-2710	8 380-610	8 300-386	no data	8 11-21	8 21-60	3 8-61	no data	8 0.3-1.0	no data	1 Ba 61 Cu and Zn (?) ND	no data
Big Dalton Wash R2 (between reservoirs)		405.41	1.86	CA410.0 680R					Unassessed				Urban runoff (m)	
Big Dalton Reservoir		405.41	21.9 ac	CA410.1 040L					Unassessed					
Big Dalton Wash R3 (abv reservoir)		405.41	2.89	CA410.1 050R					Unassessed					
Puddingstone Reservoir 303(d)-law 314 319		405.62	362 ac	CA410.1 180L	480 impaired	F F N N F N	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Fish consumption		DO,TIS(PCBs,chlordane, Hg,DDT) AMM TIS(PCBs,chlordane, Hg,DDT)		TIS(dieldrin, oxadiazon, As) pH		Natural sources (m) Urban runoff (m) Aerial deposition (a) Recreational use (m)	
167 10-39 18 ± 6	189 6.6-8.7 7.5 ± 0.5	167 6.1-14.9 4.3 ± 3.5	75 177-346 214 ± 18	75 369-491 375 ± 48	no data	no data	75 10-44 27 ± 13	75 18-49 34 ± 10	Tissue ('91): chlordane(MTRLs), PCBs(MTRLs), Dieldrin(EDL85), oxadiazon(EDL85), As(EDL85), Hg(MB) [illegible] Tissue ('92): Chlordane(MTRLs), DDT(MTRLs), PCBs(MTRLs), As(EDL85), oxadiazon(EDL85) [illegible]	75 ND-6 0.289	75 ND-2 0.89	no data	75 Cu 120 (pb not scorne d)	43+ [illegible]

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Reach/Location (San Gabriel)		Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Sources	
Temp	pH	DO	TDS	SC	Hard	B	CHI	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
Live Oak Channel/Wash R1 (Puddingstone to ~Foothill)		405 52	4.45	CA410.1 190R					Unassessed					
Santa Fe Dam Park Lake 303(d)-low		405 41	70 ac	CA410.1 370L		FT N N F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		pH Pb Cu AMM pH		sil		Natural sources (m) Urban runoff (m) Aerial deposition (s) Recreational use (m)	
102 12-29 21 ± 6	95 7 5-9 6 8.7 ± 0 3	102 0 5-12.6 10 6 ± 2.0	37 181-346 259 ± 39	37 370-494 426 ± 35	no data (180)	no data	37 52-84 66 ± 10	37 30-54 45 ± 6	Tissue ('92): No organic chemicals at elevated levels *	37 ND-0.4 0.79	37 ND-0.2 0 039	no data	37 Cu 58 Pb 51 Zn 65	no data
San Gabriel River R4 (Ramona to Santa Fe Spreading Basin Dam) and R5 (Santa Fe Spreading basin Dam to ~east Milbrae St) and R6 (~east Milbrae St to Royal Oaks Drive Ext.) and R7 (Ext Royal Oaks Drive to Morris Dam)		405 41 405 41 405 42 405 43	3 67 and 2.0 and 1.29 and 5.67	CA410.1 330R and CA410 1 350R and CA410.1 410R and CA410.1 430R	42 Intermi	F F F FT F	Agriculture Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		(Cd (n=1) IS ABV STND) Turb		COLOR		Natural runoff (m) Urban runoff(m) Resource extraction (m)	
3 11-17 14 ± 3	6 7.7-8 1 8.3 ± 0.5	1 10 3	4 184-410 297 ± 88	2 335-600 468 ± 133	4 132-170 149 ± 16	2 ND	4 9-105 54 ± 43	4 19-78 42 ± 20		2 0.9-1.1 0.95 ± 0.15	3 0 6-1.8 1.0 ± 0.4	no data	2 Be 67 Cd 2 Cu 13	2 ND
Morris Reservoir		405 43	442	CA410.1 600L	420 unknown	F F F F F	Agriculture Drinking: Primary Drinking: Second Aquatic life Recreation: cont. Recreation: non-c Basin Plan				6		Former military testing	
39 4-23 12 ± 4	46 7 0-19 0 8 4 ± 2.0	39 4 3-12.2 9 9 ± 1.7	41 140-438 215 ± 60	40 258-822 361 ± 96	31 140-248 176 ± 29	42 ND-1.6 0.29	46 ND-66 79	46 0.4-161 29 ± 25		1 0.7	nsad	no data	1 Be 100	1 ND
San Gabriel River R8 (Morris reservoir to San Gabriel Reservoir)		405 43	0.95	CA410.1 660R					Unassessed					
San Gabriel Reservoir		405 43	820 ac	CA410.1 690L	600 gsad									
San Gabriel River West Fork R1 (to Cogswell res)		405 43	6.19	CA410.1 690R	19 gsad	F F FT FT	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		SO4*		TRASH: fully but threatened TRASH: fully but threatened		Recreational use (m) Illegal dumping (m)	
4 7-16 12 ± 5	11 7 4-8.9 8.1 ± 0.4	1 9.0	9 45-300 182 ± 67	6 186-480 328 ± 86	7 80-169 148 ± 31	3 ND	9 3-9 5 ± 2	9 11-160 41 ± 42		no data	9 ND-0.46 0.169	3 ND-4	3-4 Be 69	no data

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Reach/Hydro. Unit (San Gabriel)	Hydro Unit	Size	Code	Prev WQA	WQA	Assessed Uses		Not supporting		Partially supporting		Potential Source	
Temp / pH	DO	TDS	SC	Hard	B	CN	SO4	Tissue, Sediment and Toxicity Data	AMM	N+N	Fec Col	metals	VOCs
San Gabriel River North Fork	405.43	10.0	CA410.1 660R		F F FT FT	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan				COLOR, TRASH: fully but threatened TRASH: fully but threatened		Recreational use (h) Illegal dumping (m)	
4 7-15 11 ± 3 / need	1 9.6	10 180-245 219 ± 19	7 273-390 358 ± 39	6 145-208 179 ± 16	3 ND-0.1 0.03#	10 3-8 5 ± 1	10 8-150 26#		1 0.7	9 ND-2.8 0.62#	3 ND-4	1-8 Be 204 Zn 80	1 ND
Crystal Lake 303(d)-low 314 319	405.43	6.8	CA410.1 770L	6 impaired	N FT F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c		DO AMM				Natural sources (n) Urban runoff (m) Aerial deposition (a) Recreational use (m)	
Cedar Creek	405.43	2.37	CA410.1 790R					Unassessed					
100 7-28 12 ± 6 / 100 6.3-8.5 7.1 ± 0.5	100 0.1-13.0 3.99	40 83-179 125 ± 22	40 173-267 213 ± 27	no data	no data	40 1-5 3 ± 1	40 3-11 7 ± 1		40 ND-1.84 0.14#	40 ND	no data	no data	20+ a,s,v,w,y,z,aq,ah,ad,au,av,aw,ay,b,c,bo
1 7 / 2 7.9-8.2	no data	2 178-208	1 298	2 178-180	1 0.2	2 3-4	2 ND-10		no data	1 0.69	no data	no data	no data
San Gabriel River West Fork R2 (Cogswell res to Red Box Gap)	405.43	8.14	CA410.1 820R					Unassessed					
San Gabriel East Fork 303(d)-low	405.43	12	CA410.1 860R	16 good	F F N N	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		TRASH TRASH SO4*				Recreational use (h) Illegal dumping (m) Septic systems (d)	
6 7-16 11 ± 4 / 14 7.9-8.9 8.2 ± 0.3	2 8.6-9.8 9.79	12 168-262 211 ± 28	7 274-380 330 ± 38	9 140-216 179 ± 24	5 ND	12 2-8 4 ± 2	12 14-210 41#		1 0.6	11 ND-1.3 0.43#	2 <2	2-4 As 3 Be 68 Pb 4 Zn 40	no data
Cattle Cyn Creek	405.43	6.69	CA410.2 880R	16 good	F F F F	Drinking: Primary Drinking: Second. Aquatic life Recreation: cont. Recreation: non-c Basin Plan		FULLY SUPPORTING					
1 8 / 3 7.6-8.3 8.0 ± 0.2	no data	3 220-383 342 ± 16	1 322	2 169-220 204#	2 ND	3 5-8 6 ± 1	3 14-30 21 ± 7		1 0.7	2 0.7-1.2 0.95 ± 0.25	no data	no data	no data

R0033718

VOL 12

C3002

Ventura County Coastal Features and Bays

Reach/Location (Ventura County Coastal Features and Bays)	Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQ A	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal Coliform (Wet and Dry)	Total Coliform (Wet and Dry)			Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Ventura County Nearshore zone: Pt Mugu to Latigo Point		11410	CA412.0000O	11410 ac good	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
Nearshore: other areas		ask Deb	CA412.0010O				Unassessed		
Ventura County offshore zone	401.00	ask Deb	CA412.0020O				Unassessed		
Rincon Beach (county line to Pitas Point)	401.00	7.73 mi	CA412.0030C				Unassessed		
Solimar Beach	401.00	3.88	CA412.0040C				Unassessed		
Emma Wood Beach	401.00	1.59	CA412.0050C				Unassessed		
Seaside Wilderness Park Beach	401.00	0.79	CA412.0060C				Unassessed		
Seaside Park Beach	402.10	0.87	CA412.0070C				Unassessed		
San Buena/Ventura Beach	402.10	2.03	CA412.0080C				Unassessed		
Marina Park Beach	403.11	1.26	CA412.0090C				Unassessed		
Ventura Harbor: main harbor area (except Keyes area)	403.11	125 ac	CA412.0100B	223 good	F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption			Urban runoff (m) Recreational use (m)
no data	no data			none		no advisories	Tissue ('88): DDT(800ppb),TBT(8700 ppb), Cu(120 ppb), Zn(520ppb) [1] Bed tox('93): good survival [2]		
Ventura Harbor beaches	403.11	0.82	CA412.0110C				Unassessed		
Ventura Marina	403.11	33.3 ac	CA412.0120B				Unassessed		
Ventura Harbor: Ventura Keyes at Arundell Barranca 303(d)-low 319	403.11	40 ac	CA412.0130B	195 Interm	F N F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption	COLIFORM		Urban runoff (m) Agricultural runoff (m) Marine activities (n)
75%	98%			none		no advisories			
Marina Cove Beach	403.11	0.07	CA412.0140C	8 Impaired			Unassessed		
Santa Clara River Estuary beach/Surfers Knoll 303(d)-low	403.11	0.88	CA412.0160C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	COLIFORM		Urban runoff (m) Agricultural runoff (m)
	32%			none		no advisories			

R0033719

COMM VOL 12

Reach/location (Ventura County Coastal Features and Bays)	Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
McGrath Beach 303(d)-low	403.11	1.35	CA412.0170C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	COLIFORM	beach closures	Oil spills (m) Urban runoff (m) Agricultural runoff (m)
	21-46%			1993(14 days) 1994(10 days) 1994(37 days)		no advisories	no data		
Edison Canal area beach	403.11	0.37	CA412.0180C				Unassessed		
Mandalay Beach 303(d)-low	403.11	1.55	CA412.0190C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		beach closures	Sewage spills (m) Urban runoff (m) Agricultural runoff (m)
				1995(3 days)		no advisories	no data		
Oxnard Beach	403.11	0.65	CA412.0120C				Unassessed		
Hollywood Beach	403.11	1.10	CA412.0210O				Unassessed		
Hollywood by the Sea beach	403.11	0.30	CA412.0120C				Unassessed		
Channel Islands Harbor 303(d)-low	403.11	220 ac	CA412.0230B	220 ac Interm	FT U U F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption		Sed(Pb,Zn): FT	Agricultural drains (m) Urban runoff (m) Harbor activities (m)
no data	no data			none		no advisories	Tissue ('86): DDT(2ppm), Zn(320 ppb) [1] Sed tox('93): high toxicity during winter rainy season but low toxicity in re-samples later[2] Sed Chem: Pb(180ppm), Zn(380ppm) [3]		
Channel Islands Harbor beaches	403.11	0.64	CA412.0240C				Unassessed		
Mandalay Bay marina	403.11	75 ac	CA412.0250B						
Silver Strand Beach	403.11	1.00	CA412.0260C				Unassessed		
Port Hueneme Harbor (back basins) 303(d)-low 319	403.11	80	CA412.0270B	121 ac Impaired	N U U F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption	Sed(PAHs) TIS/DDT,PCBs,TBT,Zn]		Naval activities (m) Spills (m) Urban runoff (m) Agricultural runoff (m)
no data	no data			none		no advisories	Tissue ('89): DDT(700ppb),PCBs(2000ppb), TBT(7000 ppb), Zn(400ppm) [1] Sed tox: good survival [2] US Navy-Sed Chem ('89): PAHs(10ppm)		
Port Hueneme Harbor (main harbor)	403.11	70	CA412.0275B	121 ac Impaired	F U U F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption			Naval activities (m) Spills (m) Urban runoff (m) Agricultural runoff (m)
Port Hueneme Harbor Beaches	403.11	0.88	CA412.0280C				Unassessed		
Port Hueneme Beach Park Beach	403.11	0.68	CA412.0290C				Unassessed		

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COMCO VOL 12

Reach/Location (Ventura County Coastal Features and Bays)	Hydro Unit	Size (miles or acres)	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Ormand Beach	403.11	2.5	CA412.0300C				Unassessed		
Ormand Beach Wetland	403.11	9.6 ac	CA412.0310T				Unassessed		
Beach between Ormand Beach and Mugu Lagoon	403.11	4.37	CA412.0320C				Unassessed		
Mugu Lagoon Beach	403.11	8.22	CA412.0330C				Unassessed		
Las Cerritos Beach (to county line)	404.46	9.47	CA412.0370C				Unassessed		

R0033721

COMO5 VOL 12

Reach/Location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
SANTA MONICA BAY NEARSHORE ZONE AND OFFSHORE ZONE Hyperion 5 mile and 7 mile outfall area Joint Water Pollution Control Plant outfall area Palos Verdes shelf Marina del Rey area Santa Monica Pier area Manhattan Beach area Redondo Pier area Malibu Pier area Short Bank Point Dume area Malibu area Point Vicente area Palos Verdes-NW White's Point 310(d) - low 319		1995: 226 square miles total 30 square miles impaired		CA41 3.000 08	1992: 239500 ac intermediate 16500 impaired	N (26) F F N (4) N (4)	Aquatic life Recreation: contact Recreation: non-c Fish Consumption Shellfish Harvesting	SED TOX TIS(Ag DDT Cr Pb PCBs) Sed(Cd Cu Pb Hg Ni Zn DDT PCBs chlordane PAHs) debris (see beach closures, COLIFORM below for impairment) Advisories (DDT PCBs)		Natural sources (m) POTWs (m) Dredge spoils dumping (s) Urban runoff (m) Spills (m) Refinery discharges (m) Historic DDT discharges (m) Generating stations (m) Marine activities (m) Aerial fallout (m) Natural oil seeps (s) Fires (n) Illegal dumping (s)
See beach information below	See beach information below	See beach information below	See beach information below				Due to DDT and PCBs[4]: Redondo Pier: Corbina Malibu Pier: Queenfish Short Bank: White Croaker Malibu: White Croaker Point Dume: White Croaker Point Vicente: White Croaker Palos Verdes NW: White Croaker White's Point: White Croaker, sculpin, rock fishes, kelp bass	Malibu, Santa Monica, Manhattan Beach, Redondo Pier-Tissue: Ag(5 ppm), DDT(400ppb), PCBs(1.5ppm)[1] Tissue (95, and 98-99): DDT, PCBs in ridgeback rock shrimp[4] Tissue (90): DDT, PCBs in yellow rock crab[4]		
Las Cerritos Beach (south of County line) 303(d)-low		404.44	1.18 mi	CA41 3.002 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		COLIFORM, beach closure	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
<10	12	<10	28		1991(5 days) 1992(9 days)					
Nicholas Cyn Beach 303(d)-low		404.43	1.94	CA41 3.003 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closure	Septic system washouts (m) Sewage spills (m) Urban runoff (m)

R0033722

COMPO VOL 12

Reach/location (LA County Coastal Features and Bays)	Fecal C. dry	Fecal C. wet	Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
	Fecal C. dry	Fecal C. wet	Total C. dry	Total C wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
	no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Robert H Mayer Memorial Beach 303(d)-low			404.42	1.23	CA41 3.004 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
See Level Beach 303(d)-low			404.41	0.67	CA41 3.005 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	<10	<10	<10	<10		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Trancas Beach (Broad Beach) 303(d)-low			404.37	2.02	CA41 3.006 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	COLIFORM, beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	<10	21	<10	21		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Zuma (Westward) Beach 303(d)-low			404.39	1.65	CA41 3.007 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	<10	11	<10	<10		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Point Dume Beach 303(d)-low			404.38	0.96	CA41 3.008 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Paradise Cove Beach 303(d)-low			404.36	1.33	CA41 3.009 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	COLIFORM, beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
	<10	27	<10	27		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			

R0033723

COMOT VOL 12

Reach/location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Escondido Beach 303(d)-low		404.34	2.05	CA41 3.010 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Dan Blocker Memorial (Corral) Beach 303(d)-low		404.31	1.04	CA41 3.011 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		COLIFORM	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
<10	21	<10	14		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Puerco Beach 303(d)-low		404.31	1.88	CA41 3.012 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
<10	14	<10	<10		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Amarillo Beach 303(d)-low		404.21	0.30	CA41 3.013 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Malibu Beach 303(d)-low		404.21	0.83	CA41 3.014 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(5 days) 1992(9 days)		See Santa Monica Bay (above)			
Malibu Lagoon Beach (Surfrider) 303(d)-low		404.21	0.68	CA41 3.015 0C		F N F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	COLIFORM Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m) Fuel spills (m)
26	88	11	41		1991(13 days) 1991(1 days) 1992(9 days)		See Santa Monica Bay (above)			

R0033724

COMO
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Reach/Location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Carbon Beach 303(d)-low		404.16	1.46	CA41 3.016 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(13 days) 1992(9 days)		See Santa Monica Bay (above)			
La Costa Beach 303(d)-low		404.16	0.74	CA41 3.017 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(13 days) 1992(9 days)		See Santa Monica Bay (above)			
Las Flores Beach 303(d)-low		404.15	0.76	CA41 3.018 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	COLIFORM, beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
<10	19	<10	46		1991(13 days) 1992(9 days)		See Santa Monica Bay (above)			
Big Rock Beach 303(d)-low		404.16	1.09	CA41 3.019 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	COLIFORM, beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
14	30	<10	10		1991(13 days) 1992(9 days)		See Santa Monica Bay (above)			
Las Tunas Beach 303(d)-low		404.12	1.26	CA41 3.020 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1991(13 days) 1992(9 days)		See Santa Monica Bay (above)			
Topanga Beach 303(d)-low		404.11	1.01	CA41 3.021 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures Advisory (DDT, PCBs)	COLIFORM	Septic system washouts (m) Sewage spills (m) Urban runoff (m)
<10	28	<10	28		1990(4 days) 1991(6 days) 1991(13 days) 1992(9 days) 1993(4 days) 1993(5 days) 1993(3 days) 1993(4 days)		See Santa Monica Bay (above)			

R0033725

C3009

VOL 12

Reach/location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting		Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data			
Castlerock Beach 303(d)-low		405.13	0.81	CA41 3.022 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures		Sewage spills (m) Urban runoff (m)
no date	no date	no date	no date		1991(6 days) 1992(9 days) 1993(4 days) 1993(3 days)		See Santa Monica Bay (above)				
Will Rogers Beach 303(d)-low		405.13	2.20	CA41 3.023 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures	COLIFORM		Sewage spills (m) Urban runoff (m)
11	32	<10	36		1988(1 day) 1988(3 days) 1989(2 days) 1990(4 days) 1991(6 days) 1992(9 days) 1993(4 days) 1993(6 days) 1993(3 days) 1993(4 days) 1993(11 days) 1995(4 days)						
Santa Monica Beach 303(d)-low		405.13	2.86	CA41 3.024 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures	COLIFORM		Sewage spills (m) Urban runoff (m) Construction debris (m)
10	38	11	39		1988(2 days) 1988(1 day) 1989(3 days) 1989(3 days) 1990(4 days) 1990(9 days) 1991(6 days) 1992(9 days) 1992(1 day) 1993(4 days) 1993(6 days) 1993(3 days) 1993(4 days) 1993(3 days) 1994(4 days)						
Venice Beach 303(d)-low		405.13	1.80	CA41 3.025 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures	COLIFORM		Sewage spills (m) Urban runoff (m)

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Reach/Boat, Coastal Features and Bays)	, County	Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
<10	13	<10	27		1988(3 days) 1990(4 days) 1991(6 days) 1992(9 days) 1992(3 days) 1993(4 days) 1993(6 days) 1993(4 days) 1993(4 days) 1995(1 day)					
Marina del Rey Harbor-back basins 303(d)-low		405.13	413 ac	CA41 3.028 08	121 Impaired	N N F N N	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	TIS(chlordane, dieldrin, DDT, PCBs, TBT, Zn, Cu) Sed(Zn,Cu,Pb, Cr,PCBs,chlordane, DDT) SED TOX, Benthic community COLIFORM TIS(chlordane,dieldrin, DDT,PCBs,TBT,Zn,Cu) Advisory (DDT, PCBs)	TIS(ChemA,Pb)	Sewage spills (m) Marina activities (m) Anti-fouling paints (m) Urban runoff (m) Runoff from dumps (m) RCRA site (m)
								Tissue ('93) chlordane(MTRLs, EDL95), DDT(MTRLs, EDL95), dieldrin(MTRLs, EDL95), PCBs(MTRLs, EDL95), ChemA(EDL95), Cu(EDL95), Pb(EDL95) * Tissue: chlordane (300ppb), DDT(700ppb), PCBs(1000ppb), TBT(8000ppb), Zn(800ppm), Cu(100ppm) * Sed Chem: Zn(500ppm), Cu(400ppm), Pb(100ppm) * Sed tox: poor survival * Benthic community effects * Sed chem('92): Cu, Pb, Zn, chlordane, DDT * Tissue: DDT, PCBs * Sed chem('95): Pb, Cr, PCBs **		
Marina del Rey Harbor-Public beach areas 303(d)-low		405.13	0.66	CA41 3.029 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	COLIFORM, beach closures		Sewage spills (m) RCRA site(s) Urban runoff (m) Marina activities (m)
17	39	<10	46		1988(3 days) 1990(4 days) 1991(15 days) 1992(11 days) 1992(3 days) 1992(4 days) 1993(4 days) 1993(6 days) 1993(6 days) 1993(4 days) 1993(4 days) 1003(1 day) 1994(2 days) 1995 (4 days) 1995 (1 day)					
Dockweiler Beach 303(d)-low		405.12	6.40	CA41 3.031 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures	COLIFORM	Sewage spills (m) Urban runoff (m)

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Reach/location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
<10	24	12	39		1988(1 day) 1988(3 days) 1989(2 days) 1990(4 days) 1991(15 days) 1991(4 days) 1992(11 days) 1992(3 days) 1992(3 days) 1992(1 day) 1993(4 days) 1993(6 days) 1993(3 days) 1993(4 days) 1993(1 day) 1994(2 days) 1995(4 days) 1995(1 day)					
Manhattan Beach 303(d)-low		405.12	2.08	CA41 3.032 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures		Sewage spills (m) Urban runoff (m) Fuel spills (m)
<10	<10	<10	<10		1990(4 days) 1991(6 days) 1991(2 days) 1992 (11 days) 1993(4 days) 1993(6 days) 1993(3 days) 1995 (4 days)					
Hermosa Beach 303(d)-low		405.12	1.88	CA41 3.033 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures		Sewage spills (m) Urban runoff (m)
<10	12	<10	18		1990(4 days) 1991(6 days) 1992 (11 days) 1993(4 days) 1993(6 days) 1993(3 days) 1995 (4 days)					
King Harbor 319		405.12	110 ac	CA41 3.034 0B	40 good 80 interm	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
							none	Tissue ('98): TBT(6 ppm), Cu(170ppm), Zn(660 ppm) [1] Sed Chem ('98): Cu(100ppm) [Regional Board data]		

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Reach/location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Redondo Beach 303(d)-low		405.12	1.37	CA41 3.038 0C		F N F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures Advisory (DDT, PCBs)	COLIFORM	Sewage spills (ps) Urban runoff (ps)
12	32	<10	18		1989(3 days) 1990(4 days) 1990(4 days) 1991(6 days) 1992 (11 days) 1992(1 day) 1992(1 day) 1992(3 days) 1992(3 days) 1993(4 days) 1993(6 days) 1993(3 days) 1995 (4 days)		See Santa Monica Bay (above)			
Torrance Beach 303(d)-low		405.12	0.88	CA41 3.039 0C		F N F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures	COLIFORM	Sewage spills (ps) Urban runoff (ps)
<10	15	<10	25		1990(4 days) 1991(6 days) 1992 (11 days) 1993(4 days) 1993(6 days) 1993(3 days) 1995 (4 days) 1995(3 days)					
Malaga Cove Beach 303(d)-low		405.11	1.13	CA41 3.041 0C		F N F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	beach closures Advisory (DDT, PCBs)		Sewage spills (ps) Urban runoff (ps)
<10	10	<10	<10		1990(4 days) 1991(6 days) 1992 (11 days) 1993(4 days) 1993(6 days) 1993(3 days) 1995 (4 days) 1995(3 days)		See Santa Monica Bay (above)			
Flat Rock Point beach area 303(d)-low		405.11	0.20	CA41 3.042 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (ps) Urban runoff (ps)

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Reach/Location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
no data	no data	no data	no data		1990(4 days) 1991(6 days) 1992 (11 days) 1995(3 days)					
Bluff Cove beach 303(d)-low		405.11	0.61	CA41 3.044 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
14	<10	<10	<10		1990(4 days) 1991(6 days) 1992 (11 days) 1995(3 days)		See Santa Monica Bay (above)			
Rocky Point beach 303(d)-low		405.11	0.52	CA41 3.045 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days) 1995(3 days)					
Luneta Bay beach 303(d)-low		405.11	0.35	CA41 3.047 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days) 1995(3 days)					
Resort Point beach 303(d)-low		405.11	0.49	CA41 3.048 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days) 1995(3 days)					
Point Vicente beach 303(d)-low		405.11	2.13	CA41 3.049 0C		F P F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days) 1995(3 days)					
Long Point Beach 303(d)-low		405.11	0.49	CA41 3.050 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)

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Reach/Location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
<10	<10	<10	<10		1992 (11 days) 1995(3 days)		See Santa Monica Bay (above)			
San Pedro Bay nearshore and offshore zone (Cabrillo Pier area) 303(d)-low 319			800	CA41 3.051 0B	10700 ac 800 impaired	N F F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	TIS(DDT) SED TOX Sed(PAHs DDT Zn Cu Cr) Advisory (DDT, PCBs)		Sewage spills (m) POTW effluent (m) Fuel spills (m) Urban runoff (m) Historic DDT discharges (m)
							See Santa Monica Bay (above)	Tissue: DDT(1200ppb) [1] Sed tox: variable survival rates [2] Sed Chem: PAHs(3.4ppm), DDT(280ppb), Zn(280ppm), Cu(270 ppm), Cr(80ppm)[2]		
San Pedro Bay nearshore and offshore zone except Cabrillo Pier area			1020 0 ac	CA41 3.051 B B	10200 ac Intermed	F F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting			
								Sed tox: good survival rates [1] Sed chem: Pb(50 ppm) [1] Benthic community-no evidence of degradation [1]		
Abalone Cove beach 303(d)-low		405.11	0.94	CA41 3.054 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
<10	<10	<10	<10		1992(11 days)		See Santa Monica Bay (above)			
Portuguese Bend beach 303(d)-low		405.11	2.20	CA41 3.055 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
<10	<10	<10	<10		1992(11 days)		See Santa Monica Bay (above)			
Inspiration Point beach 303(d)-low		405.11	0.30	CA41 3.056 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days)		See Santa Monica Bay (above)			
Palos Verdes Shoreline Park beach 303(d)-low		405.11	0.12	CA41 3.057 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
no data	no data	no data	no data		1992 (11 days)		See Santa Monica Bay (above)			

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Reach/location (LA County Coastal Features and Bays)	Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry / Fecal C. wet	Total C. dry / Total C. wet			Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Royal Palms Beach 303(d)-low	405.11	1.08	CA41 3.058 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
no data / no data	no data	no data		1992 (11 days)		See Santa Monica Bay (above)			
White's Point Beach 303(d)-low	405.11	0.70	CA41 3.059 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
<10 / <10	<10	<10		1992(11 days)		See Santa Monica Bay (above)			
Pt Fermon Park Beach 303(d)-low	405.11	1.6	CA41 3.060 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
no data / no data	no data	no data		1992 (11 days)		See Santa Monica Bay (above)			
Cabrillo Beach-outer 303(d)-low	405.12	0.61	CA41 3.061 0C		F P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	Advisory (DDT, PCBs)	beach closures	Sewage spills (m) Urban runoff (m)
<10 / <10	<10	<10		1992(11 days)		See Santa Monica Bay (above)			
Cabrillo Beach (inner)-LA Harbor area 303(d)-low	405.12	0.79	CA41 3.062 0C		F N F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	COLIFORM, beach closures Advisory (DDT, PCBs)		Sewage spills (m) Urban runoff (m)
38 / 19	<10	38		1991(3 days) 1991(2 days) 1992(11 days) 1992(7 days) 1994(2 days) 1995(4 days)		See LA Harbor (below)			
Los Angeles Harbor, especially Main Channel, Fish Harbor, Cabrillo Pier, and breakwater 303(d)-low 310	405.12	3766 ac	CA41 3.064 0B	Inner 1260 Impaired	N P F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	TIS/DDT PCB Zn Cu PAHs) Bed/DDT PCBs Cu, Zn PAHs TBT) SED TOX Advisory (DDT, PCBs)	Beach closures	Oil/other spills (m) Refinery discharges (m) Anti-fouling paints (m) Boatyard practices (m) Urban runoff (m) Historic DDT loading (m) Industrial paint sources (m)

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Reach/location (LA County Coastal Features and Bays)	Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry / Fecal C. wet	Total C. dry / Total C. wet			Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
				1992(11 days)		PCBs and DDT: LA Harbor, especially Cabrillo Pier-White croaker, Queenfish, Black croaker, Surfperches [4]	Main Channel and Fish Harbor: Tissue: DDT(1ppm), PCBs(1 ppm), Zn(400ppm), Cu(100ppm), PAHs(5 ppm) [1] Sed Chem: DDT(0.5ppm), PCBs(0.5 ppm), Cu(200ppm), Zn(560ppm), PAHs(15ppm), TBT(5 ppb) [1]		
LA Harbor-Consolidated Slip 303(d)-low 319	405.12	37.13 ac	CA41 3.074 0B		N F F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	TIS(DDT,chlordane,PCBs,TBT,Zn) SED TOX, Benthic community effects, Sed(PAHs,Zn,Cr,Pb,DDT, chlordane, PCBs) Advisory (DDT, PCBs)		Oil/other spills (m) Refinery discharges (m) Anti-fouling paints (m) Boatyard practices (m) Urban runoff (m) Historic DDT loading (m) Industrial point sources (m)
						see LA Harbor	Sed Chem: PAHs(10ppm),Zn(500ppm), Cu(140ppm), Cr(100ppm), Pb(120ppm), DDT(600ppb),chlordane(100ppb),PCBs(1000ppb) [1] Sed tox: poor survival rates [1] Benthic community: degraded [1] Tissue: DDT(1ppm), chlordane(110ppm), PCBs(600ppb), TBT(2000ppb),Zn(400ppm) [1]		
LA Harbor-Southwest Slip 303(d)-low 319	405.12	30 ac	CA41 3.074 0H		N F F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	SED TOX Advisory (DDT, PCBs)		Oil/other spills (m) Refinery discharges (m) Anti-fouling paints (m) Boatyard practices (m) Urban runoff (m) Historic DDT loading (m)
						see LA Harbor	Sed tox: poor survival rates [1]		
Long Beach Harbor, especially Main Channel, Southeast Basin, West Basin, Pier J, and breakwater 303(d)-low 319	405.12	3684 ac	CA41 3.076 0B	LB Inner 840 ac impaired	N F F N F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting	TIS(DDT, PCBs), Benthic community effects, Sed(PAHs), SED TOX Advisory (DDT, PCBs)		Oil/other spills (m) Refinery discharges (m) Anti-fouling paints (m) Boatyard practices (m) Urban runoff (m) Historic DDT loading (m) Naval activities (m)
						DDT and PCBs: Pier J: Surfperches LB Harbor and LB breakwater: White croaker, Queenfish, Black croaker, Surfperches	Main channel, SE basin, W Basin (Naval Base)-Tissue: DDT(800ppb),PCBs(800ppb) [1] DOP-West Basin: Benthic community impacts SE and West Basins-Sed chem: PAHs (4000ppb) [1] SE and West Basins-Sed tox: poor survival rates [1]		
Long Beach shore aquatic park beach	405.12	0.60	CA41 3.088 0C				Unassessed		
Bluff Park beach	405.12	0.90	CA41 3.091 0C				Unassessed		
Belmont Shore beach	405.12	1.80	CA41 3.092 0C				Unassessed		

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COMPT VOL 12

Reach/location (LA County Coastal Features and Bays)		Hydro Unit	Size	Code	Previous WQA	WQA	Assessed Uses	Not Supporting	Partially Supporting	Potential Sources
Fecal C. dry	Fecal C. wet	Total C. dry	Total C. wet		Beach Closures		Fish Consumption	Tissue, sediment and toxicity data		
Alamitos Bay beaches		405.12	1.80	CA413.093 0C				Unassessed		
Alamitos Bay 319		405.12	360 ac	CA413.094 0B	286 ac Interim	FT F F F F	Aquatic life Recreation: cont. Recreation: non-c Fish Consumption Shellfish Harvesting		TSI(PCBs, ChemA) Fully supported but threatened	Urban runoff (ns)
							none	Tissue('91): PCB(EDL85), ChemA(EDL85) [5] Sed chem: PAHs(900ppb) [1] Sed tox: good survival rates [1]		

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Groundwater Basins

Basin	Hydro Unit	Area	Aquifers	Use	Status	Evidence	Possible Sources
Upper Ojai Valley (CA415.0001G)	402.31 403.22	8 sq mi	all	drinking and industrial	F	–	–
				agriculture	F	–	
Lower Ojai Valley (CA415.0002G)	402.32	23 sq mi	all	drinking and industrial	FT	Nitrate concentrations in municipal supply wells show increasing trend.	Domestic septic systems Infiltration of contaminated animal waste runoff
				agriculture	F	–	
Upper Ventura (CA415.0003aG)	402.2	11 sq mi	all	drinking and industrial	F	–	–
				agriculture	U	Unassessed	
San Antonio (CA415.0003bG)	402.2	4 sq mi	all	drinking and industrial	P	Elevated nitrate concentrations in sampled ground water wells.	Domestic septic systems Infiltration of contaminated animal waste runoff Infiltration of contaminated urban runoff
				agriculture	U	Unassessed	
Lower Ventura (CA415.0003cG)	402.1	8 sq mi	all	drinking and industrial	N	Elevated nitrate concentrations in sampled ground water wells as well as detectable hydrocarbons.	Domestic septic systems Infiltration of contaminated animal waste runoff Oil field activities.
				agriculture	U	Unassessed	
Santa Clara - Piru (CA415.0004aG)	403.41	14 sq mi	all	drinking and industrial	P	Elevated nitrate concentrations in sampled ground water wells.	Domestic septic systems Infiltration of contaminated agricultural runoff Infiltration of contaminated animal waste runoff Infiltration of contaminated urban runoff
				agriculture	F	–	
Santa Clara - Saugus (CA415.0004bG)	403.31	31 sq mi	all	drinking and industrial	P	Elevated nitrate concentrations in sampled ground water wells.	Domestic septic systems Infiltration of contaminated agricultural runoff
				agriculture	F	–	
Santa Clara - Santa Paula (CA415.0004cG)	403.12	42 sq mi	all	drinking and industrial	F	–	–
				agriculture	F	–	
Oxnard Plain (CA415.0004dG)	403.12	111 sq mi	all	drinking and industrial	P	Elevated nitrate concentrations in sampled ground water wells in some areas. Seawater intrusion within 2 miles of coast.	Domestic septic systems Infiltration of contaminated agricultural runoff Abandoned wells acting as conduits Seawater intrusion
				agriculture	U	Unassessed	
Pleasant Valley (CA415.0006G)	403.21	38 sq mi	all	drinking and industrial	FT	Localized areas of high TDS and chloride.	Infiltration of irrigation waters past the root zone Abandoned wells acting as conduits
				agriculture	F	–	
Arroyo Santa Rosa (CA415.0007G)	403.63	5 sq mi	all	drinking and industrial	N	Blending required for nitrate contamination (more than 50% of production). Elevated ethylene dibromide and dibromo-chloropropane concentrations in sampled ground water wells.	Domestic septic systems Infiltration of contaminated agricultural runoff
				agriculture	F	–	
Las Posas - South (CA415.0008aG)	403.62	22 sq mi	all	drinking and industrial	U	Unassessed	–
				agriculture	F	–	

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Basin	Hydro Unit	Area	Aquifers	Use	Status	Evidence	Possible Sources
Las Posas -North (CA415.0008bG)	403.62	41 sq mi	all	drinking and industrial	F	–	–
				agriculture	F	–	
Acton Valley (CA415.0005aG)	403.56	28 sq mi	all	drinking and industrial	F	–	–
				agriculture	U	Unassessed	
Sierra Pelona Valley (CA415.0005bG)	403.56	11 sq mi	all	drinking and industrial	P	Elevated nitrate concentrations in sampled ground water wells (affects approximately 30% of production).	Domestic septic systems Infiltration of contaminated animal waste runoff
				agriculture	U	Unassessed	
Upper Mint Cyn (CA415.0005cG)	403.53	5.9 sq mi	all	–	U	Unassessed	–
Upper Bouquet Canyon (CA415.0005dG)	403.52	3.2 sq mi	all	–	U	Unassessed	–
Green Valley (CA415.0005gG)	403.51	1.9 sq mi	all	–	U	Unassessed	–
L. Elizabeth & L. Hughes (CA415.0005fG)	403.51	0.23 sq mi	all	–	U	Unassessed	–
Eastern Santa Clara Basin (CA415.000407G)	403.51	41 sq mi	all	drinking and industrial	F	–	–
				agriculture	U	Unassessed	
Simi Valley (CA415.0008aG)	403.67	19 sq mi	all	–	U	Unassessed	–
Gillibrand (CA415.0008bG)	403.66	7 sq mi	all	drinking and industrial	F	–	–
				agriculture	F	–	
Conejo Valley (CA415.0010G)	403.64	9 sq mi	all	drinking and industrial	F	–	–
				agriculture	F	–	
West Coast Basin-upper (CA415.0011aUG)	405.12	141 sq mi	shallow and semi-perched zones	drinking and industrial v	N	Over 800 cases of known leaking underground storage tanks that have contaminated soil and/or ground water with petroleum hydrocarbons (including BTEX) and other VOCs. Eleven cases of refineries/tank farms that have contaminated soil and/or ground water with petroleum hydrocarbons (including BTEX). Seawater intrusion (chloride) into the Gaspur aquifer through Dominguez Gap.	Leaks from refineries, pipelines, and underground storage tanks Infiltration of contaminated storm water and urban runoff Other illegal discharges Seawater intrusion through the Dominguez Gap
				agriculture	U	Unassessed	

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Basin	Hydro Unit	Area	Aquifers	Use	Status	Evidence	Possible Sources
West Coast Basin-lower (CA415.0011aLG)	405.12	141 sq. mi.	production (deeper) zones	drinking and industrial [illegible]	P	Approximately 250,000 AF of ground water contaminated by chloride, necessitating shutdown or wellhead treatment/blending for 17% of production capacity.	Plume of saline water trapped behind seawater intrusion barrier Seawater intrusion (underflow) beneath parts of the West Coast Basin Barrier Migration of contaminants from shallow and semi-perched aquifers
				agriculture	U	Unassessed	
Central Basin-upper (CA415.0011bUG)	405.15	277 sq. mi.	shallow and semi-perched aquifers	drinking and industrial [illegible]	N	Over 1,100 cases of known leaking underground storage tanks that have contaminated soil and/or ground water with petroleum hydrocarbons (including BTEX) and other VOCs. Six cases of refineries/tank farms that have contaminated soil and/or ground water with petroleum products.	Leaks from refineries and underground storage tanks Infiltration of contaminated storm water and urban runoff Other illegal discharges
				agriculture	U	Unassessed	
Central Basin-lower (CA415.0011bLG)	405.15	277 sq. mi.	production zones	drinking and industrial	FT	Wellhead treatment/blending required for VOC contamination at several wells (4% of production).	Migration of contaminants from shallow and semi-perched aquifers Threat of contaminant (VOCs) migration from the San Gabriel Basin into the Central Basin Leaks from an old landfill
				agriculture	U	Unassessed	
Santa Monica (CA415.0011cG)	405.13	40 sq. mi.	all	drinking and industrial	P	Wellhead treatment required for VOC contamination in ground water from several production wells. MTBE contamination in Charnock wellfield.	Industrial discharge of solvents
				agriculture	U	Unassessed	
Hollywood (CA415.0011dG)	405.14	20 sq. mi.	all	--	U	Unassessed	--
Sylmar (CA415.0012aG)	405.22	10 sq. mi.	all	drinking and industrial	F	--	--
				agriculture	U	Unassessed	
Verdugo (CA415.0012bG)	405.24	11 sq. mi.	all	drinking and industrial	N	All production shut down due to nitrate contamination.	Domestic septic systems
				agriculture	U	Unassessed	
San Fernando (CA415.0012cG)	405.21	180 sq. mi.	all	drinking and industrial	P	Some production wells shut down due to nitrate, PCE, and/or TCE contamination.	Domestic septic systems Infiltration of contaminated urban runoff Industrial discharge of solvents Old landfills
				agriculture	U	Unassessed	
Eagle Rock (CA415.0012dG)	405.25	2 sq. mi.	all	--	U	Unassessed	--
Raymond Basin (CA415.0013aG)	405.31	37 sq. mi.	all	drinking and industrial	P	Wellhead treatment required for PCE contamination (approximately 30% of production).	Industrial discharge of solvents Leaking landfills
				agriculture	U	Unassessed	

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Basin	Hydro Unit	Area	Aquifers	Use	Status	Evidence	Possible Sources
Main San Gabriel Basin CA415.0013bG)	405.42 405.41	141 sq. mi.	all	drinking and industrial	P	Wellhead treatment, blending, and/or shut down for PCE and/or TCE contamination.	Industrial discharge of solvents Leaking landfills
				agriculture	U	Unassessed	
Puente Basin CA415.0013cG)	405.41	16 sq. mi.	all	drinking and industrial	N	All drinking water production shut down for PCE, TCE, and/or TDS contamination.	Industrial discharge of solvents Leaking landfills Historical agriculture and cattlefeed operations
				agriculture	P	Blending required for elevated TDS concentrations.	
Chino Area (CA415.0014cG)	481.21	10 sq. mi.	all	drinking and industrial	N	Wellhead treatment required for nitrate contamination.	Domestic septic systems Agriculture and animal waste runoff
				agriculture	U	Unassessed	
Live Oak Area (CA415.0014 aG)	405.41 405.44	5.1 sq. mi.	all	–	U	Unassessed	–
Claremont Hills (CA415.0014b)	405.53	6.7 sq. mi.	all	–	U	Unassessed	–
Pomona Area (CA415.0014dG)	405.52	9.0 sq. mi.	all	–	U	Unassessed	–
Spadra Area (CA415.0014eG)	405.51	6.0 sq. mi.	all	–	U	Unassessed	–
Terra Rejada (CA415.0015G)	403.65	2 sq. mi.	all	–	U	Unassessed	–
Hidden Valley - Santa Monica Mountains (CA415.0016)	404.26	3.8 sq. mi.	all		U	Unassessed	–
Thousand Oaks - Santa Monica Mountains (CA415.0019)	403.64 403.68	11.5 sq. mi.	all		U	Unassessed	–
Russell Valley- Santa Monica Mountains (CA415.0020)	404.23 404.26	9.1 sq. mi.	all		U	Unassessed	–
Conejo - Santa Monica Mountains (CA415.0021)	403.64	2.4 sq. mi.	all		U	Unassessed	–
Southern Slopes - Santa Monica Mountains (CA415.0022)	–	1.3 sq. mi.	all	–	U	Unassessed	–
Lockwood Valley (CA415.0017)	403.44	13 sq. mi.	all	drinking and industrial	F	–	–
				agriculture	F	–	
Pleasant Valley & Hungry Valley (CA415.0018)	403.43	18 sq. mi.	all	–	U	Unassessed	–

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303(d) List

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303(d) List: Inland Watersheds

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems.
Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
McGrath Lake (estuary)	403.11	Aquatic life	Sed(DDT, chlordane, total pesticides), SED TOX	Nonpoint source
Ventura River Estuary	402.10	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(DDT), EUT Trash, Algae Trash, Algae TIS(DDT)	Nonpoint source and point source
Ventura River (estuary to Weldon Cyn)	402.10	Aquatic life Recreation: contact Recreation: non-contact	TIS(Cu, Se, Ag, Zn) Algae Algae	Nonpoint source and point source
Ventura River (Weldon Cyn to Camino Cielo)	402.10 402.20	Aquatic life	Water diversion and pumping	Nonpoint source
Matilija Creek and reservoir	402.20	Aquatic life	Fish barrier	Nonpoint source
Santa Clara River Estuary	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River (W Pier Hwy 99 to Bouquet Cyn Rd Bridge)	403.61	Aquatic life Recreation: contact	AMM Coliform	Nonpoint source and point source
Mugu Lagoon	403.11	Aquatic life Fish consumption*	Cu, Hg, Ni, Zn, bird reproductivity (DDT), TIS (Chlordane, DDT, endosulfan, dacthal, toxaphene, PCBs, As, Cd, Ag), Nitrogen, Sed(DDT, toxaphene), SED TOX, excessive sediment TIS(DDT, PCBs, toxaphene)	Nonpoint source and point source
Rio de Santa Clara (tributary to Mugu Lagoon)	403.11	Aquatic life Fish consumption	SED TOX, TIS(chlordane, toxaphene, DDT, ChemA, PCBs), Nitrogen TIS(chlordane, toxaphene, DDT, ChemA, PCBs)	Nonpoint sources
Tributary from duck ponds to Mugu Lagoon	403.11	Aquatic life Fish consumption	TOX, SED TOX, Sed(DDT), TIS(Chlordane, toxaphene, DDT, ChemA), Nitrogen TIS(Chlordane, toxaphene, DDT, ChemA)	Nonpoint source
Calleguas Creek (Estuary to Arroyo Las Posas)	403.11 403.12	Drinking water/GWR Aquatic life Fish consumption	N+N AMM, TOX, Sed (DDT, toxaphene), TIS (PCBs, DDT, toxaphene, ChemA, chlordane, dacthal, endosulfan), Nitrogen, SED TOX TIS (DDT, toxaphene, ChemA, chlordane)	Nonpoint source and point source
Revolon Slough and Beardsley Channel/Wash	403.11 403.61	Drinking water/GWR Aquatic life Recreation: contact Recreation: non-contact Fish consumption	N+N Se, TOX, Sed (toxaphene, chlordane, DDT, endosulfan, dacthal), TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, chlorpyrifos, hexochlorobenzene, PCBs, dacthal), Nitrogen Algae, Trash Algae, Trash TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, PCBs)	Nonpoint source
Conejo Creek /Arroyo Conejo (confluence Calleguas to above Lynn Rd)	403.12 403.63 403.64 403.68	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	DO, AMM, TOX, TIS(endosulfan, toxaphene, DDT, ChemA, dacthal, Ag, Cd, Cr, Ni), Sed(toxaphene) Algae Algae TIS(endosulfan, toxaphene, DDT, ChemA)	Nonpoint source and point source
Conejo Creek/Arroyo Conejo North Fork	403.64	Aquatic life Fish consumption	AMM, TIS(chlordane, DDT) TIS(chlordane, DDT)	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Arroyo Las Posas	403.62	Aquatic life	AMM, Sed(DDT)	Nonpoint source and point source
Arroyo Simi (~Moorpark Fwy (23) to Brea Cyn)	403.62	Aquatic life	TIS(Cr, Ni, Ag, Zn, Se)	Nonpoint source and point source
Malibu Lagoon	404.21	Aquatic life Recreation: contact Fish consumption Shellfish Harvesting	Benthic community, TIS (As, Cr, Ni, Se, Pb, Ag), EUT Coliform, Enteric viruses, swimming restriction TIS(As, Se, Pb) Advisory	Nonpoint source and point source
Malibu Creek: lagoon to Malibu Lake	404.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	Fish barrier, TIS (As, Cr, Ni, Cd, Se, Ag, Pb, Cu) Trash, Algae, Coliform, Scum Trash, Algae, Scum TIS (As, Cr, Ni, Se)	Nonpoint source and point source
Las Virgenes Creek	404.22	Aquatic life Recreation: contact* Recreation: non-contact	Se, DO Coliform, Scum, Algae, Trash Scum, Trash, Algae	Nonpoint source
Stokes Creek	404.22	Recreation: contact	Coliform	Nonpoint source
Medea Creek	404.24 404.23	Aquatic life Recreation: contact* Recreation: non-contact	Se Coliform, Algae, Trash Coliform, Algae, Trash	Nonpoint source
Lindero Creek	404.23	Aquatic life Recreation: contact Recreation: non-contact	Se Coliform, Trash, Algae, Scum Coliform, Trash, Algae, Scum	Nonpoint source
Palo Comado	404.23	Recreation: contact Recreation: non-contact	Coliform Coliform	Nonpoint source
Triunfo Cyn Creek	404.24 404.26	Aquatic life	Hg, Pb	Nonpoint source
Topanga Canyon Creek	404.11	Aquatic life	Pb	Nonpoint source
Santa Monica Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	Pb Coliform Coliform	Nonpoint source
Pico Kenter Drain	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, TOX, PAHs Coliform, Enteric viruses, Trash Coliform, Trash	Nonpoint source
Ashland Avenue Drain	405.13	Aquatic life Recreation: contact*	DO, TOX Coliform	Nonpoint source
Ballona Creek Estuary	405.13	Aquatic life Recreation: contact Shellfish harvesting	SED TOX, Sed(Pb, Zn, DDT, aroclor, PCBs, PAHs, chlordane), TIS(chlordane, PCBs) Coliform Advisory	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Ballona Creek	405.13	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	Pb, SED TOX, TOX, TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA, Cr, Cu, Pb, Ag, Zn), Sed(Cd, TBT, Cu, Pb, Ag) Coliform, Trash, enteric viruses Coliform, Trash TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA)	Nonpoint source and point source
Ballona Wetland	405.13	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(As, Pb, Cr), Habitat alteration, Exotic vegetation, Reduced tidal flushing, Hydromodification Trash Trash TIS(As)	Nonpoint source
Sepulveda Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source
Dominguez Channel (includes estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	AMM, Cu, Pb, Sed(Cr, Zn, DDT, PAHs), TIS(aldrin, chlordane, DDT, dieldrin, PCBs, ChemA, Pb) Benthic community impairment Coliform Coliform TIS(chlordane, DDT, dieldrin, PCBs)	Nonpoint source and point source
Wilmington Drain	405.12	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb Coliform Coliform	Nonpoint source
Torrance Carson Channel	405.12	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb Coliform Coliform	Nonpoint source
Colorado Lagoon	405.12	Aquatic life Fish consumption	Sed(Pb, Zn, chlordane, PAHs), TIS(chlordane, DDT, dieldrin, PCBs, Ag, Pb, Cu, ChemA), SED TOX TIS(chlordane, DDT, dieldrin, PCBs)	Nonpoint source
Los Cerritos Channel	405.12	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, Zn Coliform Coliform	Nonpoint source
Los Angeles River Reach 1 (upstream Carson St to Estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact	pH, AMM, Pb Coliform, Trash, Scum, Algae Coliform, Trash, Scum, Algae	Nonpoint source and point source
Los Angeles River Reach 2 (Figueroa St to upstream Carson St)	405.18	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, Odors, Oil Coliform, Trash, Scum, Algae, Odors, Oil	Nonpoint source and point source
Compton Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb, pH Coliform Coliform	Nonpoint source and point source
Rio Hondo Reach 1 (Santa Ana Fwy to Los Angeles River)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, Zn, pH Coliform, Trash Coliform, Trash	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Rio Hondo Reach 2 (from Whittier Narrows Flood Control Basin to Spreading Grounds)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM Coliform Coliform	Nonpoint source and point source
Monrovia Canyon Creek	405.33	Aquatic life	Pb	Nonpoint source
Arroyo Seco Reach 1 (downstream Devils Gate Dam)	405.15	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Trash, Algae	Nonpoint source
Los Angeles River Reach 3 (Riverside Drive to Figueroa St)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM Trash, Algae, Odors, Scum Trash, Algae, Odors, Scum	Nonpoint source and point source
Verdugo Wash	405.21	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Coliform, Trash, Algae	Nonpoint source
Los Angeles River Reach 4 (Sepulveda Dam to Riverside Dr)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, Odors Coliform, Trash, Scum, Algae, Odors	Nonpoint source and point source
Burbank Western Channel	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cd Trash, Scum, Algae, Odors Trash, Scum, Algae, Odors	Nonpoint source and point source
Tujunga Wash (downstream Hansen Dam to Los Angeles River)	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu Coliform, Trash, Scum, Odors Trash, Scum, Odors	Nonpoint source and point source
Los Angeles River Reach 5 (within Sepulveda Basin)	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, TIS(Ag, chloropyrifos, ChemA) Trash, Scum, Algae, Odors, Oil Trash, Scum, Algae, Odors, Oil TIS(ChemA)	Nonpoint source and point source
Los Angeles River Reach 6 (upstream of Sepulveda Flood Control Basin)	405.21	Drinking water/GWR Recreation: contact Recreation: non-contact	1, 1-DCE, PCE, TCE Coliform Coliform	Nonpoint source
Alleo Canyon Wash	405.21	Aquatic life	Se	Nonpoint source
Bell Creek	405.21	Recreation: contact* Recreation: non-contact	Coliform Coliform	Nonpoint source and point source
San Gabriel River Estuary	405.15	Aquatic life Fish consumption	TOX, TIS(As, Cu, Ag, Cr), HIST TIS(As)	Nonpoint source and point source
Coyote Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST, CHL, TIS(Cr, Cu, Ag) Coliform, Algae, Coliform, Algae,	Nonpoint source and point source
San Gabriel River Reach 1 (Estuary to Firestone)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST Coliform, Algae Coliform, Algae	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
San Gabriel River Reach 2 (Firestone to Whitter Narrows Dam)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source and point source
San Gabriel River Reach 3 (Whittier Narrows to Ramona)	405.41	Aquatic life	TOX	Nonpoint source and point source
San Jose Creek	405.41	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX Coliform, Algae Coliform, Algae	Nonpoint source and point source
Walnut Creek	405.41	Aquatic life	pH, TOX	Nonpoint source and point source
San Gabriel River East Fork	405.43	Recreation: contact Recreation: non-contact	Trash Trash	Nonpoint source

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303(d) List: Coastal Features and Bays

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing Impairment	Known or Potential Sources
Ventura Harbor: Ventura Keys at Arundell Barranca	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River Estuary Beach/Surfers Knoll	403.11	Recreation: contact	Coliform	Nonpoint source
McGrath Beach	403.11	Recreation: contact	Coliform, beach closures	Nonpoint source
Mandalay Beach	403.11	Recreation: contact	Beach closures	Nonpoint source
Channel Islands Harbor	403.11	Aquatic life	Sed (Pb, Zn)	Nonpoint source
Port Hueneme Harbor	403.11	Aquatic life	Sed (PAHs), TIS(DDT, PCBs, TBT, Zn)	Nonpoint source
SANTA MONICA BAY NEARSHORE ZONE AND OFFSHORE ZONE: Hyperion 5 mile and 7 mile outfall area Joint Water Pollution Control Plant outfall area Palos Verdes shelf Marina del Rey area Santa Monica Pier area Manhattan Beach area Redondo Pier area Malibu Pier area Short Bank Point Dume area Malibu area Point Vicente area Palos Verdes-NW Whites Point	various	Aquatic life Fish Consumption	SED TOX, TIS(Ag, DDT, Cr, Pb, PCBs), Sed(Cd, Cu, Pb, Hg, Ni, Zn, DDT, PCBs, chlordane, PAHs), debris Advisories (DDT, PCBs)	Nonpoint source and point source
Santa Monica Bay/Southern LA County beaches: Ventura County Line to Long Beach City Line	various	Recreation: contact Fish consumption	All beaches are impaired due to periodically high coliform counts and/or beach closures. Many areas are impaired due to fish consumption advisories.	Nonpoint Source
Marina del Rey Harbor	406.13	Aquatic life Recreation: contact Fish consumption Shellfish Harvesting	TIS (chlordane, DDT, PCBs, TBT, Zn, Cu, Pb, ChemA, dieldrin), Sed (Zn, Cu, Pb, chlordane, DDT), SED TOX, Benthic community effects Coliform Advisory Advisory (DDT, PCBs)	Nonpoint source
San Pedro Bay nearshore and offshore zone: Cabrillo Pier area	406.12	Aquatic life Fish consumption	TIS (DDT), SED, TOX, Sed (PAHs, DDT, Zn, Cu, Cr) Advisory (DDT, PCBs)	Nonpoint source and point source
Los Angeles Harbor: particularly Main Channel, Fish Harbor, Cabrillo Pier, and breakwater	406.12	Aquatic life Recreation: contact Fish Consumption	TIS (DDT, PCB, Zn, Cu, PAHs), Sed (DDT, PCBs, Cu, Zn, PAHs, TBT), SED TOX Beach closures Advisory (DDT, PCBs)	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Los Angeles Harbor: Consolidated Slip	405.12	Aquatic life Fish Consumption	TIS(DDT, chlordane, PCBs, TBT, Zn), SED TOX, Benthic community effects, Sed (PAHs, Zn, Cr, Pb, DDT, chlordane, PCBs) Advisory (DDT, PCBs)	Nonpoint source
Los Angeles Harbor: Southwest Slip	405.12	Aquatic life Fish Consumption	SED TOX Advisory (DDT, PCBs)	Nonpoint source
Long Beach Harbor , particularly Main Channel, Southeast Basin, West Basin, Pier J, and breakwater	405.12	Aquatic life Fish Consumption	TIS (DDT, PCBs), Benthic community effects, Sed (PAHs), SED TOX Advisory (DDT, PCBs)	Nonpoint source

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303(d) List: Lakes

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Waterbody	Hydro unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Lake Hughes	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT, Fish kills Trash, Odors, Algae Trash, Odors, Algae	Nonpoint source
Munz Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT Trash Trash	Nonpoint source
Elizabeth Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	pH, EUT, DO pH, Trash Trash	Nonpoint source
Malibou Lake	404.24	Aquatic life Recreation: contact Recreation: non-contact	DO, EUT, TIS (PCBs, chlordane, Cd, Cu, Zn) Algae Algae	Nonpoint source
Lake Lindero	404.23	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	CHL, SC, Se, EUT, TIS (Se, oxadiazon) Odors, Trash, Algae Odors, Trash, Algae TIS(Se)	Nonpoint source
Westlake Lake	404.25	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, Cu, Pb, EUT, TIS(chlordane, Cd, Cu, Zn) Algae Algae TIS(chlordane)	Nonpoint source
Lake Sherwood	404.26	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, EUT, TIS (Hg) Algae Algae TIS (Hg)	Nonpoint source
Machado Lake (Harbor Lake)	405.12	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, EUT, TIS (chlordane, ChemA, DDT, dieldrin, PCBs) Odors, Trash, Algae Odors, Trash, Algae Advisory (DDT, chlordane), TIS (chlordane, ChemA, DDT, dieldrin, PCBs)	Nonpoint source
Calabasas Lake	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, TIS (DDT, Cu, Zn, Cd), EUT, DO, pH Odors Odors TIS (DDT)	Nonpoint source
Echo Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, Cu, Pb, EUT, TIS (PCBs), pH Odors, Trash, Algae Odors, Trash, Algae TIS (PCBs)	Nonpoint source
Lincoln Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb, EUT, DO Odors, Trash Odors, Trash	Nonpoint source

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Waterbody	Hydro unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Peck Rd Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	DO, Pb, TIS (DDT, chlordane) Odors, Trash Odors, Trash TIS (DDT, chlordane)	Nonpoint source
El Dorado Lakes	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, EUT, TIS (Hg, Cr), pH Algae Algae	Nonpoint source
Legg Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact	Cu, Pb, AMM, pH Odors, Trash Odors, Trash	Nonpoint source
Puddingstone Reservoir	405.52	Aquatic life Fish Consumption	DO, TIS (PCBs, chlordane, DDT, dacthal, oxadiazon, Hg, As) TIS (PCBs, DDT, chlordane, Hg)	Nonpoint source
Santa Fe Dam Park Lake	405.41	Aquatic life	Pb, Cu, pH	Nonpoint source
Crystal Lake	405.43	Aquatic life	DO	Nonpoint source

ABBREVIATIONS AND FOOTNOTES

*	Although people sometimes swim, bathe, drink, fish, and otherwise use these waterbodies, access is restricted. Please refer to the Basin Plan (1994) for footnotes which identify specific restrictions.
GWR	Groundwater recharge use
AMM	Ammonia-N
N+N	Nitrate-N + Nitrite-N
Temp	Temperature of effluent is greater than 8° above ambient temperature in waterbody.
DO	Dissolved oxygen (depleted levels)
Coliform	Coliform bacteria: fecal coliform for inland surface waterbodies; total and fecal coliform for beaches.
TRASH	Significant trash and debris observed
Odors	Significant odors observed
Algae	Significant algal growth observed
OIL	Oily film observed on surface of water
Scum	Nonnatural foams, flotsam, scum material or other floating material observed.
Turb	Turbidity
EUT	Eutrophic
PAHs	Polycyclic aromatic hydrocarbons
Sed(x)	Level of constituent in sediment is elevated.
HIST	Abnormal fish histology observed.
TIS(x)	Fish or mussel data from State Mussel Watch and State Toxic Substances Monitoring programs. The constituent in parentheses exceeds the standard(s).
TOX	Tests or studies of chronic or acute toxicity of species (water column).
SED TOX	Tests or studies of chronic or acute toxicity of species (sediment).
ChemA	Toxic Substances Monitoring Program combination of pesticides: Aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, HCH (including lindane), endosulfan, and toxaphene.
Metals	Ag (Silver), Ba (Barium), Cd (Cadmium), Cr (Chromium), CrVI (Chromium VI), Cu (Copper), Pb (Lead), Se (Selenium), TNT (tributyl tin), Zn (Zinc), and Hg (Mercury).

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303(d) List Public Review and Response

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R0033749

STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION
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VOL 12

Date: December 21, 1995

To: Interested Parties
Los Angeles and Ventura County Coastal Watersheds

From: Deborah J. Smith, Chief
Regional Programs Section

Subject: Public Notice for Draft 303(d) List

Attachment: Draft 303(d) List–Los Angeles Region

Introduction

Under Section 305 of the Clean Water Act (CWA),[1] each state is required to periodically assess all surface waters within the state. Based on this assessment, each state must submit a list of those waters that do not, or are not expected to, attain water quality standards after application of required technology-based controls. This list, known as the 303(d) list, serves to focus water quality efforts and resources toward the most significant water quality problems.

The 303(d) List

Regional Board staff have prepared a draft 303(d) list for surface waters in the Los Angeles and Ventura coastal watersheds (Los Angeles Region). This list is attached for your review, and the rationale used to prepare this list is briefly described in the following section.

The Regional Board will use a variety of approaches to address water quality problems affecting waters on the 303(d) list. In addition to water quality controls in Waste Discharge Requirements, these approaches may include: new watershed-based management efforts; enhanced stormwater programs for releases from municipal, industrial, and construction sources; and estimates of total maximum daily loads (TMDLs) of pollutants. TMDLs are a way to quantify pollutants loads from point and nonpoint sources, and can be used to allocate allowable loads in order to meet water quality standards. TMDL efforts are already underway for the Los Angeles River and Malibu Creek watersheds. Other efforts to estimate and reduce pollutant loadings will be initiated as the Watershed Initiative in the Los Angeles Region proceeds and as Regional Board resources allow.

The 303(d) Rationale

In accordance with federal guidelines,[2] several broad categories of beneficial uses of surface water in the Los Angeles Region were assessed, namely: drinking water supply, fish

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[1] *Federal Water Pollution Control Act*, as amended (1972).

[2] *Guidelines for Preparation of the 1996 State Water Quality Assessments* (USEPA 1995).

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tested at all sampling stations. Therefore, it is not correct to assume that constituents not cited on this list are not causing water quality problems.

Additionally, please note that the terms 'partially supporting' and 'not supporting' are federal terms, and roughly equate to 'intermediate' and 'impaired' terms used by the state in preparing previous water quality assessments for the Los Angeles Region.

Public Review Period

Comments on the attached 303(d) list must be received by the Regional Board by January 25, 1996. In the event that you feel waterbodies or parts of waterbodies should be added to or eliminated from the attached list, please provide supporting data.

Comments and questions should be addressed to Heather Trim, who may be reached at (213) 266-7553 or at the address above.

Thank you for your interest in water quality.

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STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
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To: Interested Parties
Los Angeles Region

From: Wendy Phillips
Chief, Planning Unit
California Regional Water Quality Control Board, Los Angeles Region

Re: Revised 303(d) List for the Los Angeles Region

Date: February 15, 1996

Attachments: 1. Los Angeles Region Revised 303(d) List
2. Responsiveness Summary

Introduction

Thank you for your comments on and interest in our efforts to assess water quality in the Los Angeles Region. As you'll recall, on December 21, 1995 we released a draft list of impaired waterbodies in the Los Angeles Region. Since then, we have had many communications regarding the purpose of the list, the way in which the list was developed, and how the list will be used.

Purpose of the 303(d) List

To recap, the purpose of the list is to identify waterbodies that are not fully supporting beneficial uses. Although water quality assessments are part of our standard planning process in this state, the US EPA requires all states to submit a list, based upon periodic water quality assessments, of all impaired waterbodies. This list is known as the 303(d) list (after section 303(d) of the Clean Water Act).

Rationale for Developing the 303(d) List

The list was developed using data (since 1987) that were reasonably available to Regional Board staff. Water quality data from numerous agencies and districts[1] supplemented in-house data.

The data were used, in accordance with federal guidelines,[2] to assess several broad categories of beneficial uses of surface waters, namely: drinking water supply (raw), fish

[1]Other agencies providing data include the US Geological Survey, US Forest Service, California Department of Water Resources, Ventura County Flood Control District, Los Angles County Department of Public Works, City of Thousand Oaks, City of San Buenaventura, City of Pasadena, City of Los Angeles, the Metropolitan Water District, Water Replenishment District, and the Central and West Basin Municipal Water Districts.

[2]*Guidelines for Preparation of the 1996 State Water Quality Assessments* (US EPA 1995).

consumption and shell fish harvesting, contact and noncontact recreation, aquatic life support, and agriculture. These broad categories do not precisely match all the beneficial use categories used in our *Water Quality Control Plan* (*Basin Plan*, 1994); accordingly, beneficial uses designated in the *Basin Plan* were combined into the broader federal categories, as appropriate. In particular, note that groundwater recharge (GWR), which is a separate category in our *Basin Plan*, has been combined with a federal category for drinking water supply.

The following briefly describes the rationale for assessments in the various categories of beneficial uses.

Drinking Water Supply: Assessment of water quality for drinking is based on concentrations of constituents that are regulated for drinking water. In this assessment, data are for raw (untreated) surface water. (Note that such water would be treated and disinfected, in accordance with requirements from the State Department of Health Services, prior to distribution for potable use.) Again, please note that groundwater recharge (GWR), which is a separate category in our *Basin Plan*, has been included in this category.

Aquatic Life Support: Assessment of water quality for aquatic life support is primarily based on water quality data for physical parameters and chemical constituents as well as sediment, toxicity and bioaccumulation data. Data on chemical constituents (i.e., in the water column) include not only conventional parameters and constituents (such as dissolved oxygen, pH, and temperature) but–where available–toxic substances (priority pollutants, chlorine, and ammonia). Other considerations included in assessment of water quality for aquatic life support included fish kills, barriers to fish migration, and impairment of benthic communities.

Contact and Non-contact Recreation: Assessment of contact recreation is based on closure data for bathing areas, coliform bacteria data, hazardous substances and aesthetics. In some cases, other criteria such as secondary maximum contaminants levels for odorous substances in drinking water, were considered. Also, additional factors, such as persistent scum, oily films, excessive algae growth, significant trash, and persistent observations of non-natural foam and/or odor, were considered in assessing contact as well as non-contact recreational uses.

Fish Consumption and Shellfish Harvesting: Assessment of water quality for fish and shellfish consumption is based on fishing advisories.

Agriculture: Water quality standards for agriculture can vary by area and by crop. Due to the lack of state or federal standards, assessment of water quality for agricultural use is based upon local guidelines.

It is important to understand that data are limited and that a complete suite of water quality data were not available for measurement against appropriate water quality standards for each waterbody. Therefore, it is not correct to assume that constituents <u>not</u> cited on this list are <u>not</u> causing water quality problems.

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Use of the 303(d) List

As mentioned above, we are under federal requirements to submit this list to the State Board, which will compile the lists for all of California's nine regions for submittal to the US EPA. The US EPA will use this list to report to Congress on the quality of the nation's waterbodies.

Setting aside these reporting requirements, we plan to use information from our water quality assessment and list of impaired waterbodies in the Watershed Initiative. Specifically, this information will be a starting point as we assess water quality problems watershed by watershed. In most areas, we shall need to supplement our data with additional data in order to link impaired waterbodies with sources of pollutants. As you'll note from the 303(d) list, we suspect that most of these pollutants are of a nonpoint source nature. While the data for the 303(d) list also will be helpful, in certain cases, as we develop appropriate limits in Waste Discharge Requirements, Regional Board staff do not intend to use the list as a basis for recommending new, advanced, and/or upgraded treatment technologies for POTWs. Rather, these issues will be considered in greater depth by stakeholders within the context of individual watersheds.

Finally, you'll recall that our draft 303(d) list had a column indicating TMDL priorities (high, medium, or low). Total maximum daily loads (TMDLs) of pollutants are a way to quantify pollutants loads from point and nonpoint sources, and can be used to allocate allowable loads in order to meet water quality standards. Priorities on our draft 303(d) list were based on a combination of many factors, including the severity of problems, the value of the resource, the watershed schedule, staff resources, and practicality/available solutions.

As a result of the discussion of TMDL priorities, we have eliminated this column on our revised 303(d) list. Since we must commit to make significant progress, if not complete, any TMDLs we designate as 'high' priority, we have dropped the TMDL priority of all waterbodies to 'low,' with the exception of the Malibu Creek and Los Angeles River watersheds. TMDLs for certain constituents in these watersheds are still ranked high priority; to date, we have already collected substantial data and modeling efforts are well underway.

The priority of all future TMDLs will be discussed and evaluated by stakeholder groups under the Watershed Approach. Staff and other stakeholder resources will be key factors in determining the number of TMDLs we can undertake in the future.

Other Issue (Municipal and Domestic Supply)

Many dischargers expressed concern that certain waterbodies were noted as impaired for drinking water on the draft 303(d) list (dated December 21, 1995), even though these waterbodies are not known to supply drinking water. The reason that most of these waterbodies were included is that they are considered potential sources of drinking water (potential MUN), in accordance with our policy entitled *Sources of Drinking Water* (State Board Resolution No. 88-063) and, as such, must be protected as potential sources of drinking water.

Based on recent discussions with State Board and US EPA staff, we decided not to assess drinking water use for those waterbodies that were recently added as potential sources of

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drinking water in the *Basin Plan*, solely on the basis of the *Sources of Drinking Water* policy (see asterisks in MUN designations on Table 2-1 of the *Basin Plan*). Accordingly, the assessment of 36 waterbodies for drinking water use has been eliminated from our water quality assessment. Please note that any of the above-mentioned waterbodies that also are designated for groundwater recharge (GWR) in our *Basin Plan* were still assessed under the drinking water category, and still included on the revised 303(d) list.

The fact that we are not assessing certain waterbodies designated as potential sources of drinking water at this time does not mean that they have been de-designated for MUN in the *Basin Plan*. A review of our exemption criteria for MUN is on-going, and Regional Board staff plan to make recommendations for appropriate revisions to our *Sources of Drinking Water* policy later this year. Appropriate revisions to the 303(d) list will follow, if necessary.

Conclusion

We are grateful for the many comments and additional information received since December 21, 1996. Please see the attached Responsiveness Summary, which outlines, by subject, our responses and revisions.

Should you have questions, you may reach Heather Trim (213) 266-7553 or me at (213) 266-7557.

cc: David Smith, US EPA, Region IX
Nancy Richard, Monitoring and Assessment Unit, State Board

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Revised 303(d) List: Inland Watersheds

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
McGrath Lake (estuary)	403.11	Aquatic life	Sed(DDT, chlordane, total pesticides), SED TOX	Nonpoint source
Ventura River Estuary	402.10	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(DDT), EUT Trash, Algae Trash, Algae TIS(DDT)	Nonpoint source and point source
Ventura River (estuary to Weldon Cyn)	402.10	Aquatic life Recreation: contact Recreation: non-contact	TIS(Cu, Se, Ag, Zn) Algae Algae	Nonpoint source and point source
Ventura River (Weldon Cyn to Camino Cielo)	402.10 402.20	Aquatic life	Water diversion and pumping	Nonpoint source
Matilija Creek and reservoir	402.20	Aquatic life	Fish barrier	Nonpoint source
Santa Clara River Estuary	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River (W Pier Hwy 99 to Bouquet Cyn Rd Bridge)	403.51	Aquatic life Recreation: contact	AMM Coliform	Nonpoint source and point source
Mugu Lagoon	403.11	Aquatic life Fish consumption*	Cu, Hg, Ni, Zn, bird reproductivity (DDT), TIS (Chlordane, DDT, endosulfan, dacthal, toxaphene, PCBs, As, Cd, Ag), Nitrogen, Sed(DDT, toxaphene), SED TOX, excessive sediment TIS(DDT, PCBs, toxaphene)	Nonpoint source and point source
Rio de Santa Clara (tributary to Mugu Lagoon)	403.11	Aquatic life Fish consumption	SED TOX, TIS(chlordane, toxaphene, DDT, ChemA, PCBs), Nitrogen TIS(chlordane, toxaphene, DDT, ChemA, PCBs)	Nonpoint sources
Tributary from duck ponds to Mugu Lagoon	403.11	Aquatic life Fish consumption	TOX, SED TOX, Sed(DDT), TIS(Chlordane, toxaphene, DDT, ChemA), Nitrogen TIS(Chlordane, toxaphene, DDT, ChemA)	Nonpoint source
Calleguas Creek (Estuary to Arroyo Las Posas)	403.11 403.12	Drinking water/GWR Aquatic life Fish consumption	N+N AMM, TOX, Sed (DDT, toxaphene), TIS (PCBs, DDT, toxaphene, ChemA, chlordane, dacthal, endosulfan), Nitrogen, SED TOX TIS (DDT, toxaphene, ChemA, chlordane)	Nonpoint source and point source
Revolon Slough and Beardsley Channel/Wash	403.11 403.61	Drinking water/GWR Aquatic life Recreation: contact Recreation: non-contact Fish consumption	N+N Se, TOX, Sed (toxaphene, chlordane, DDT, endosulfan, dacthal), TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, chlorpyrifos, hexochlorobenzene, PCBs, dacthal), Nitrogen Algae, Trash Algae, Trash TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, PCBs)	Nonpoint source
Conejo Creek /Arroyo Conejo (confluence Calleguas to above Lynn Rd)	403.12 403.63 403.64 403.68	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	DO, AMM, TOX, TIS(endosulfan, toxaphene, DDT, ChemA, dacthal, Ag, Cd, Cr, Ni), Sed(toxaphene) Algae Algae TIS(endosulfan, toxaphene, DDT, ChemA)	Nonpoint source and point source
Conejo Creek/Arroyo Conejo North Fork	403.64	Aquatic life Fish consumption	AMM, TIS(chlordane, DDT, Ag) TIS(chlordane, DDT)	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
Arroyo Las Posas	403.62	Drinking water/GWR Aquatic life	N+N AMM, Sed(DDT)	Nonpoint source and point source
Arroyo Simi (~Moorpark Frwy (23) to Brea cyn)	403.62	Aquatic life Recreation: contact Recreation: non-contact	AMM, Temp, TOX, TIS(Cr, Ni, Ag, Zn, Se) Algae Algae	Nonpoint source and point source
Malibu Lagoon	404.21	Aquatic life Recreation: contact Fish consumption Shellfish Harvesting	Benthic community, TIS (As, Cr, Ni, Se, Pb, Ag), EUT Coliform, Enteric viruses, swimming restriction TIS(As, Se, Pb) Advisory	Nonpoint source and point source
Malibu Creek: lagoon to Malibu Lake	404.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	Fish barrier, TIS (As, Cr, Ni, Cd, Se, Ag, Pb, Cu) Trash, Algae, Coliform, Scum Trash, Algae, Scum TIS (As, Cr, Ni, Se)	Nonpoint source and point source
Las Virgenes Creek	404.22	Aquatic life Recreation: contact* Recreation: non-contact	Se, DO Coliform, Scum, Algae, Trash Scum, Trash, Algae	Nonpoint source
Stokes Creek	404.22	Recreation: contact	Coliform	Nonpoint source
Medea Creek	404.24 404.23	Aquatic life Recreation: contact* Recreation: non-contact	Se Coliform, Algae, Trash Coliform, Algae, Trash	Nonpoint source
Lindero Creek	404.23	Aquatic life Recreation: contact Recreation: non-contact	Se Coliform, Trash, Algae, Scum Coliform, Trash, Algae, Scum	Nonpoint source
Palo Comado	404.23	Recreation: contact Recreation: non-contact	Coliform Coliform	Nonpoint source
Triunfo Cyn Creek	404.24 404.25	Aquatic life	Hg, Pb	Nonpoint source
Topanga Canyon Creek	404.11	Aquatic life	Pb	Nonpoint source
Santa Monica Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	Pb Coliform Coliform	Nonpoint source
Pico Kenter Drain	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, TOX, PAHs Coliform, Enteric viruses, Trash Coliform, Trash	Nonpoint source
Ashland Avenue Drain	405.13	Aquatic life Recreation: contact*	DO, TOX Coliform	Nonpoint source
Ballona Creek Estuary	405.13	Aquatic life Recreation: contact Shellfish harvesting	SED TOX, Sed(Pb, Zn, DDT, aroclor, PCBs, PAHs, chlordane), TIS(chlordane, PCBs) Coliform Advisory	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
Ballona Creek	405.13	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	Pb, SED TOX, TOX, TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA, Cr, Cu, Pb, Ag, Zn), Sed(Cd, TBT, Cu, Pb, Ag) Coliform, Trash, enteric viruses Coliform, Trash TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA)	Nonpoint source and point source
Ballona Wetland	405.13	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(As, Pb, Cr), Habitat alteration, Exotic vegetation, Reduced tidal flushing, Hydromodification Trash Trash TIS(As)	Nonpoint source
Sepulveda Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source
Dominguez Channel (includes estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	AMM, Cu, Pb, Sed(Cr, Zn, DDT, PAHs), TIS(aldrin, chlordane, DDT, dieldrin, PCBs, ChemA, Pb) Benthic community impairment Coliform Coliform TIS(chlordane, DDT, dieldrin, PCBs)	Nonpoint source and point source
Wilmington Drain	405.12	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb Coliform Coliform	Nonpoint source
Torrance Carson Channel	405.12	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb Coliform Coliform	Nonpoint source
Colorado Lagoon	405.12	Aquatic life	Sed(Pb, Zn, chlordane, PAHs), TIS(chlordane, DDT, dieldrin, PCBs, Ag, Pb, Cu, ChemA), SED TOX	Nonpoint source
Los Cerritos Channel	405.12	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, Zn Coliform Coliform	Nonpoint source
Los Angeles River Reach 1 (upstream Carson St to Estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact	pH, AMM, Pb Coliform, Trash, Scum, Algae Coliform, Trash, Scum, Algae	Nonpoint source and point source
Los Angeles River Reach 2 (Figueroa St to upstream Carson St)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, ODOR, Oil Coliform, Trash, Scum, Algae, ODOR, Oil	Nonpoint source and point source
Compton Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb, pH Coliform Coliform	Nonpoint source and point source
Rio Hondo Reach 1 (Santa Ana Freeway to Los Angeles River)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, Zn, pH Coliform, Trash Coliform, Trash	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
Rio Hondo Reach 2 (from Whittier Narrows Flood Control Basin to Spreading Grounds)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM Coliform Coliform	Nonpoint source and point source
Monrovia Canyon Creek	405.33	Aquatic life	Pb	Nonpoint source
Arroyo Seco Reach 1 (downstream Devils Gate Dam)	405.15	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Trash, Algae	Nonpoint source
Los Angeles River Reach 3 (Riverside Drive to Figueroa St)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM Trash, Algae, ODOR, Scum Trash, Algae, ODOR, Scum	Nonpoint source and point source
Verdugo Wash	405.21	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Coliform, Trash, Algae	Nonpoint source
Los Angeles River Reach 4 (Sepulveda Dam to Riverside Dr)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, ODOR Coliform, Trash, Scum, Algae, ODOR	Nonpoint source and point source
Burbank Western Channel	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cd Trash, Scum, Algae, ODOR Trash, Scum, Algae, ODOR	Nonpoint source and point source
Tujunga Wash (downstream Hansen Dam to Los Angeles River)	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu Coliform, Trash, Scum, ODOR Trash, Scum, ODOR	Nonpoint source
Los Angeles River Reach 5 (within Sepulveda Basin)	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, TIS(Ag, chloropyrifos, ChemA) Trash, Scum, Algae, ODOR, Oil Trash, Scum, Algae, ODOR, Oil TIS(ChemA)	Nonpoint source and point source
Los Angeles River Reach 6 (upstream of Sepulveda Flood Control Basin)	405.21	Drinking water/GWR Recreation: contact Recreation: non-contact	1, 1-DCE, PCE, TCE Coliform Coliform	Nonpoint source
Alisso Canyon Wash	405.21	Aquatic life	Se	Nonpoint source
Bell Creek	405.21	Recreation: contact* Recreation: non-contact	Coliform Coliform	Nonpoint source and point source
San Gabriel River Estuary	405.15	Aquatic life Fish consumption	TOX, TIS(As, Cu, Ag, Cr), HIST TIS(As)	Nonpoint source and point source
Coyote Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST, CHL, TIS(Cr, Cu, Ag) Coliform, Algae, Coliform, Algae,	Nonpoint source and point source
San Gabriel River Reach 1 (Estuary to Firestone)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST Coliform, Algae Coliform, Algae	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
San Gabriel River Reach 2 (Firestone to Whittier Narrows Dam)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source and point source
San Gabriel River Reach 3 (Whittier Narrows to Ramona)	405.41	Aquatic life	TOX	Nonpoint source and point source
San Jose Creek	405.41	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX Coliform, Algae Coliform, Algae	Nonpoint source and point source
Walnut Creek	405.41	Aquatic life	pH, TOX	Nonpoint source and point source
San Gabriel River East Fork	405.43	Recreation: contact Recreation: non-contact	Trash Trash	Nonpoint source

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Revised 303(d) List: Coastal Features and Bays

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of impairment	Known or Potential Sources
Ventura Harbor: Ventura Keys at Arundell Barranca	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River Estuary Beach/Surfers Knoll	403.11	Recreation: contact	Coliform	Nonpoint source
McGrath Beach	403.11	Recreation: contact	Coliform, beach closures	Nonpoint source
Mandalay Beach	403.11	Recreation: contact	Beach closures	Nonpoint source
Channel Islands Harbor	403.11	Aquatic life	Sed (Pb, Zn)	Nonpoint source
Port Hueneme Harbor	403.11	Aquatic life	Sed (PAHs), TIS(DDT, PCBs, TBT, Zn)	Nonpoint source
SANTA MONICA BAY NEARSHORE ZONE AND OFFSHORE ZONE: Hyperion 5 mile and 7 mile outfall area Joint Water Pollution Control Plant outfall area Palos Verdes shelf Marina del Rey area Santa Monica Pier area Manhattan Beach area Redondo Pier area Malibu Pier area Short Bank Point Dume area Malibu area Point Vicente area Palos Verdes-NW Whites Point	various	Aquatic life Fish Consumption	SED TOX, TIS(Ag, DDT, Cr, Pb, PCBs), Sed(Cd, Cu, Pb, Hg, Ni, Zn, DDT, PCBs, chlordane, PAHs), Sed(DDT, PCBs), debris Advisories	Nonpoint source and point source
Santa Monica Bay/Southern LA County beaches: Ventura County Line to Long Beach City Line	various	Recreation: contact Fish consumption	All beaches are impaired due to periodically high coliform counts and/or beach closures. Many areas are impaired due to fish consumption advisories.	Nonpoint Source
Marina del Rey Harbor	405.13	Aquatic life Recreation: contact Shellfish Harvesting	TIS (chlordane, DDT, PCBs, TBT, Zn, Cu, Pb, ChemA, dieldrin), Sed (Zn, Cu, Pb, chlordane, DDT), SED TOX, Benthic community effects Coliform Advisory (DDT, PCBs)	Nonpoint source
San Pedro Bay nearshore and offshore zone: Cabrillo Pier area	405.12	Aquatic life Fish consumption	TIS (DDT), SED, TOX, Sed (PAHs, DDT, Zn, Cu, Cr) Advisory (DDT, PCBs)	Nonpoint source and point source
Los Angeles Harbor: particularly Main Channel, Fish Harbor, Cabrillo Pier, and breakwater	405.12	Aquatic life Recreation: contact Fish Consumption	TIS (DDT, PCB, Zn, Cu, PAHs), Sed (DDT, PCBs, Cu, Zn, PAHs, TBT), SED TOX Beach closures Advisory (DDT, PCBs)	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
Los Angeles Harbor: Consolidated Slip	405.12	Aquatic life Fish Consumption	TIS(DDT, chlordane, PCBs, TBT, Zn), SED TOX, Benthic community effects, Sed (PAHs, Zn, Cr, Pb, DDT, chlordane, PCBs) Advisory (DDT, PCBs)	Nonpoint source
Los Angeles Harbor: Southwest Slip	405.12	Aquatic life Fish Consumption	SED TOX Advisory (DDT, PCBs)	Nonpoint source
Long Beach Harbor , particularly Main Channel, Southeast Basin, West Basin, Pier J, and breakwater	405.12	Aquatic life Fish Consumption	TIS (DDT, PCBs), Benthic community effects, Sed (PAHs), SED TOX Advisory (DDT, PCBs)	Nonpoint source

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Revised 303(d) List: Lakes

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assume that contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Waterbody	Hydro unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Sources
Lake Casitas	402.20	Aquatic life	DO	Nonpoint source
Lake Hughes	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT, Fish kills Trash, Odors, Algae Trash, Odors, Algae	Nonpoint source
Munz Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT Trash Trash	Nonpoint source
Elizabeth Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	pH, EUT, DO pH, Trash Trash	Nonpoint source
Malibou Lake	404.24	Aquatic life Recreation: contact Recreation: non-contact	DO, EUT, TIS (PCBs, chlordane, Cd, Cu, Zn) Algae Algae	Nonpoint source
Lake Lindero	404.23	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	CHL, SC, Se, EUT, TIS (Se, oxadiazon) Odors, Trash, Algae Odors, Trash, Algae TIS(Se)	Nonpoint source
Westlake Lake	404.25	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, Cu, Pb, EUT, TIS(chlordane, Cd, Cu, Zn) Algae Algae TIS(chlordane)	Nonpoint source
Lake Sherwood	404.26	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, EUT, TIS (Hg) Algae Algae TIS (Hg)	Nonpoint source
Machado Lake (Harbor Lake)	405.12	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, EUT, TIS (chlordane, ChemA, DDT, dieldrin, PCBs) Odors, Trash, Algae Odors, Trash, Algae Advisory (DDT, chlordane), TIS (chlordane, ChemA, DDT, dieldrin, PCBs)	Nonpoint source
Calabasas Lake	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, TIS (DDT, Cu, Zn, Cd), EUT, DO, pH Odors Odors TIS (DDT)	Nonpoint source
Echo Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, Cu, Pb, EUT, TIS (PCBs), pH Odors, Trash, Algae Odors, Trash, Algae TIS (PCBs)	Nonpoint source

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Waterbody	Hydro unit	Beneficial Use Categories Impaired	Evidence of Impairment	Known or Potential Source
Lincoln Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb, EUT, DO Odors, Trash Odors, Trash	Nonpoint source
Peck Rd Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	DO, Pb, TIS (DDT, chlordane) Odors, Trash Odors, Trash TIS (DDT, chlordane)	Nonpoint source
El Dorado Lakes	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, EUT, TIS (Hg, Cr), pH Algae Algae	Nonpoint source
Legg Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact	Cu, Pb, AMM, pH Odors, Trash Odors, Trash	Nonpoint source
Puddingstone Reservoir	405.52	Aquatic life Fish Consumption	DO, TIS (PCBs, chlordane, DDT, dacthal, oxadiazon, Hg, As) TIS (PCBs, DDT, Hg)	Nonpoint source
Santa Fe Dam Park Lake	405.41	Aquatic life	Pb, Cu, pH	Nonpoint source
Crystal Lake	405.43	Aquatic life	DO	Nonpoint source

ABBREVIATIONS AND FOOTNOTES

*	Although people sometimes swim, bathe, drink, fish, and otherwise use these waterbodies, access is restricted. Please refer to the Basin Plan (1994) for footnotes which identify specific restrictions.
GWR	Groundwater recharge use
AMM	Ammonia-N
N+N	Nitrate-N + Nitrite-N
Temp	Temperature of effluent is greater than 5° above ambient temperature in waterbody.
DO	Dissolved oxygen (depleted levels)
Coliform	Coliform bacteria: fecal coliform for inland surface waterbodies; total and fecal coliform for beaches.
TRASH	Significant trash and debris observed
Odors	Significant odors observed
Algae	Significant algal growth observed
OIL	Oily film observed on surface of water
Scum	Nonnatural foams, flotsam, scum material or other floating material observed.
Turb	Turbidity
EUT	Eutrophic
PAHs	Polycyclic aromatic hydrocarbons
Sed(x)	Level of constituent in sediment is elevated.
HIST	Abnormal fish histology observed.
TIS(x)	Fish or mussel data from State Mussel Watch and State Toxic Substances Monitoring programs. The constituent in parenthesis exceeds the standard(s).
TOX	Tests or studies of chronic or acute toxicity of species (water column).
SED TOX	Tests or studies of chronic or acute toxicity of species (sediment).
ChemA	Toxic Substances Monitoring Program combination of pesticides: Aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, HCH (including lindane), endosulfan, and toxaphene.
Metals	Ag (Silver), Ba (Barium), Cd (Cadmium), Cr (Chromium), CrVI (Chromium VI), Cu (Copper), Pb (Lead), Se (Selenium), TNT (tributyl tin), Zn (Zinc), and Hg (Mercury).

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Regional Water Quality Control Board, Los Angeles Region
1996 303(d) Responsiveness Summary

February 15, 1996

Public Notice Summary

On December 21, 1995, an explanatory letter and attached draft 303(d) list were sent to over 700 governmental agencies, dischargers, water districts, environmental groups, and other interested parties in the region. In early January, additional copies of the list were sent to Malibu Creek watershed stakeholders and parties interested in the Los Angeles County Municipal Stormwater NPDES permit. In addition, public notices were posted on December 25 and 27, 1995, in Los Angeles and Ventura areas papers. The public review period was originally posted through January 25, 1996. After requests from several agencies for more review time, the review period was extended to February 8, 1996.

Approximately 25 individuals representing cities, environmental groups, and dischargers, called Regional Board staff with questions during the comment period. These questions were primarily about the nature and use of the 303(d) list. Many cities were concerned about the use of the list in the pending re-issue of the Los Angeles County Municipal Stormwater NPDES permit. Most oral comments were later formalized in letters from commenters. In all, 19 comment letters were received from 15 organizations or agencies.

Also, on January 18, 1996, members of the Southern California Alliance of Publicly Owned Treatment Works (SCAP) requested a meeting with Regional Board staff to discuss issues regarding the 303(d) list. This meeting was held on January 31, 1996 (see attached attendance list) at the Regional Board's office. Regional Board staff gave a brief overview of the need for the 303(d) list, development of the list, and the use of the list. After the presentation, discussions centered around issues of concern to the agencies, including the MUN designation for certain waterbodies, natural sources related to impairments, chronic versus acute toxics standards, and other issues.

Responsiveness Summary

Comments below are organized with general concerns presented first, followed by waterbody-specific concerns second. Multiple comments on the same issue are combined. Every effort has been made to accurately reflect the actual comments and direct quotes are used whenever possible. Copies of the original comment letters are available upon request. In addition to changes noted in this responsiveness summary, additional changes were made to the 303(d) list in response to internal staff comments (correction of errors, clarification).

<u>List of Commenters</u>

Comments were received from the following people. Each commenter has been assigned an abbreviation which is referenced at the end of each comment.

Abbreviation	Agency/Organization/Person	Contact Person(s)
CDFG	California Department of Fish and Game 330 Golden Shore, Suite 50 Long Beach, CA 90802 Letter dated February 6, 1996	John Sunada
CamSD	Camarillo Sanitary District 601 Carmen Drive, PO Box 37 Camarillo, CA 93011 Letter dated January 31, 1996	John Elwell

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Carson	Carson, City of PO Box 6234 Carson, CA 90749 Letter dated January 30, 1996	George Schultz John Wisz
FVR	Friends of the Ventura River 63 South Olive Street San Buenaventura, CA 93001 Letter dated January 12, 1996	Mark Capelli
HTB	Heal the Bay 2701 Ocean Park Blvd., Suite 150 Santa Monica, CA 90404 Letter dated January 24, 1996	Mark Gold Jaque Forrest
LVMWD	Las Virgenes Municipal Water District 4232 Las Virgenes Road Calabasas, CA 91302 Letter dated January 25, 1996 Letter dated February 1, 1996	Jim Colbaugh Randal Orton
LACity	Los Angeles, City of, Department of Public Works Suite 1400, City Hall East 200 North Main Street Los Angeles, CA 90012 Letter dated January 24, 1996	Sam Furuta Delwin Biagi
LACo	Los Angeles, County of, Department of Public Works 900 South Fremont Avenue Alhambra, CA 91803-1331 Letter dated February 8, 1996	Harry Stone Fred Rubin Bill DePoto
LACSD	Los Angeles County, County Sanitation Districts PO Box 4998 Whittier, CA 90607 Letter dated December 27, 1995 Letter dated January 25, 1996	Charles Carry Sharon Green
OjaiVSD	Ojai Valley Sanitary District 1072 Tico Road Ojai, CA 93023 Letter dated February 8, 1996	Eric Oltmann Ronald Sheets
SCAP	Southern California Alliance of Publicly Owned Treatment Works 30290 Rancho Viejo Road, Suite 113 San Juan Capistrano, CA 92675 Letter dated January 18, 1996 Letter dated February 7, 1996	Sharon Green
SCLARITA	Santa Clarita, City of 23920 Valencia Blvd., Suite 300 Santa Clarita, CA 91355-2196 Letter dated January 4, 1996	Don Williams

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SVCSD	Simi Valley County Sanitation District 2929 Tapo Canyon Road Simi Valley, CA 93063-2199 Letter dated January 25, 1996 Letter dated February 7, 1996	Ronald Coons John Behjan
USFS	United States Department of Agriculture Forest Service 701 N. Santa Anita Avenue Arcadia, CA 91006-2725 Letter dated January 25, 1996	Michael Rogers Joe Gonzales
VentCo	Ventura, County of Environmental Health Division 800 South Victoria Avenue Ventura, CA 93009-1730 Letter dated January 25, 1996	Donald Koepp Robert Williamson

Format used for Responsiveness Summary

COMMENT #: The comment number, for reference.

COMMENT:	The summary of the comment.
COMMENTERS:	The reference abbreviation(s) of the commenter(s).
STAFF RESPONSE:	Regional Board staffs' response to the comment.

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Comments and Responses organized by general issues followed by waterbody-specific concerns

COMMENT #: 1

COMMENT: Schedule and clarification issues: SCAP requested that Regional Board staff meet with members of SCAP and that the public review period be extended an additional 30 days beyond January 25, 1996. Also, a more extensive public review, involving stakeholders early on would be appreciated in the future. The 303(d) list should be integrated into the Watershed Approach. Several dischargers requested that they review the data and criteria used to make the 303(d) list assessments. Clarification was needed regarding the aggregation of the state beneficial use categories into the seven 305(b) categories.

COMMENTERS: SCAP, LACity, SVCSD, LACSD, CamSD

STAFF RESPONSE: Data summaries were sent to LACSD. Regional Board staff made a special presentation to members of SCAP at a meeting on January 31, 1996. Many issues, such as the relationship of state beneficial uses to the required USEPA use categories were described. Members of SCAP, as well as all interested parties, have been informed that they may visit the Regional Board office to review all pertinent data.

The review period was extended an additional two weeks, for a total period of 49 days. Thirty extra days was not feasible due to State Board deadlines.

As was explained at the January 31, 1996, meeting, this assessment will likely be the last of the biennial regional-wide assessments required by USEPA. In the future, assessments will be done on a watershed basis and will be incorporated as part of the Watershed Approach. Stakeholders will be able to update and refine these lists as the Regional Board cycles through the watersheds on a year-to-year basis.

COMMENT #: 2

COMMENT: Labels on draft 303(d) list table: Labels on the 303(d) list for "Beneficial Uses Not Supporting" and "Partially Supporting" on the 303(d) list are misleading.

COMMENTERS: LACSD

STAFF RESPONSE: These labels are misleading and will be reworded. Accompanying text should clarify the meanings.

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COMMENT #: 3

COMMENT: Standards for Aquatic Life: LACSD believes that it is inappropriate to use EPA Gold Book criteria for making assessments. "Under federal regulations for development of 303(d) lists, states are required to identify water quality-limited segments requiring TMDLs for which specified types of controls are not stringent enough to implement any water quality standards (WQS) applicable to such waters.'"

COMMENTERS: LACSD

STAFF RESPONSE: The federal guidance for assessing waterbodies for 303(d) lists and 305(b) reports allows use of best professional judgement and specifically suggests use of the Gold Book standards.

COMMENT #: 4

COMMENT: Prioritization of TMDLs: How were TMDLs prioritized? Twenty high priority TMDLs does not seem reasonable. "SCAP requests that the Board not finalize these priorities until stakeholder groups in the target watershed have the opportunity to discuss and provide input on the priorities."

COMMENTERS: LACSD, SCAP

STAFF RESPONSE: TMDLs were originally prioritized based on a combination of many factors, including the severity of the problem, the "value" of the resource, our watershed schedule, staff resources, and practicality/available solutions. We must commit to make significant progress, if not to complete, any TMDLs we designate as "high" priority targeted waterbodies in the next few years; therefore, all of the waterbodies have now been dropped to "low" priority with the exception of two watersheds. The Malibu Creek and the Los Angeles River watersheds, both of which already have TMDL assessments underway, are listed as "high" priority and are targeted for TMDLs. The priority of all future TMDLs will be discussed and decided by stakeholder groups under the Watershed Approach. Staff and other stakeholder resources will be a key factor in determining the number we can perform in the future.

COMMENT #: 5

COMMENT: As a summary of the January 31, 1996, meeting with SCAP, SCAP understood that "natural" will be added to the source column where information indicates natural sources of constituents are causing or contributing to the impairment.

COMMENTERS: LACSD, SCAP

STAFF RESPONSE: The listing of specific sources (including "natural sources") will be included in the 305(b) and 303(d) database that is sent to State Board. State Board prints the final 303(d) list for the state. The simpler format of nonpoint and point sources will be left in the region's draft 303(d) list. To alleviate confusion, the "Standards exceeded, but effect on beneficial uses uncertain column" will be removed from the draft 303(d) list. In general, constituents that are eleveated and are due to natural sources (i.e., TDS, sulfates) were not included on the 303(d) list.

COMMENT #: 6

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COMMENT: Drinking water use: Many dischargers were concerned that certain waterbodies are listed as impaired for drinking water even though there are no known users of those waterbodies for drinking water purposes.

Second letter from SVCSD dated February 7, 1996: "We agree with your staff proposal to: The RWQCB will be revisiting the designation of MUN on all waterbodies and the appropriateness of this designation. The RWQCB will remove the MUN designation from waterbodies with no history of drinking water use."

February 7, 1996 letter from SCAP summarizes that "potential MUN" designations for waterbodies are under consideration for review under the Triennial Review process. Further, "SCAP recommends that the Board move any constituents that exceeded drinking water objectives to the "standards exceeded but effect uncertain column" if the designated use is "potential MUN" and the waterbody has not yet been reviewed and determined to be a source of drinking water."

COMMENTERS: LACity, SVCSD, Carson, CamSD, SCAP

STAFF RESPONSE: The 303(d) list and 305(b) report include an assessment of the drinking water use for the region. Assessed under this "federal" use are two "state" beneficial uses, namely MUN (municipal supply) and GWR (ground water recharge). Currently, all waterbodies in the region are designated as MUN per the 1988 Sources of Drinking Water Policy. A large number of waterbodies, however, were footnoted in the 1994 Basin Plan as being eligible for review and possible exemption status during the Triennial Review (1994-1997). Currently, the Regional Board is reviewing these footnoted MUN waterbodies but the review process is not complete. Later this year, the Regional Board staff intend to bring forward a revised MUN policy more appropriate for this region.

As was pointed out in the January 31, 1996, meeting with members of SCAP, the 303(d) list must be completed before the MUN designation issue will be settled. No definitive answers or solutions were given at that meeting, contrary to the opinion of the staff from SVCSD. Regional board staff are, however, in the process of developing criteria specific to this region for possible exemptions from the MUN designation. Also the February 7, 1996, letter from SCAP incorrectly lists all "potential MUN" designations as waterbodies under consideration for review under the Triennial Review process. Staff are reviewing only those waterbodies with asterisks (in the MUN column) in the Basin Plan.

After discussions with State Board and USEPA staff, Regional Board staff decided to not assess the drinking water use for those waterbodies that were footnoted MUN in the 1994 Basin Plan and do not have a GWR use. Accompanying text will clarify that some of these waterbodies may be removed from our Basin Plan within this year and, if any of them are determined to have drinking water uses and are impaired, staff will revise the 303(d) accordingly.

Using the above described criteria, for the 305(b) report and 303(d) list the Drinking Water use not be assessed the following waterbodies:

Arrundell Barranca
Little Sycamore Canyon Creek
Deer Canyon

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Lion Canyon Creek
Tapo Canyon Creek (Santa Clara River tributary)
Beardsley Wash
Corral Canyon Creek
Topanga Canyon Creek
Santa Monica Canyon Creek
Pico Kenter Drain
Ashland Avenue Drain
Sims Pond
Los Cerritos Channel
Malibu Creek
Cold Creek
Las Virgenes Creek
Stokes Creek
Malibou Lake
Lindero Creek
Westlake Lake
Lake Lindero
Ballona Creek
Sepulveda Channel
Dominguez Channel
Torrance-Carson (Lateral) Channel
Wilmington Drain
Machada (Harbor Park) Lake
Arroyo Seco South of Devil's Gate Reservoir
Burbank Western Channel
Echo Park Lake
Belvedere Lake
Lincoln Park Lake
San Gabriel River: estuary to Firestone
Coyote Creek (tributary to San Gabriel River)
El Dorado Lake
Crystal Lake

The fact that MUN use has not been included in this 305(b) and 303(d) assessment does not indicate that any of these waterbodies will be excepted for MUN when the Regional Board completes their review of *Sources of Drinking Water Policy* (State Board Resolution No. 88-063). Re-designation of waterbodies is a basin planning process and is not part of the water quality assessment process. Additional discussion of this issue more properly falls in that arena.

COMMENT #: 7

COMMENT: 305(b) public review: The Regional Board should perform a public review, per Section 305 of the Clean Water Act, that includes economic, social and environmental impacts.

COMMENTERS: SVCSD

STAFF RESPONSE: The 305(b) report is prepared by State Water Resources Control Board; the public review requirements are under their jurisdiction. The Regional Board performs the public review for the 303(d) list for this region only.

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COMMENT #: 8

COMMENT: TMDLs: LACity is concerned about the "use of the total maximum daily loads (TMDLs) in prioritizing each of the surface water reaches and location and the use of essentially aesthetic water quality parameters (color, odor, trash, algae, scum) in the prioritization process. As it is not apparent how these constituents might be quantified (not to mention allocated) with respect to identified point and nonpoint sources, we believe that more conventional water quality parameters (TDS, ammonia, coliform) will form the primary basis for the TMDL effort." Also, LACity questioned whether TMDL estimates "have to involve issues such as biological populations, assimilation pathways, sediment toxicity, seasonal affects and other related matters that would either be inappropriate or beyond the scope of an effort of this kind."

COMMENTERS: LACity

STAFF RESPONSE: Total maximum daily loads (TMDLs) are not used to prioritize waterbodies; rather, waterbodies are prioritized for future TMDL assessments. Moreover, TMDLs do not necessarily require elaborate numerical modeling; they can incorporate simple assessments of problems such as trash, scum, etc. and development of simple solutions. Aesthetic constituents were evaluated on a region-wide basis by Regional Board staff during field observations. We did not, however, impair any waterbody based solely on these aesthetic factors (with one exception: the Upper San Gabriel River: East Fork - an area that has been severely impacted by recreational use). In addition, it is appropriate for TMDLs for certain constituents to take into account biological factors as well as seasonal variability.

COMMENT #: 9

COMMENT: Data: "The sources of data should be referenced on the table. Also, how recent must the data be to be of use in making determinations of the beneficial use impairment table?"

COMMENTERS: HTB

STAFF RESPONSE: Data used for this assessment were collected from 1988 to present. Specific requests for data sources have been fulfilled and any group was/is invited to the Regional Board office to take a closer look at the database used for the assessment. The cover letter accompanying the draft 303(d) list, sent in December, included a list of data sources for the assessment.

COMMENT #: 10

COMMENT: Drinking water - treated versus raw water: It should be made clear that the data reflect raw ambient data rather than treated drinking water.

COMMENTERS: HTB

STAFF RESPONSE: Staff agree: a note in the accompanying text will be added to that effect.

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COMMENT #: 11

COMMENT: Additional data: LACSD requested in a letter dated December 27, 1995, additional data and explanatory documentation for 18 waterbodies within Los Angeles County.

COMMENTERS: LACSD

STAFF RESPONSE: A letter and attached data summary and assessment guidelines were sent to LACSD on January 16, 1996.

COMMENT #: 12

COMMENT: Justification for removing waterbodies from 303(d) list: "SCAP applauds the Board for consulting with interested parties regarding the listing of particular constituents and waterbodies. However, we would advocate that necessary control mechanisms should not be limited to construction schedules for new facilities, since other approaches to reducing loads and attaining uses may be equally effective at eliminating use impairment...we would like to suggest that other reasons for not listing a waterbody or de-listing be considered, such as the availability of new data, planned development of site-specific water quality objectives, or modifications that may be made to beneficial use designations and /or water quality objectives to address 'effluent dependent waterbodies.'"

COMMENTERS: SCAP

STAFF RESPONSE: Most of the approaches outlined above will be appropriate, as they become available, for future 303(d) list assessments. Merely stating that a study will be performed, however, does not improve the water quality. Waterbodies, however, can be dropped if plans are underway (e.g., in permit) to correct the problem in the immediate future.

COMMENT #: 13

COMMENT: Ventura coastal beaches - COLIFORM: The impairment of recreational waters due to coliform is of particular concern because if the standard for ocean water contact is exceeded, and the cause of the elevated level constitutes a public health hazard, then, pursuant to Health and Safety Code Section 427.13, the health officer must post warning signs. For standards not supported (standards exceeded in over 25% of samples): What standards are used for coliform in ocean and freshwater recreational activities? Have there been enough coliform samples collected to be statistically significant? Do any of the waterbodies listed, that are within Ventura County, represent violations of waste discharge requirements?

COMMENTERS: VentCo

STAFF RESPONSE: The standards used for coastal beaches are from the state's Ocean Plan (1992): fecal coliform (10% of samples exceeded 400 mpn/100) and total coliform (20% of samples exceeded 1000 mpn/100). For inland or freshwater areas, the region's Basin Plan standards were used.

While the ocean standards are designed for time periods of 60 days, the data staff used spanned longer time periods (up to 6 years). Therefore, we used a more conservative approach that impaired a beach when fecal coliform counts exceeded the standard in 15% rather than in 10% of the samples. The data

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used for Ventura County beaches were based on weekly monitoring by the City of SanBuenaventura of 1) the Santa Clara River and nearby surf zones and 2) the Ventura Harbor area. The listed Surfer's Knoll Beach has exceedences in 32% of the samples. In response to this comment, Regional Board staff reviewed additional data and discovered that additional waterbodies have coliform problems: Santa Clara River estuary (coliform exceedences in 78-93% of the samples), Ventura Harbor: Keyes area at Arrundell Barranca (coliform exceedences in 75-96% of the samples), McGrath Beach (coliform exceedences in 21-46% of the samples). These waterbodies (or additional impairments) will be added to the 303(d) list.

Because the available data did not conform exactly to the more frequent monitoring and follow-up monitoring required under California Title 22, possible Health Department warnings should be based on follow-up more frequent monitoring by the Ventura County Health Department. It would seem that consistent and significantly high coliform counts at these locations warrant further study by Ventura County. To our knowledge, these coliform listings do not represent specific waste discharge violations.

COMMENT #: 14

COMMENT: Ventura River and Estuary: FVR requests that the Total Maximum Daily Loads (TMDL) priority for Ventura River Estuary and Ventura River to Weldon Canyon be changed from medium to high priority based on the substantial wildlife resources... as well as heavy recreational uses, supported by these waterbodies and adjacent nearshore ocean waters.

COMMENTERS: FVR

STAFF RESPONSE: TMDL priority will not be raised for these waterbodies because, with the exception of two TMDLs already underway, all waterbodies will be listed as "low" priority. Stakeholder groups within each watershed will be asked to decide future "high" priority TMDLs (see comment #4).

COMMENT #: 15

COMMENT: Santa Clara River (West Pier Highway 99 to Bouquet Canyon Road bridge): The waterbody is incorrectly listed as part of the Ventura County Coastal watershed.

COMMENTERS: SClarita

STAFF RESPONSE: The title of the table will be changed to reflect the correct location of this reach of the Santa Clara River.

COMMENT #: 16

COMMENT: Arroyo Las Posas and Arroyo Simi: SVCSD objects to inclusion of these waterbodies on the 303(d) list due to drinking water use or MUN (see comment # 6 above) and aquatic life use for ammonia, temperature, toxicity and algae. SVCSD feels that by designation of impairment on these waterbodies, the draft 303(d) list "is clearly indicating that [the Regional Board] has no intention of allowing site specific objective for ammonia as indicated in the Basin Plan, page 3-3 'If it is determined that there is an immediate threat or impairment of beneficial uses due to ammonia, the objectives in Table 3-1 to 3-4 shall apply.'"

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SVCSD also requests that the Regional Board submit all pertinent data, assumptions and calculations supporting assessment of exceedences to temperature and toxicity in these waterbodies. "We are in full compliance with the narrative toxicity objective set forth in the Basin Plan. There is no narrative objective of chronic toxicity for the receiving waters in the Basin Plan. What is the basis for determining the toxicity, temperature and algae impairment of our reaches?"

COMMENTERS: SVCSD

STAFF RESPONSE: As Regional Board staff stated, in the January 31, 1996, meeting with members of SCAP (SVCSD was in attendance), the 303(d) list does not preclude site specific objectives. In addition, staff invited the dischargers to come to our office to review any data of concern.

Algae was listed as an impairment because of field observations by Regional Board staff throughout the region. Temperature and chronic toxicity impairments were based solely on a recent report that was submitted to the Regional Board:

> Simi Valley County Sanitation District. 1995 (September). Report on Arroyo Simi Characterization. Prepared by Montgomery Watson.

Standards used for the 303(d) list and 305(b) report assessment need not be contained in the Basin Plan; the listing based on toxicity is consistent with listing for other waterbodies in the region based on other special toxicity studies.

COMMENT #: 17

COMMENT: Belvedere Lake - aquatic life: The California Department of Public Works has recently (April 1995) restored the lake to qualify as a recreational fishing lake. Improvements include: 1) rerouting storm drains so that no street runoff enters the lake; 2) removing lake sediments; 3) installing aeration systems to increase water circulation and oxygen levels; 4) removing existing fish and restocking with hatchery and farm fish; 5) deepening lake to eight feet.

COMMENTERS: CDFG

STAFF RESPONSE: Belvedere Lake will be removed from the 303(d) list. (The Regional Board's lake study just preceded the lake restoration.)

COMMENT #: 18

COMMENT Elizabeth and Crystal Lakes: USFS would like to review specific information about these lakes in order to possibly add both lakes to the Forest Watershed Improvement Needs (WIN) inventory.

COMMENTERS: USFS

STAFF RESPONSE: Regional Board staff sent information from the lakes study:

> Regional Water Quality Control Board. 1994 (December). Evaluation

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of Water Quality for Selected Lakes in the Los Angeles Hydrologic Basin. Final Report. Prepared by L. Lund, M. Anderson, and C. Amrhein, Department of Soil and Environmental Sciences, University of California, Riverside.

COMMENT #: 19

COMMENT: Santa Monica Bay waterbodies: The following constituents should be added for the following waterbodies (HTB provided citations):

Pico Kenter Drain - PAHs
Ashland Avenue Drain - Coliform
Ballona Creek Estuary - metals, coliform, shellfish advisories
Ballona Creek - enteric viruses
Marina del Rey Harbor - Coliform, shellfish advisories
Malibou lake - Remove Benzene and xylene

COMMENTERS: HTB

STAFF RESPONSE: These recommendations were checked and revisions were made to the list.

COMMENT #: 20

COMMENT: Storm drains: "How were storm drains chosen for assessment? For example, Ashland Ave is a relatively small but polluted drain. However, so are drains at the Santa Monica and Redondo piers among others."

COMMENTERS: HTB

STAFF RESPONSE: Waterbodies, for which water column or bioaccumulation data were not directly available, were included on the list if published reports contained sufficient information regarding impairments.

COMMENT #: 21

COMMENT: San Gabriel River watershed - biotoxicity and ammonia: Because the LACSD permits contain receiving water objectives for both ammonia and chronic toxicity, LACSD "believe that it is no longer necessary for the RWQCB to continue to list either the [San Gabriel] river or the estuary on the 303(d) list, and we request that the 303(d) and 305(b) lists no longer include toxicity or ammonia as a source of impairment." They wish to have time to perform site specific studies or Use Attainability Analyses to determine less restrictive objectives or reassess beneficial use designations.

COMMENTERS: LACSD

STAFF RESPONSE: Use Attainability Analyses are not expected to be completed within the short term (~2 years). The 303(d) list included impairments that are not anticipated to be remedied within the short term.

COMMENT #: 22

COMMENT: Santa Clara River - toxicity: LACSD would like to see a copy of the recent Toxicity Study that covers Santa Clara River. "We believe that in general it is inappropriate for the RWQCB to use draft studies as a basis for determinations of impairment to waterbodies."

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Coyote Creek and San Gabriel River R1 - histology: The Regional Board did not send a reference for this impairment in the January 16, 1996, response letter. "We would appreciate if the RWQCB would provide these data for us to review, along with an explanation of how it was evaluated and used to make an impairment determination."

COMMENTERS: LACSD

STAFF RESPONSE: This report, which is still in draft form, has undergone Regional Board and State Board staff review. Staff used best professional judgement in including this information as part of the assessment process. Staff are willing to discuss the draft results of the study with interested parties, and will be pleased to send the final report as soon as it is available. For the Santa Clara River, the toxicity information did not trigger placement on the 303(d) list; the aquatic life use was determined to be "fully supporting but threatened" for toxicity.

Regional Board staff did neglect to reference this impairment in the January 16, 1996 letter. Histological problems are described in the *Toxicity Study of the Santa Clara River, San Gabriel River, and Calleguas Creek* report mentioned above.

COMMENT #: 23

COMMENT: Coyote Creek and San Gabriel River R1 - Contact recreation: For these waterbodies, "coliform is listed as a cause of impairment for the body contact recreational use. While we recognize that this is a health concern if full body contact (e.g., swimming) occurs in the waterbody, it is important to note, as was done in the 1994 Basin Plan, that access is in fact prohibited to these concrete-lined channels by the Los Angeles County Department of Public Works. Therefore, we believe that these listings of impairment are unnecessary, since the use itself is not legal. At a minimum, this use restriction should be noted on the 303(d) list."

COMMENTERS: LACSD

STAFF RESPONSE: This use restriction will be noted in the accompanying text using the language that is in the 1994 Basin Plan. Beneficial use designations are part of the basin planning process not the water quality assessment process. Certain issues of concern that were identified during the 1994 Basin Plan update, such as MUN designation, are part of the Triennial Review list to be addressed by the Planning Unit.

COMMENT #: 24

COMMENT: Multiple Los Angeles County waterbodies - contact and non-contact recreation: "Contact recreation is an inappropriate beneficial use for these flood control channels and storm drains...Because of the potential for injury, access to these flood control channels is restricted year-round. For the underground stormdrains on the list, both contact and non-contact water recreation are inappropriate beneficial uses for these drains. The Effluent Dependent Waterbodies Task Force recognized the shortcomings inherent in a list of beneficial uses that does not reflect actual conditions. It recommended to the State Resources Control Board alternative methods for developing appropriate beneficial uses categories. While these alternatives are still only under consideration by the State Board, we ask that your Regional Board re-examine

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the beneficial uses it has assigned to these streams and remove the water bodies identified [below] from the impacted list." Specifically:

Drinking water use should be removed because it is an underground drain: Pico-Kenter Drain.

Contact and non-contact recreation use should be removed because it is an underground drain: Ashland Drain.

Contact recreation use should be removed because they are lined-flood control channels: Santa Monica Channel, Ballona Creek, Sepulveda Channel, Dominguez Channel, Los Cerritos Channel, Compton Creek, Rio Hondo, Arroyo Seco, Verdugo Wash, Burbank Western Channel, Tujunga Wash, Aliso Canyon Wash, Bell Creek, Coyote Creek, Wilmington Drain and Torrance Carson Channel [Carson added the last two]

Contact recreation use should be removed because they are lined flood control channels and convey treated effluent: Los Angeles River, San Gabriel River and San Jose Creek.

Carson added: Aquatic life, fish consumption, and shellfish harvesting should be removed from Dominguez Channel (estuary to Vermont), and aquatic life from Wilmington Drain and Torrance-Carson Channel because they are underground or fenced off.

COMMENTERS: LACo, Carson

STAFF RESPONSE: See response to comment # 23 above. In addition, the two storms that are listed as underground (Pico-Kenter and Ashland) surface at the beach which is where the water quality sampling occurs. Those sampling points are also areas of significant recreational contact.

COMMENT #: 25

COMMENT: Rio Hondo R2 - Aquatic Life use: Selenium may be erroneously listed as a cause of impairment. In samples collected as part of the Montebello Forebay Groundwater Replenishment Project, selenium has not been detected. LACSD is not aware of any nonpoint sources of selenium and is aware of an indirect industrial source of selenium that discharges to the Whittier Narrows WRP. "Significant actions have been taken to control this selenium source including additional pretreatment requirements and enforcement actions. As a result, selenium levels in the Whittier Narrows effluent have been at or below detection limits. We therefore request that the RWQCB reconsider this listing and remove selenium as a cause of impairment."

COMMENTERS: LACSD

STAFF RESPONSE: Regional Board staff reviewed the data submitted by LACSD as well as the RWQCB database and agree that the selenium problem appears to have diminished. Selenium was elevated in 1988-1990 and levels have since dropped. Selenium has been removed from the 303(d) list for this waterbody.

COMMENT #: 26

COMMENT: Malibu Lagoon - aquatic life: LVMWD points out that excessive freshwater (i.e.,

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imported water) inputs have not yet been irrevocably proven to have adverse impacts on aquatic life in lagoon.

COMMENTERS: LVMWD

STAFF RESPONSE: Excessive freshwater will be moved to the "fully supporting but threatened " category.

COMMENT #: 27

COMMENT: Malibu Lagoon - shellfish and fish consumption: Recent studies have shown that game species have not been recovered in recent fish surveys and only one form of bivalve species has been found. "The board may wish to note those entries [in the 303(d) list] where a finding of impairment was required in spite of minimal risk."

COMMENTERS: LVMWD

STAFF RESPONSE: Assessment of fish consumption use has been clarified to specifically indicate elevated metals in tissue that exceed standards. The shellfish advisory is on the 303(d) list, per USEPA guidelines, because of posted advisory signs at the lagoon. These impairments are listed regardless of the number of shellfish or fish species in the lagoon. The accompanying text, however, will include a note about the minimal risk in some areas. It should be mentioned, however, that people fish for and eat non-game fish.

COMMENT #: 28

COMMENT: Malibu Lagoon - secondary and primary recreation: From first letter dated January 25, 1996: LVMWD questions whether coliform counts are a "credible measure of impairment and to include [RWQCB's] findings on this point as a footnote to the 303(d) list....No reasonable person would insist that a southland coastal lagoon be made safe for swimming according to the same standards used for other bodies of fresh waters such as lakes and streams."

From second letter dated February 1, 1996: "we appreciate LARWQCB staff's recognition that natural sources of coliform bacteria (particularly from birds) may severely limit the utility of such data for coastal lagoons. We recommend the Board include a note to this effect in the 303(d) list and in the cover letter that accompanies this list when it is submitted to the US Environmental Protection Agency."

COMMENTERS: LVMWD

STAFF RESPONSE: While it is true that high coliform counts do not always equate to human health impairments, these standards and indicators are the only indicators we have and we are required to use them at this time. These points, as well as comments about natural sources of coliform, will be noted in the accompanying text.

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COMMENT #: 29

COMMENT: Malibu Creek - drinking water: It is not clear from the list what the difference is between primary and secondary drinking water. "Regardless, the list should indicate the impairments listed (TDS, sulfate) are primarily natural conditions in the watershed."

COMMENTERS: LVMWD

STAFF RESPONSE: The drinking water secondary and primary listings differentiate between primary and secondary standards or MCLs. This difference will be made clear in accompanying text. TDS and sulfate were mentioned on the 303(d) list as additional constituents (in this case due to natural sources) that create impairments of uses. They do not serve as items that qualify the waterbody for inclusion on the 303(d) list.

COMMENT #: 30

COMMENT: Malibu Creek - aquatic life: Rindge Dam may be built on a topographic high "which may have constituted a natural barrier to fish migration." Fish tissue contaminants may be due to natural causes. "The Board should also consider this information if the 'point sources' entry in column seven is intended to implicate the Tapia Water Reclamation Facility (the matrix is unclear on this point), since (1) concentrations of metals in fish studied by Ambrose et al. (1995) were higher upstream of Tapia than below; (2) this finding is replicated by Mikel (1995)..."

COMMENTERS: LVMWD

STAFF RESPONSE: Regardless of the condition and geometry of the unknown underlying bedrock below Rindge Dam, the dam serves as a significant fish migration barrier. Most dams are, in fact, built on natural geologic "notches", where possible, but those barriers usually allow for some fish passage.

The 303(d) list table and the 305(b) report do not link specific sources and causes. That is, no specific point source is "implicated" for any specific contaminant. The Regional Board staff agrees that some, or many of the contaminants come from nonpoint sources.

COMMENT #: 31

COMMENT: Malibu Creek - Contact and non-contact recreation: From first letter dated January 25, 1996: LVMWD disagrees with listing of the watershed as high for algae and trash. "There is strong correlation between productivity in streams [i.e. contributing to algae problem] and TDS, as evidenced by decades of data from Sierra streams (Morhardt, 1994)....Elevated levels of dissolved solids are typical of these [Santa Monica Mountain] streams in the summer, regardless of their location relative to urban development or other potential human impacts." "With respect to trash, this is perhaps the one issue any visiter to Malibu Creek would agree is a pervasive problem. The only issue here is whether trash is an impairment of recreational use, or a consequence of it."

From second letter dated February 1, 1996: "Regarding our comments on trash, we appreciate the clarification that the basis for comparison is national, and that our area is being ranked alongside wilderness areas far from urban

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centers. Against this standard, we would agree with LARWQCB staff that trash is "fully impairing" recreation in the Malibu Creek Watershed. And we trust other parties will join us in not pressing your staff on how they classified graffiti."

COMMENTERS: LVMWD

STAFF RESPONSE: Dumping of trash in the watershed is considered a nonpoint source type of pollution. The Regional Board is currently conducting a TMDL for nutrients in this watershed which may shed light on algae and other problems.

COMMENT #: 32

COMMENT: Ventura River (estuary to Weldon Canyon) - Aquatic life, recreation (contact and non-contact), agriculture, and drinking water: OjaiVSD states that due to upgrade of its current treatment plant (under Cease and Desist Order No. 90-063) are expected to alleviate impairments caused by dissolved oxygen and ammonia. Compliance is expected within two years. The new upgrade should also reduce nutrient levels thereby reducing algae. "If OVSD's treatment plant is considered the sole source of impairment [due to color and turbidity], it is requested the impairment be removed because of the current upgrade project.

In addition, OjaiVSD would like a footnote added to the 303(d) list that highlights that certain elevated constituents are due to natural sources. "If natural background water quality values are higher than beneficial use designation(s) water quality, then it should be identified as such (unattainable or cannot reasonably be achieved) through footnotes, fact sheet, etc. Removing the beneficial use levels as unattainable would be the most desirable action."

Elevated levels of Cu, Se, Ag and Zn are identified as impairments. "How were these identified? Please identify the sampling agencies and locations which resulted in identifying these constituents as impairments."

COMMENTERS: OjaiVSD

STAFF RESPONSE: Dissolved oxygen and ammonia have been removed from the 303(d) listing for this waterbody in accordance with the fact that the treatment plant expects to implement new technology within two years to address these problems. Color, algae and turbidity are not considered to be due solely to the treatment plant effluent. Algae will remain as a 303(d) listed constituent. Color and turbidity were not listed as evidence of impairment for 303(d) list.

Explanatory text, accompanying the list when it is submitted to State Board and USEPA, will include a discussion of natural sources of constituents in the region as they relate to different beneficial uses. We do not have enough information at this point to entirely remove any use as unattainable but impairments due to naturally occurring constituents are not listed on the 303(d) list (i.e., agriculture and drinking water for this waterbody).

The elevated metals were identified as bioaccumulating in fish tissues through the State's Toxic Substances Monitoring Program. OjaiVSD's staff are invited to review this data. In addition, recent Toxic Substances Monitoring data are available over the state's computer bulletin board at (916) 657-9722.

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COMMENT #: 33

COMMENT: Conejo Creek - contact recreation: "Five years ago the Camarillo District conducted a study of the Conejo Creek below the discharge of the Waste Water Treatment Plant and found virtually no contact of recreation or humans in the water. The area below the discharge point is privately owned, persons who are in the creek water are trespassing in most cases, and those justifications for assigning additional impaired water based on those beneficial uses is not justified."

COMMENTERS: CamSD

STAFF RESPONSE: Contact recreation occurs in Conejo Creek and there is no footnote in the Basin Plan that mentions fences or control of access. Under the Public Trust doctrine in the State of California, all persons are allowed in waterbodies. The only constituent that is listed on the 303(d) list as impairing the contact recreation in Conejo Creek is algae which could be due to point or nonpoint sources. The more significant impairments for Conejo Creek are the dissolved oxygen, ammonia, toxicity, and bioaccumulation of many pesticides impairments to aquatic life, again potentially from point and nonpoint sources.

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Regional Water Quality Control Board, Los Angeles Region
meeting with
members of the Southern California Alliance of Publicly Owned Treatment Works
January 31, 1996
Draft 303(d) List

SIGN IN SHEET

NAME	AGENCY	TELEPHONE
Bill Straub	City of LA / Bur San	(213) 485-1820
John Elwell	Camarillo	(805-388-5381)
Ron Sheets	Ojai Valley SD	805-648-5066
Margie Nellor	LACSD	310-699-7411
Sharon Green	"	"
Kenneth Simon	LVMWD	818 880-4110
Don Davis	City of Ventura	805 642-4759
John Tschylar	City of Simi Valley	805-583-6400
Don Rebeck	So. Calif. Alliance of P.O.T.W. (SCAP)	714/962-2621
Heather Tim	RWQCB	
Deb Smith	RWQCB	
Wendy Phillips	RWQCB	
Mark Smythe	RWQCB	

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R0033783

California Regional Water Quality Control Board
Los Angeles Region
February 26, 1996
391st Regular Board Meeting (Glendale)

ITEM: 12

SUBJECT: Water Quality Assessment

DISCUSSION: The Clean Water Act requires each state agency responsible for water quality to periodically assess the quality of surface waters. Based on this assessment, each state must then prepare a list of those waters that do not, or are not expected to, attain water quality standards after application of required technology-based controls. This list, known as the 303(d) list, is intended to assist the Board in setting priorities and to focus water quality efforts and resources on the most significant water quality problems.

Staff released a draft 303(d) list for the Los Angeles Region to the public on December 21, 1995. This list was developed from water quality data that were available to Regional Board staff. Water quality data from numerous agencies and districts[1] supplemented in-house data. Staff will use the list and supporting data as a starting point for watershed-based planning activities and, in particular, finding solutions to nonpoint source water quality problems. While these data also will be helpful, in certain cases, in developing appropriate limits in Waste Discharge Requirements, staff do not intend to use this list as a basis for recommending new, advanced, and/or upgraded treatment technologies for major POTWs in our Region. Rather, these issues will be considered in greater depth by stakeholders within the context of individual watersheds.

The draft 303(d) list has generated comments from many groups (dischargers and environmentalists) and some articles in local newspapers. Staff have met, and are continuing to meet, with individual dischargers to discuss specific waterbodies on the draft 303(d) list, and the implications of the 303(d) designation. Additionally, staff held a meeting for members of SCAP (Southern California Alliance of Publicly Owned Treatment Works), during which staff gave a presentation on the need for the list, development of the list, and the use of the list. As appropriate, staff have incorporated comments and/or made revisions to the 303(d) list.

Staff plans to make appropriate revisions to the 303(d) list by February 15, 1996, and then must submit this list to the State Board. In April, the State Board will submit a 303(d) list for the entire state to the US EPA.

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[1]Other agencies providing data include the US Geological Survey, US Forest Service, California Department of Water Resources, Ventura County Flood Control District, Los Angles County Department of Public Works, City of Thousand Oaks, City of San Buenaventura, City of Pasadena, City of Los Angeles, the Metropolitan Water District, Water Replenishment District, and the Central and West Basin Municipal Water Districts.

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R0033784

For your information, we have attached the following:

a) Memorandum to public, dated February 15, 1996, regarding the purpose, development, and use of the 303(d) list.

b) The revised 303(d) list.

c) Responsiveness Summary, outlining public comments and staffs' responses.

d) Related newsclippings.

REQUIRED BOARD ACTION:

Receive and file. This report is intended to brief Board Members on staffs' efforts to assess water quality, prepare the required 303(d) list, and address public concerns. (Board action is not required for submittal of this list to the State Board and US EPA.)

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R0033785

STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500
FAX: (213) 266-7600

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March 14, 1996

Mr. John Behjan
Principal Engineer
City of Simi Valley
500 West Los Angeles Avenue
Simi Valley, California 93065

File no. 700.517

Dear Mr. Behjan:

Re: Revised Draft 303(d) List for the Los Angeles Region

We are grateful for the time that staff at the City of Simi Valley has taken help us refine a 303(d) list for our Region. As you are aware, information from the 303(d) list for the Los Angeles Region will be compiled in a general format with water quality information for waterbodies nationwide and presented to the US Congress. This list is then used by federal and state agencies to allocate federal and state monies for protection of water quality.

In Mr. Ron Coon's letter dated February 23, 1996 and during our meeting on March 11, 1996, you requested clarification on the criteria used to assess impairment of beneficial uses. Please see the attachment, which summarizes guidelines we used for assessing impairments to aquatic life, recreation, and drinking water (including recharge of ground water). This attachment, which has been revised to cover only those impaired beneficial uses under discussion for Arroyo Simi and Arroyo Las Posas, is a version of a table distributed to members of SCAP (Southern California Alliance of POTWs) and to staff from the City of Simi Valley during a meeting with Regional Board staff on January 31, 1996. The guidelines are based upon instructions from the State Water Resources Control Board and the US EPA (*Guidelines for Preparation of the 1996 State Water Quality Assessments*, US EPA, 1995). We hope that this information, as well as the raw data provided by Heather Trim during our meeting on February 20, 1996, will clarify our assessment approach and use of data. Should you need further clarification, Heather Trim and I will be glad meet with you again.

As always, please don't hesitate to contact Heather Trim at (213) 266-7553 or me at (213) 266-7557.

Sincerely,

Wendy Phillips

Wendy Phillips, Chief
Planning Unit

attachment

0450

Water Quality Assessment guidelines - City of Simi Valley request (March 14, 1996).

Assessment guidelines for water column toxic substances for aquatic life use support *Priority pollutants, chlorine, ammonia*	
Fully supporting	For any one pollutant, no more than 2 violations of chronic criteria within a 6 year period based on at least 20 grab or 1-day composite samples. If fewer than 20 samples are available, then best professional judgement is used considering the number of pollutants having violations and the magnitudes of the exceedance(s).
Partially supporting	For any one pollutant, criteria exceeded more than twice within a 6-year period, but in ≤ 10 percent of samples.
Not supporting	For any one pollutant, criteria exceeded in > 10 percent of samples.
Assessment guidelines for water column conventional constituents and stressors for aquatic life use support ***Dissolved oxygen, temperature, chloride, pH***	
Fully supporting	For any one pollutant, criteria exceeded in ≤ 10 percent of measurements.
Partially supporting	For any one pollutant, criteria exceeded in 11 to 25 percent of measurements.
Not supporting	For any one pollutant, criteria exceeded in > 25 percent of measurements.
Assessment guidelines for primary and secondary contact recreation use	
Fully supporting	For any one pollutant or stressor, criteria exceeded in ≤ 10 percent of measurements or observations.
Partially supporting	For any one pollutant, criteria exceeded in 11 to 25 percent of measurements or observations.
Not supporting	For any one pollutant, criteria exceeded in > 25 percent of measurements or observations.
Assessment guidelines for water quality data for drinking water use	
Fully supporting	No contaminants where the median concentration exceeds the state water quality standard. No restrictions (i.e., no source water closures or advisories, no waters requiring more than conventional treatment to enable drinking water use)
Fully supporting but threatened	No contaminants where the median concentration exceeds the state water quality standards. Increased monitoring imposed on public water supplies supplied by the waterbody (due to previous detections of contaminants that triggered an increased monitoring frequency) or potential for water quality degradation by contaminants that are known to be used or present in the watershed or basin.
Partially supporting	No contaminants where the median concentration exceeds the state water quality standards. One or more drinking water source advisories lasting greater than 30 days per year or public water supplies supplied by the waterbody require more than conventional treatment due to contaminants concentrations in source water that may adversely affect treatment costs or the quality of finished water (e.g., due to taste, odor, turbidity, dissolved solids, etc.).
Not supporting	One or more contaminants where the median concentration exceeds the state water quality standards. One or more contamination-based closures of a drinking water source.
Assessment guidelines for cases where there are fewer than 20 data points (all uses)	
Not supporting	For constituents where there are <20 and ≥ 3 samples, more than 40% of the values exceed the standard.

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R0033787

State of California
Environmental Protection Agency
Memorandum

To: Board Members

Date: March 28, 1996

File: 100.606

From: Robert P. Ghirelli, Executive Officer
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD-LOS ANGELES REGION
101 Centre Plaza Drive, Monterey Park, CA 91754-2156
Telephone: (213) 266-7500

Re: Revised 303(d) List

As directed, Regional Board staff have resolved outstanding issues related to the 303(d) list presented to Board Members during the Board meeting on February 26, 1996. Specifically, staff have discussed water quality issues in Arroyo Simi and Arroyo Las Posas with staff from the City of Simi Valley. As a result of these meetings, Regional Board staff have made the following revisions to the 303(d) list: (a) deleted nitrate plus nitrite as pollutants that impair ground water recharge in Arroyo Las Posas, and (b) deleted ammonia, toxicity, algae, and temperature as pollutants that impair beneficial uses in Arroyo Simi.

Both Arroyo Las Posas and Arroyo Simi remain on the revised 303(d). Aquatic life in Arroyo Simi is listed as impaired, based upon data indicating bioaccumulation of metals in fish tissue. Aquatic life in Arroyo Las Posas is listed as impaired, based upon the presence of pesticides in sediments and ammonia in the water column. Also, staff at the City of Simi Valley are no longer requesting de-designation of ground water underlying Arroyo Las Posas, which is designated as MUN in our Basin Plan.

In addition, the Casitas Municipal Water District recently contacted us with additional information about Lake Casitas. As a result, Regional Board staff have removed Lake Casitas from the 303(d) list. The apparent impairment due to dissolved oxygen was determined to be an anomaly. The Casitas Municipal Water District has installed aeration systems to maintain high levels of dissolved oxygen in the lake.

Regional Board Staff have made minor clarifications to the list of evidence for impaired waterbodies.

Regional Board staff will be forwarding data to the State Board for California's 305(b) Water Quality Assessment Report and 303(d) List. This will be the last region-wide water quality assessment that is prepared in the format specified by the US EPA and State Board. Future assessments will be wrapped into the watershed process.

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R0033789

303(d) List: Inland Watersheds

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assumthat contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
McGrath Lake (estuary)	403.11	Aquatic life	Sed(DDT, chlordane, total pesticides), SED TOX	Nonpoint source
Ventura River Estuary	402.10	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(DDT), EUT Trash, Algae Trash, Algae TIS(DDT)	Nonpoint source and point source
Ventura River (estuary to Weldon Cyn)	402.10	Aquatic life Recreation: contact Recreation: non-contact	TIS(Cu, Se, Ag, Zn) Algae Algae	Nonpoint source and point source
Ventura River (Weldon Cyn to Camino Cielo)	402.10 402.20	Aquatic life	Water diversion and pumping	Nonpoint source
Matilija Creek and reservoir	402.20	Aquatic life	Fish barrier	Nonpoint source
Santa Clara River Estuary	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River (W Pier Hwy 99 to Bouquet Cyn Rd Bridge)	403.51	Aquatic life Recreation: contact	AMM Coliform	Nonpoint source and point source
Mugu Lagoon	403.11	Aquatic life Fish consumption*	Cu, Hg, Ni, Zn, bird reproductivity (DDT), TIS (Chlordane, DDT, endosulfan, dacthal, toxaphene, PCBs, As, Cd, Ag), Nitrogen, Sed(DDT, toxaphene), SED TOX, excessive sediment TIS(DDT, PCBs, toxaphene)	Nonpoint source and point source
Rio de Santa Clara (tributary to Mugu Lagoon)	403.11	Aquatic life Fish consumption	SED TOX, TIS(chlordane, toxaphene, DDT, ChemA, PCBs), Nitrogen TIS(chlordane, toxaphene, DDT, ChemA, PCBs)	Nonpoint sources
Tributary from duck ponds to Mugu Lagoon	403.11	Aquatic life Fish consumption	TOX, SED TOX, Sed(DDT), TIS(Chlordane, toxaphene, DDT, ChemA), Nitrogen TIS(Chlordane, toxaphene, DDT, ChemA)	Nonpoint source
Calleguas Creek (Estuary to Arroyo Los Posas)	403.11 403.12	Drinking water/GWR Aquatic life Fish consumption	N+N AMM, TOX, Sed (DDT, toxaphene), TIS (PCBs, DDT, toxaphene, ChemA, chlordane, dacthal, endosulfan), Nitrogen, SED TOX TIS (DDT, toxaphene, ChemA, chlordane)	Nonpoint source and point source
Revolon Slough and Beardsley Channel/Wash	403.11 403.61	Drinking water/GWR Aquatic life Recreation: contact Recreation: non-contact Fish consumption	N+N Se, TOX, Sed (toxaphene, chlordane, DDT, endosulfan, dacthal), TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, chlorpyrifos, hexochlorobenzene, PCBs, dacthal), Nitrogen Algae, Trash Algae, Trash TIS (endosulfan, chlordane, toxaphene, DDT, ChemA, dieldrin, PCBs)	Nonpoint source
Conejo Creek /Arroyo Conejo (confluence Calleguas to above Lynn Rd)	403.12 403.63 403.64 403.68	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	DO, AMM, TOX, TIS(endosulfan, toxaphene, DDT, ChemA, dacthal, Ag, Cd, Cr, Ni), Sed(toxaphene) Algae Algae TIS(endosulfan, toxaphene, DDT, ChemA)	Nonpoint source and point source
Conejo Creek/Arroyo Conejo North Fork	403.64	Aquatic life Fish consumption	AMM, TIS(chlordane, DDT) TIS(chlordane, DDT)	Nonpoint source and point source

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Arroyo Las Posas	403.62	Aquatic life	AMM, Sed(DDT)	Nonpoint source and point source
Arroyo Simi (~Moorpark Fwy (23) to Bras Cyn)	403.62	Aquatic life	TIS(Cr, Ni, Ag, Zn, Se)	Nonpoint source and point source
Malibu Lagoon	404.21	Aquatic life Recreation: contact Fish consumption Shellfish Harvesting	Benthic community, TIS (As, Cr, Ni, Se, Pb, Ag), EUT Coliform, Enteric viruses, swimming restriction TIS(As, Se, Pb) Advisory	Nonpoint source and point source
Malibu Creek: lagoon to Malibu Lake	404.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	Fish barrier, TIS (As, Cr, Ni, Cd, Se, Ag, Pb, Cu) Trash, Algae, Coliform, Scum Trash, Algae, Scum TIS (As, Cr, Ni, Se)	Nonpoint source and point source
Las Virgenes Creek	404.22	Aquatic life Recreation: contact* Recreation: non-contact	Se, DO Coliform, Scum, Algae, Trash Scum, Trash, Algae	Nonpoint source
Stokes Creek	404.22	Recreation: contact	Coliform	Nonpoint source
Medea Creek	404.24 404.23	Aquatic life Recreation: contact* Recreation: non-contact	Se Coliform, Algae, Trash Coliform, Algae, Trash	Nonpoint source
Lindero Creek	404.23	Aquatic life Recreation: contact Recreation: non-contact	Se Coliform, Trash, Algae, Scum Coliform, Trash, Algae, Scum	Nonpoint source
Palo Comado	404.23	Recreation: contact Recreation: non-contact	Coliform Coliform	Nonpoint source
Triunfo Cyn Creek	404.24 404.25	Aquatic life	Hg, Pb	Nonpoint source
Topanga Canyon Creek	404.11	Aquatic life	Pb	Nonpoint source
Santa Monica Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	Pb Coliform Coliform	Nonpoint source
Pico Kenter Drain	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, TOX, PAHs Coliform, Enteric viruses, Trash Coliform, Trash	Nonpoint source
Ashland Avenue Drain	405.13	Aquatic life Recreation: contact*	DO, TOX Coliform	Nonpoint source
Ballona Creek Estuary	405.13	Aquatic life Recreation: contact Shellfish harvesting	SED TOX, Sed(Pb, Zn, DDT, aroclor, PCBs, PAHs, chlordane), TIS(chlordane, PCBs) Coliform Advisory	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Ballona Creek	405.13	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	Pb, SED TOX, TOX, TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA, Cr, Cu, Pb, Ag, Zn), Sed(Cd, TBT, Cu, Pb, Ag) Coliform, Trash, enteric viruses Coliform, Trash TIS(As, chlordane, DDT, dieldrin, PCBs, ChemA)	Nonpoint source and point source
Ballona Wetland	405.13	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	TIS(As, Pb, Cr), Habitat alteration, Exotic vegetation, Reduced tidal flushing, Hydromodification Trash Trash TIS(As)	Nonpoint source
Sepulveda Channel/Canyon	405.13	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source
Dominguez Channel (includes estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact Fish consumption*	AMM, Cu, Pb, Sed(Cr, Zn, DDT, PAHs), TIS(aldrin, chlordane, DDT, dieldrin, PCBs, ChemA, Pb) Benthic community impairment Coliform Coliform TIS(chlordane, DDT, dieldrin, PCBs)	Nonpoint source and point source
Wilmington Drain	405.12	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb Coliform Coliform	Nonpoint source
Torrance Carson Channel	405.12	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb Coliform Coliform	Nonpoint source
Colorado Lagoon	405.12	Aquatic life Fish consumption	Sed(Pb, Zn, chlordane, PAHs), TIS(chlordane, DDT, dieldrin, PCBs, Ag, Pb, Cu, ChemA), SED TOX TIS(chlordane, DDT, dieldrin, PCBs)	Nonpoint source
Los Cerritos Channel	405.12	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, Zn Coliform Coliform	Nonpoint source
Los Angeles River Reach 1 (upstream Carson St to Estuary)	405.12	Aquatic life Recreation: contact* Recreation: non-contact	pH, AMM, Pb Coliform, Trash, Scum, Algae Coliform, Trash, Scum, Algae	Nonpoint source and point source
Los Angeles River Reach 2 (Figueroa St to upstream Carson St)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, Odors, Oil Coliform, Trash, Scum, Algae, Odors, Oil	Nonpoint source and point source
Compton Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	Cu, Pb, pH Coliform Coliform	Nonpoint source and point source
Rio Hondo Reach 1 (Santa Ana Fwy to Los Angeles River)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu, Pb, Zn, pH Coliform, Trash Coliform, Trash	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Rio Hondo Reach 2 (from Whittier Narrows Flood Control Basin to Spreading Grounds)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM Coliform Coliform	Nonpoint source and point source
Monrovia Canyon Creek	405.33	Aquatic life	Pb	Nonpoint source
Arroyo Seco Reach 1 (downstream Devils Gate Dam)	405.15	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Trash, Algae	Nonpoint source
Los Angeles River Reach 3 (Riverside Drive to Figueroa St)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM Trash, Algae, Odors, Scum Trash, Algae, Odors, Scum	Nonpoint source and point source
Verdugo Wash	405.21	Recreation: contact* Recreation: non-contact	Coliform, Trash, Algae Coliform, Trash, Algae	Nonpoint source
Los Angeles River Reach 4 (Sepulveda Dam to Riverside Dr)	405.21	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb Coliform, Trash, Scum, Algae, Odors Coliform, Trash, Scum, Algae, Odors	Nonpoint source and point source
Burbank Western Channel	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cd Trash, Scum, Algae, Odors Trash, Scum, Algae, Odors	Nonpoint source and point source
Tujunga Wash (downstream Hansen Dam to Los Angeles River)	405.21	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Cu Coliform, Trash, Scum, Odors Trash, Scum, Odors	Nonpoint source
Los Angeles River Reach 5 (within Sepulveda Basin)	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, TIS(Ag, chloropyrifos, ChemA) Trash, Scum, Algae, Odors, Oil Trash, Scum, Algae, Odors, Oil TIS(ChemA)	Nonpoint source and point source
Los Angeles River Reach 6 (upstream of Sepulveda Flood Control Basin)	405.21	Drinking water/GWR Recreation: contact Recreation: non-contact	1, 1-DCE, PCE, TCE Coliform Coliform	Nonpoint source
Alleo Canyon Wash	405.21	Aquatic life	Se	Nonpoint source
Bell Creek	405.21	Recreation: contact* Recreation: non-contact	Coliform Coliform	Nonpoint source and point source
San Gabriel River Estuary	405.15	Aquatic life Fish consumption	TOX, TIS(As, Cu, Ag, Cr), HIST TIS(As)	Nonpoint source and point source
Coyote Creek	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST, CHL, TIS(Cr, Cu, Ag) Coliform, Algae, Coliform, Algae,	Nonpoint source and point source
San Gabriel River Reach 1 (Estuary to Firestone)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX, HIST Coliform, Algae Coliform, Algae	Nonpoint source and point source

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Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
San Gabriel River Reach 2 (Firestone to Whittier Narrows Dam)	405.15	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb Coliform Coliform	Nonpoint source and point source
San Gabriel River Reach 3 (Whittier Narrows to Ramona)	405.41	Aquatic life	TOX	Nonpoint source and point source
San Jose Creek	405.41	Aquatic life Recreation: contact* Recreation: non-contact	AMM, Pb, TOX Coliform, Algae Coliform, Algae	Nonpoint source and point source
Walnut Creek	405.41	Aquatic life	pH, TOX	Nonpoint source and point source
San Gabriel River East Fork	405.43	Recreation: contact Recreation: non-contact	Trash Trash	Nonpoint source

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303(d) List: Coastal Features and Bays

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assumethat contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Ventura Harbor: Ventura Keys at Arrundell Barrance	403.11	Recreation: contact	Coliform	Nonpoint source
Santa Clara River Estuary Beach/Surfers Knoll	403.11	Recreation: contact	Coliform	Nonpoint source
McGrath Beach	403.11	Recreation: contact	Coliform, beach closures	Nonpoint source
Mandalay Beach	403.11	Recreation: contact	Beach closures	Nonpoint source
Channel Islands Harbor	403.11	Aquatic life	Sed (Pb, Zn)	Nonpoint source
Port Hueneme Harbor	403.11	Aquatic life	Sed (PAHs), TIS(DDT, PCBs, TBT, Zn)	Nonpoint source
SANTA MONICA BAY NEARSHORE ZONE AND OFFSHORE ZONE: Hyperion 5 mile and 7 mile outfall area Joint Water Pollution Control Plant outfall area Palos Verdes shelf Marina del Rey area Santa Monica Pier area Manhattan Beach area Redondo Pier area Malibu Pier area Short Bank Point Dume area Malibu area Point Vicente area Palos Verdes-NW Whites Point	various	Aquatic life Fish Consumption	SED TOX, TIS(Ag, DDT, Cr, Pb, PCBs), Sed(Cd, Cu, Pb, Hg, Ni, Zn, DDT, PCBs, chlordane, PAHs), debris Advisories (DDT, PCBs)	Nonpoint source and point source
Santa Monica Bay/Southern LA County beaches: Ventura County Line to Long Beach City Line	various	Recreation: contact Fish consumption	All beaches are impaired due to periodically high coliform counts and/or beach closures. Many areas are impaired due to fish consumption advisories.	Nonpoint Source
Marina del Rey Harbor	405.13	Aquatic life Recreation: contact Fish consumption Shellfish Harvesting	TIS (chlordane, DDT, PCBs, TBT, Zn, Cu, Pb, ChemA, dieldrin), Sed (Zn, Cu, Pb, chlordane, DDT), SED TOX, Benthic community effects Coliform Advisory Advisory (DDT, PCBs)	Nonpoint source
San Pedro Bay nearshore and offshore zone: Cabrillo Pier area	405.12	Aquatic life Fish consumption	TIS (DDT), SED, TOX, Sed (PAHs, DDT, Zn, Cu, Cr) Advisory (DDT, PCBs)	Nonpoint source and point source
Los Angeles Harbor: particularly Main Channel, Fish Harbor, Cabrillo Pier, and breakwater	405.12	Aquatic life Recreation: contact Fish Consumption	TIS (DDT, PCB, Zn, Cu, PAHs), Sed (DDT, PCBs, Cu, Zn, PAHs, TBT), SED TOX Beach closures Advisory (DDT, PCBs)	Nonpoint source and point source

Reach/location	Hydro Unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Los Angeles Harbor: Consolidated Slip	405.12	Aquatic life Fish Consumption	TIS(DDT, chlordane, PCBs, TBT, Zn), SED TOX, Benthic community effects, Sed (PAHs, Zn, Cr, Pb, DDT, chlordane, PCBs) Advisory (DDT, PCBs)	Nonpoint source
Los Angeles Harbor: Southwest Slip	405.12	Aquatic life Fish Consumption	SED TOX Advisory (DDT, PCBs)	Nonpoint source
Long Beach Harbor , particularly Main Channel, Southeast Basin, West Basin, Pier J, and breakwater	405.12	Aquatic life Fish Consumption	TIS (DDT, PCBs), Benthic community effects, Sed (PAHs), SED TOX Advisory (DDT, PCBs)	Nonpoint source

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303(d) List: Lakes

Note: Data are limited and not all constituents were sampled for each waterbody. Therefore, it is not correct to assumthat contaminants not cited below are not causing water quality problems. Abbreviations are explained on the last page.

Waterbody	Hydro unit	Beneficial Use Categories Impaired	Pollutants causing Impairment	Known or Potential Sources
Lake Hughes	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT, Fish kills Trash, Odors, Algae Trash, Odors, Algae	Nonpoint source
Munz Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	EUT Trash Trash	Nonpoint source
Elizabeth Lake	403.51	Aquatic life Recreation: contact Recreation: non-contact	pH, EUT, DO pH, Trash Trash	Nonpoint source
Malibou Lake	404.24	Aquatic life Recreation: contact Recreation: non-contact	DO, EUT, TIS (PCBs, chlordane, Cd, Cu, Zn) Algae Algae	Nonpoint source
Lake Lindero	404.23	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	CHL, SC, Se, EUT, TIS (Se, oxadiazon) Odors, Trash, Algae Odors, Trash, Algae TIS(Se)	Nonpoint source
Westlake Lake	404.25	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, Cu, Pb, EUT, TIS(chlordane, Cd, Cu, Zn) Algae Algae TIS(chlordane)	Nonpoint source
Lake Sherwood	404.26	Aquatic life Recreation: contact Recreation: non-contact Fish consumption	AMM, DO, EUT, TIS (Hg) Algae Algae TIS (Hg)	Nonpoint source
Machado Lake (Harbor Lake)	405.12	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, EUT, TIS (chlordane, ChemA, DDT, dieldrin, PCBs) Odors, Trash, Algae Odors, Trash, Algae Advisory (DDT, chlordane), TIS (chlordane, ChemA, DDT, dieldrin, PCBs)	Nonpoint source
Calabasas Lake	405.21	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, TIS (DDT, Cu, Zn, Cd), EUT, DO, pH Odors Odors TIS (DDT)	Nonpoint source
Echo Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	AMM, Cu, Pb, EUT, TIS (PCBs), pH Odors, Trash, Algae Odors, Trash, Algae TIS (PCBs)	Nonpoint source
Lincoln Park Lake	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Pb, EUT, DO Odors, Trash Odors, Trash	Nonpoint source

Waterbody	Hydro unit	Beneficial Use Categories Impaired	Pollutants causing impairment	Known or Potential Sources
Peck Rd Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact Fish Consumption	DO, Pb, TIS (DDT, chlordane) Odors, Trash Odors, Trash TIS (DDT, chlordane)	Nonpoint source
El Dorado Lakes	405.15	Aquatic life Recreation: contact Recreation: non-contact	AMM, Cu, Pb, EUT, TIS (Hg, Cr), pH Algae Algae	Nonpoint source
Legg Lake	405.41	Aquatic life Recreation: contact Recreation: non-contact	Cu, Pb, AMM, pH Odors, Trash Odors, Trash	Nonpoint source
Puddingstone Reservoir	405.52	Aquatic life Fish Consumption	DO, TIS (PCBs, chlordane, DDT, dieldrin, endosulfan, Hg, As) TIS (PCBs, DDT, chlordane, Hg)	Nonpoint source
Santa Fe Dam Park Lake	405.41	Aquatic life	Pb, Cu, pH	Nonpoint source
Crystal Lake	405.43	Aquatic life	DO	Nonpoint source

ABBREVIATIONS AND FOOTNOTES

* Although people sometimes swim, bathe, drink, fish, and otherwise use these waterbodies, access is restricted. Please refer to the Basin Plan (1994) for footnotes which identify specific restrictions.

GWR — Groundwater recharge use
AMM — Ammonia-N
N+N — Nitrate-N + Nitrite-N
Temp — Temperature of effluent is greater than 5° above ambient temperature in waterbody.
DO — Dissolved oxygen (depleted levels)

Coliform — Coliform bacteria: fecal coliform for inland surface waterbodies; total and fecal coliform for beaches.

TRASH — Significant trash and debris observed
Odors — Significant odors observed
Algae — Significant algal growth observed
OIL — Oily film observed on surface of water
Scum — Nonnatural foams, floaters, scum material or other floating material observed.
Turb — Turbidity
EUT — Eutrophic
PAHs — Polycyclic aromatic hydrocarbons

Sed(x) — Level of constituent in sediment is elevated.
HIST — Abnormal fish histology observed.
TIS(x) — Fish or mussel data from State Mussel Watch and State Toxic Substances Monitoring programs. The constituent in parenthesis exceeds the standard(s).
TOX — Tests or studies of chronic or acute toxicity of species (water column).
SED TOX — Tests or studies of chronic or acute toxicity of species (sediment).

ChemA — Toxic Substances Monitoring Program combination of pesticides: Aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, HCH (including lindane), endosulfan, and toxaphene.

Metals — Ag (Silver), Ba (Barium), Cd (Cadmium), Cr (Chromium), CrVI (Chromium VI), Cu (Copper), Pb (Lead), Se (Selenium), TNT (tributyl tin), Zn (Zinc), and Hg (Mercury).

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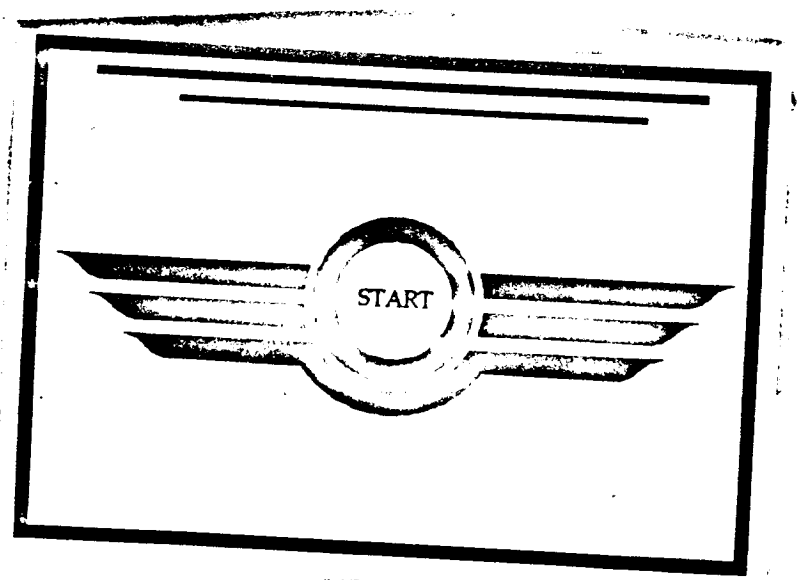

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THE LINDSAY MUSEUM PRESENTS

Changing the Course of California's Water

The Impact of Polluted Runoff on our Aquatic Resources and Responsible Actions We Can Take

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Twenty-five years after the garbage-filled Cuyahoga River spontaneously caught on fire, the waters of the United States have improved dramatically. But we still have a long way to go. Forty percent of our rivers, lakes and streams are still not suitable for fishing, swimming or drinking. The pollution that streams off city streets, suburban lawns, factory sites, and farms is the biggest remaining contributor to water pollution. The past 25 years have taught us a simple, but important, lesson: preventing pollution is far more efficient, both economically and ecologically, than cleaning it up.

Carol M. Browner
Administrator, U.S. EPA

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The Lindsay Museum has been charged by the U.S. Environmental Protection Agency to bring the issue of polluted runoff to the forefront of California's attention. This document defines the critical nature of the issue, refining current scientific research into a clear, understandable format. We found that the general public is strikingly unaware of this crisis facing our natural resources, and therefore unaware of the responsibility each of us shares in its creation. Informing people about polluted runoff is critical to changing the course of California's water.

Claudia Cohen

CLAUDIA COHEN, EXECUTIVE DIRECTOR

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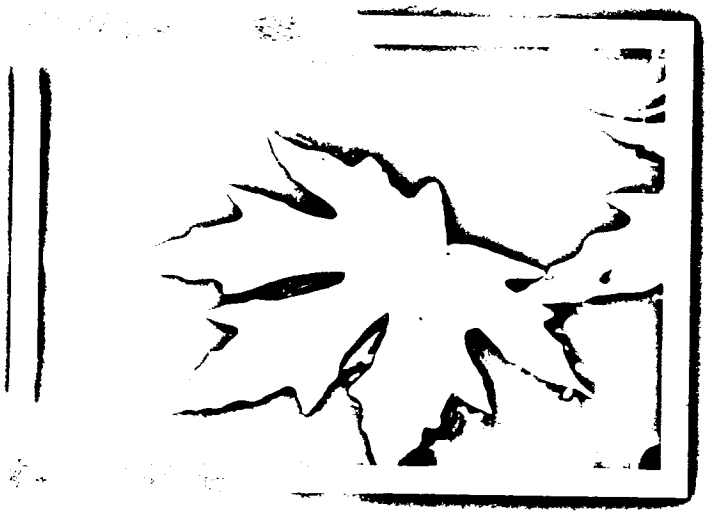

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AUTHOR: JIM MAYER • EDITOR: JENNIFER KAISER

For this report, we relied on a number of sources for information, advice and review. Jim Mayer has been an environmental writer for eight years, and covered California water issues at *The Sacramento Bee*. Our review panel was composed of leading experts in the field, whose work serves as national models:

- Gail Boyd, national practice leader at Woodward-Clyde Consultants, has been engaged in applied research in stormwater quality management since 1969. He has managed several national projects, including the Nationwide Urban Runoff Program. Gail coordinates a team of scientists and engineers who are the nation's primary consultants to municipalities on stormwater quality controls.
- Geoff Brosseau, executive director of the Bay Area Stormwater Management Agencies Association and an environmental consultant, assists municipalities with environmental protection, writes, teaches about stormwater pollution and is a principal author of the California Stormwater Best Management Practice Handbooks.
- Chuck Ellis is the public information director of the City of Los Angeles' Stormwater Management Division and created LA's public information and school outreach campaign on stormwater issues.
- Dr. Tom Mumley, urban runoff program coordinator at the San Francisco Bay Regional Water Quality Control Board, has been instrumental in building the regional board's focus on management of stormwater issues. Tom's program is highly regarded for its concentration on state, county, city and public partnerships.
- Dr. Michael Stenstrom is professor and chair of the Civil & Environmental Engineering Department at UCLA and is responsible for much of the original research that formed the massive Santa Monica Bay Restoration Plan.

We are grateful for the support and advice of many people around the state, especially the public information subcommittees of the State Stormwater Task Force and the Bay Area Stormwater Management Agencies Association and Sharon Gosselin of the Alameda County Urban Runoff Clean Water Program. Illustrator Larry Duke donated his exceptional wildlife illustrations and Jim Hatch provided his original automobile graphic. Photography was generously donated by a number of people whose names are credited at their work. Jill Richards, Susan Reynolds and her staff, and the staff at The Lindsay Museum have provided support and encouragement throughout the project.

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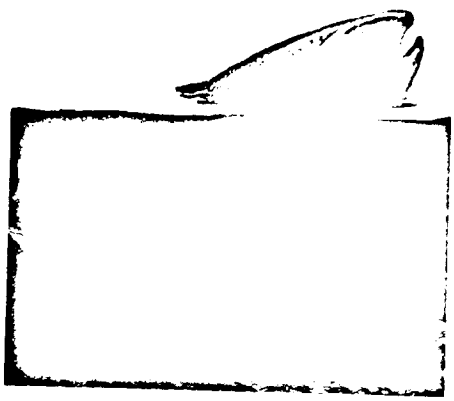
INTRODUCTION



After a generation of fighting water pollution, Californians are haunted with the truth that many of their streams, lakes and bays are still unsafe to swim in. Fish and wildlife are being poisoned. The purity of water and food supplies is still threatened.

It is a troubled fate for the glistening waters that once helped to lure people and enterprise to California.

Visitors to southern beaches are warned to not swim near storm drain outfalls and to not swim at all for three days after storms. In a region where tourism is a $7 billion business, fears about the pollution pulsing out of storm drains keep more than 20 million people a year away from world-famous beaches.[1]

Health warnings urge people to limit the fish they eat—and in some cases pregnant women and children are urged not to eat fish at all. These aren't fish pulled from industrial backwaters. The warnings apply to certain fish in stretches of the Sacramento and San Joaquin rivers, San Francisco and Santa Monica bays.[2]

And that's the fish that are left. In the Central Valley, where a multimillion-dollar sport and commercial fishing industry is declining, storm after storm washes garden and household pesticides into streams at concentrations high enough to kill the food supply for fish.[3]

Throughout urban California, creeks that once were small natural wonderlands have become health hazards, engineered channels that run like open sewers with no treatment plants.

To keep tap water safe for Californians to drink, nearly $1 billion a year may have to be spent on cutting-edge technology as a response to agricultural and urban polluted runoff.[4]

The culprits are not foaming industrial outfalls or smelly sewage plants—against those polluters real progress has been made. The pollutants of greatest concern are those that with each storm washes off city streets and front lawns, harvested forests and farms.

Currently, fifty to eighty percent of all water quality problems in the state are the result of polluted runoff. And urban California is second only to the vast agricultural areas as the source of this pollution.[5]

Currently, fifty to eighty percent of all water quality problems in the state are the result of polluted runoff.

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Because all runoff cannot be captured like sewage, and few communities can afford elaborate treatment works, the best prospect for cleaner water is to prevent runoff from becoming polluted in the first place.

ECONOMICS OF HARM

Nature offers few better examples of tenacity than the Chinook salmon, its passion for life displayed in that second it leaps up a waterfall in search of ancestral spawning grounds.

But in California, the salmon are in rapid decline—along with the $70 million per year commercial salmon catch—due to drought, habitat loss, water diversions and pollution. No one is sure how to split the blame, and it doesn't much matter to the fish or the fishermen.

The fear is that the salmon will go the way of San Francisco's oyster and crab fishery. A few of the creatures remain, but the industry is extinct.

The link between a healthy environment and a healthy economy is both obvious and hard to quantify. Tourism is one of California's growth industries, and economists expect an increase in visitors to help the state make up for the economic loss of closed military bases and a shrinking aerospace industry. Tourism already generates $52 billion a year in California, accounting for 750,000 jobs.

In Southern California, the sportfishing fleet is a $500 million a year business, and an integral part of the region's second biggest industry, tourism. The fleet trades not only on the Pacific Ocean's fecundity, but the public's faith that the fish are safe to eat.

Northern California ports do an equally brisk business, and inland, the U.S. Fish & Wildlife Service estimates that duck hunters spend $127 million a year.

Statewide, 140 million visitor days are logged at beaches, but there is evidence people are staying away because of water quality concerns.

The economics of water quality should include the billions of dollars that the California Urban Water Agencies estimate will be spent in the near future on more advanced treatment systems to counter persistent pollution problems.

The troubling realities of polluted runoff have often been overlooked in a public debate preoccupied with more visible environmental worries. But a closer look reveals that disasters can be delivered one molecule of pollution at a time:

- Polluted runoff from urban California shares blame for the broad decline in fish and wildlife, including once lucrative and now impoverished commercial fisheries.[4]
- Many of the state's most unhealthful beaches are next to outfalls from urban storm drains, and primary health concerns are the bacteria and viruses in runoff.[5]
- Despite heroic progress against water pollution, one in three streams, lakes and bays are still not safe for swimming and fishing, mostly because of polluted runoff.[6]
- For the first time in 20 years, Californians will witness an overall decline in water quality because of continued urban development, unless polluted runoff is controlled.[7]
- Despite mountains of regulations, wetlands—the natural systems that slow down urban runoff and capture pollutants—continue to be lost.[8]

Fortunately for California, the problems are matched by opportunities. Because all runoff cannot be captured like sewage, and few communities can afford elaborate treatment works, the best prospect for cleaner water is to prevent runoff from becoming polluted in the first place.

Effective prevention requires a combination of technical solutions and public action. It requires holding all polluters in a watershed responsible, allying cities and rural communities, rethinking how neighborhoods are designed and reviving community creeks and marshes.

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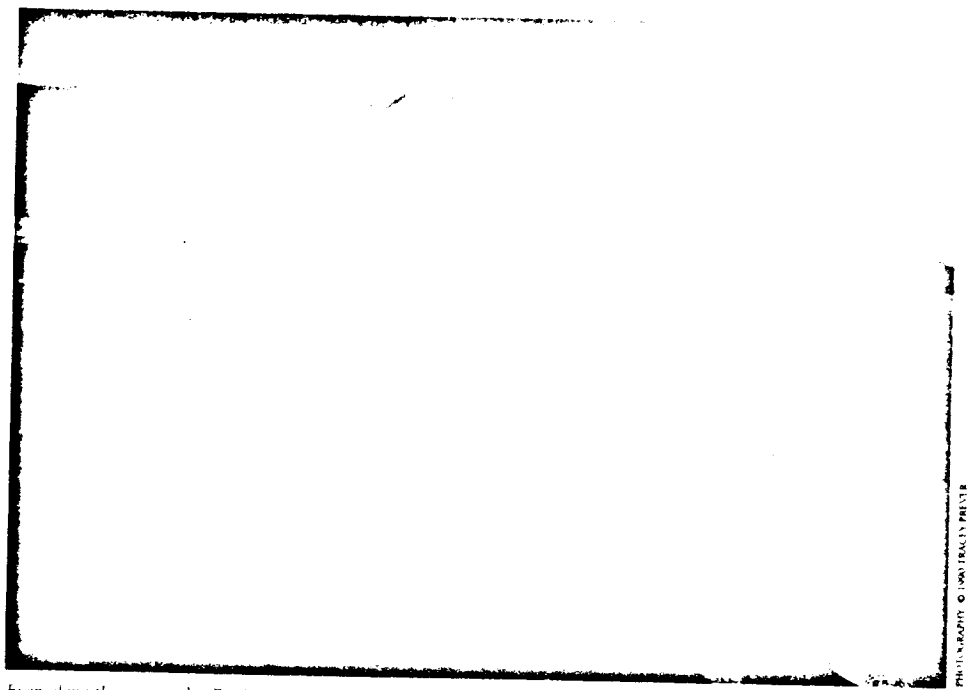

Even along the spectacular Big Sur coast, unseen toxics from automobiles fall from the roadway into the Pacific.

Polluted runoff won't be controlled until individuals realize how their everyday routines degrade or restore the natural systems that benefit all. Everyone—not just scientists—must understand where pollution comes from, how it moves through the environment, and the consequences for fish and wildlife, human health and the economy. Not only can everyone do something to curb polluted runoff, but individual action and public support is essential.

This paper was crafted for writers, reporters and storytellers of all kinds: to give them enough information to confidently ask questions, to stir curiosity and to inspire stories. These are not stories about rain forests that most Californians will never see, or about choosing between jobs and a single endangered species.

Few stories are closer to home than how we poison the rain that runs down the gutter. In no ecosystem are we more invested than our own. And if 20 years ago Americans would not condone industries that poison fish and contaminate beaches, then the question is: Why should we grant immunity to ourselves for doing the same?

Everyone—not just scientists—must understand where pollution comes from, how it moves through the environment, and the consequences for fish and wildlife, human health and the economy.

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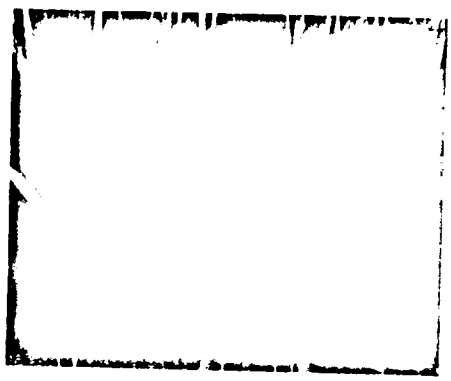
THE SEARCH FOR CLEAN WATER



A few years ago, community leaders throughout California were dismayed to discover that most people did not know that many storm drains flow directly to creeks, lakes and bays. Thanks to an army of recruited stencilers, Californians are now getting the message.

Likewise scientists over the last few years have been surprised when their studies revealed that in almost all cases urban runoff is toxic to insects and fish, and in some cases to humans.

Surprise, mystery and the occasional horror define the story of how water becomes contaminated from that moment it condenses in a cloud until it finally reaches the sea.

Water is the universal solvent, and when it falls as rain, the impact literally scours off contaminants that lie on rooftops, gardens and sidewalks—from cigarettes to pet waste to slug poison.

A generation ago, a nation embarrassed by burning rivers and rotting lakes set out to fight water pollution. At the time, lawmakers ordered controls on the obvious sources, the industrial and sewage outfalls that on some days literally burned the eyes and noses of tourists gazing across San Francisco Bay at the Golden Gate.

Only after billions of dollars were spent to capture and treat those initially-targeted sources did scientists and lawmakers fully realize how much pollution came from average Americans doing everyday things.

By fertilizing lawns and spraying for ants, by driving cars that leak oil, people are polluting streams and bays. Construction sites and road cuts, it turns out, are a major source of water pollution. And nature's filters continue to be eliminated as creeks are lined with concrete and marshes are drained.

Scientists are still documenting the cumulative consequences of this diffuse pollution, and are still looking for the best ways to reduce the damage. Such work is challenging, because polluted runoff is different from region to region, even storm to storm. Runoff can contain hundreds of contaminants, each with different characteristics and impacts. And some of them react with each other to create new pollutants.

Many people believe the nation must redouble

Water is the universal solvent, and when it falls as rain, the impact literally scours off contaminants that lie on rooftops, gardens and sidewalks—from cigarettes to pet waste to slug poison.

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its efforts against polluted runoff. Among them is US EPA Administrator Carol Browner, who in 1993 told the Water Education Foundation:

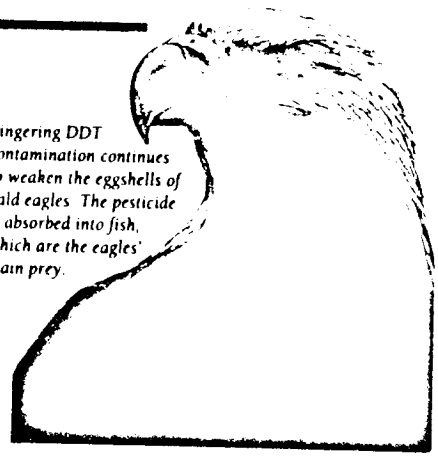
> *"The scientific data are clear: Without better control of polluted runoff, we will fail to meet the goals of the Clean Water Act. Changing the law is essential to controlling polluted runoff. And controlling polluted runoff is essential to protecting America's waters."*

The generation of research behind those conclusions have documented how everyday activities degrade water quality. Among the lessons learned

MOST POLLUTANTS END UP AS WATER POLLUTION. Air pollutants get rinsed from the sky, or settle to earth and are washed into streams. Pesticides, fertilizers, and waste dumped in landfills seep into groundwater and streams.

ALL URBAN RUNOFF IS CONTAMINATED. While the worst contamination must be resolved first, even low level pollutants can cause harm.

LAND USES AND HUMAN ACTIVITIES DEFINE THE POLLUTION. Some of the worst pollution comes from innocent-looking features: highways, parking lots, the greenest lawn in the neighborhood.



Lingering DDT contamination continues to weaken the eggshells of bald eagles. The pesticide is absorbed into fish, which are the eagles' main prey.

POLLUTED RUNOFF CREATES LONG-TERM PROBLEMS. Mining debris in the late 1800s choked rivers and ruined farmland for decades, and the scars still persist, seen and unseen. Mercury used to refine gold still poisons Northern California fish. DDT that nearly pushed the bald eagle and the peregrine falcon into near extinction can still be found in wildlife.

These lessons have forced policy makers to rethink solutions. Traditionally, pollution was treated with technology paid for by large businesses and government. But cleaning up urban runoff will require changing individual behavior and restoring the natural systems that regulate and filter runoff. Many believe water quality cannot be solved without a comprehensive strategy involving all the polluters in a watershed—from the mansions in Beverly Hills to the drivers on our freeways and the coastal refineries.

This paper looks at the laws that govern polluted runoff from urbanized areas, describes the nature of runoff and how pollutants work in the environment. It then discusses what can be done, and concludes with a regional breakdown of sources, facts and issues to keep an eye on.

BLACK-CROWNED NIGHT HERON

Black-crowned night herons typically lay three to five bluish-green eggs in nests made of cane and sticks. But San Francisco Bay researchers have observed a significant number of crushed egg shells that never matured, as well as deformed embryos—evidence that contamination is diminishing reproductivity of the heron. The suspected pollutant is DDT, the pesticide that made Americans fear silent springs. Long-since banned, DDT is still commonly detected in fish and wildlife throughout the state.

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THE GLASS IS HALF DIRTY

The Clean Water Act of 1972 set lofty goals. The first was to address the largest and most obvious sources of pollution. The second goal was to restore and maintain water quality.

The task has been challenging, requiring detailed research and complex regulations. But for all the complexity, Congress also provided an ultimate goal rich for its simplicity: Clean is when the water is safe to swim in and supports fish that can be eaten without fear.

When the Clean Water Act was passed, two-thirds of the nation's rivers didn't pass the "swimmable, fishable" test. In the years since, nearly $80 billion have been spent to treat the worst pollution from industries and sewage plants. The investment has paid dividends. In 1994, the US EPA said two-thirds of the rivers were safe for fishing and swimming.

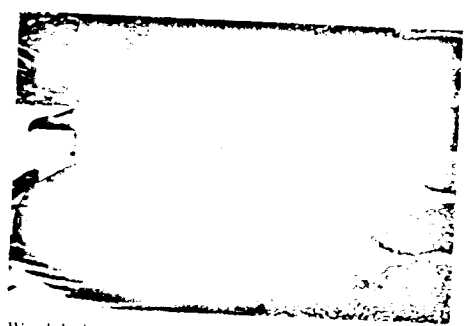
But progress has slowed, and in rapidly urbanizing areas, polluted runoff threatens to erode a generation of success.

In 1987, Congress expanded the pollution fight to include urban runoff. It required states to assess the harm that runoff was causing to streams, lakes and bays. Monitoring programs found that runoff from urban and rural areas is responsible for 45 percent of the pollution in estuaries, 65 percent of river pollution, and 76 percent of lake pollution.

The 1987 amendments also required communities to develop plans to reduce polluted runoff to "the maximum extent practicable." That meant using Best Management Practices (BMPs), doing everything possible within the limits of technology and financial resources.

And the 1987 amendments required the US EPA to formally regulate polluted runoff just as it regulates sewage treatment plants—with permits under the National Pollutant Discharge Elimination System (NPDES). The law initially regulated communities with more than 100,000 people. Most large urban areas in California applied for permits early, under rules giving them more flexibility and more time to comply.

At least two other laws govern polluted runoff from cities. The Coastal Zone Management Act reauthorization in 1990 required coastal states to



Wood ducks forage in water for aquatic plants and insects when acorns, their preferred food, are not in season. Toxics from polluted runoff are absorbed into the birds through their food.

In 1972 Congress provided an ultimate goal rich in its simplicity: Clean is when the water is safe to swim in and supports fish that can be eaten without fear.

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Runoff from urban and rural areas is responsible for 45 percent of the pollution in estuaries, 65 percent of river pollution and 76 percent of lake pollution.

develop "enforceable policies and mechanisms" to control polluted runoff in shoreline communities."

And under California's Porter-Cologne Water Quality Act, polluters can be required to do whatever is necessary to keep water clean. The law, however, also requires economic considerations to be balanced with environmental goals."

The State Water Resources Control Board, and its nine regional water quality control boards, have relied upon the federal laws to target the largest sources of polluted runoff. The state law, however, is being used in a finely targeted way, such as in the the Sierra Nevada where property owners are required to reduce polluted runoff into Lake Tahoe.

The Clean Water Act, meanwhile, is due for reauthorization by Congress. Proposals offered in the previous Congress all sought to fortify the Act's provisions for dealing with polluted runoff. As of April 1995, no changes have been approved, but Congress is strongly considering reducing or eliminating requirements of the Clean Water Act, and repealing polluted runoff regulations of the Coastal Zone Management Act. A vote on the bill may come as early as May 1995.

HOW RUNOFF BECOMES POLLUTION

Modern society has changed runoff in two significant ways: by physically altering the landscape and by covering it with pollutants.

Changes in the physical landscape change the nature of runoff. Paved surfaces and rooftops make 40 to 80 percent of an urban area impervious. Streams rise quicker and flow faster. To accommodate the additional runoff—and to foster the development of lowlands—creeks are channelized and levees built. Marshes that store and filter runoff are diked and drained. As a result, less of the runoff soaks into the ground, the natural filtering systems are eliminated, and the water runs off even faster.

The second consequence of urban development is the addition of hundreds of contaminants that can be easily washed into stormdrains. The cityscape is coated with pollution. Fertilizers and pesticides, automobile soot and oil drippings, even leaves and pollen, when dropped onto streets and walks, contaminate runoff.

How the land is used—for residential neighborhoods or industrial centers, crops or grazing—

1970

Porter-Cologne Water Quality Act requires polluters in California to do whatever is necessary to keep water clean, balancing economic considerations with environmental goals.

1972

Clean Water Act established, initial focus on reducing polluted effluent from industrial and sewage treatment facilities. Two-thirds of nation's rivers not safe for fishing or swimming.

1983

Deadline for goal of Clean Water Act that all of the nation's waterways are safe for fishing and swimming (not met).

1985

Clean Water Act goal that all polluted discharges are eliminated (not met).

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tends to define the pollutants that will end up in the adjacent waterway.

Agriculture, partly because so much of the landscape is dedicated to it, is the largest source of polluted runoff nationally and in California. The Mississippi River has yielded classic evidence. During the 1993 flood, U.S. Geological Survey scientists estimated that in a single month 193 tons of atrazine, a common cornfield herbicide, washed into the Gulf of Mexico. But even in the more typical year of 1991, 176 tons of atrazine flowed into the Gulf, and for several weeks atrazine levels in the river exceeded drinking water standards. California's agricultural watersheds have similar problems.

Some pollutants are the legacy of historic land uses. In California, more than 100 large abandoned mines leak acidic runoff laden with heavy metals into streams and lakes. Iron Mountain Mine on the banks of the Sacramento River, before cleanup began under the Superfund law, was the largest discharger to any impaired waterway in the nation.

But cities, both traditional downtowns and new suburbs, are the fastest growing source of polluted runoff—not surprising, given the half million new Californians arriving every year. And many watersheds are now predominantly urban, making cities and suburbs the primary source of polluted runoff.

HOME IS WHERE THE POLLUTION IS

Tracking down polluted runoff has led scientists to some unsuspected sources: tree-lined streets and quiet cul-de-sacs.

Single family residential areas, in many California cities, are responsible for the largest percentage of polluted runoff.

In retrospect, that conclusion shouldn't be surprising, given that residential neighborhoods comprise such a large part of most cities. The data, however, prove how everyone is part of the problem of polluted runoff.

In the Santa Monica Bay watershed, for instance, 26 percent of the land is comprised of single-family homes. Those neighborhoods are the largest contributors of nitrogen and phosphorous pollution, copper and zinc.

Multi-family housing areas are the second largest contributor of overall pollution to the Santa Monica Bay, and are the largest contributor of oil and grease.

Tests in Alameda County revealed a similar pattern, with two-thirds of the metals in polluted runoff coming from residential areas.

These data also help officials devise effective control strategies: Treating runoff from some industrial sites may make sense, but the best solution in multi-family housing areas is to prevent pollution by providing collection depots and dedicated car washing areas that drain to treated sewers. For single-family neighborhoods, storm drain stenciling and street sweeping may be the best way to keep pollutants out of the bay.

1987

Clean Water Act amendments shift focus to polluted runoff, requiring states to assess harm and reduce toxic discharges as much as possible. NPDES permits established.

1988

Coastal Zone Management Act reauthorized. Coastal states must develop policies to control polluted runoff in shoreline communities.

1994

One-third of nation's rivers still not safe for fishing or swimming.

1995

Congress considering reducing or eliminating requirements of Clean Water Act and repealing runoff regulations of Coastal Zone Management Act.

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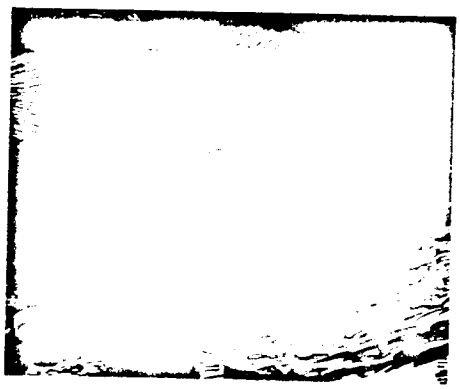
URBAN SOURCES

The watershed is your rooftop, your lawn and your sidewalk...



Runoff is a pollution cop's nightmare. Offenders are everywhere and often disguised. Pollutants can chemically conspire to make themselves more harmful, or fall from sight only to reappear later. This is why it is important to understand how pollutants work in the environment, and why prevention is the control strategy of choice.

To understand this problem, Californians need look no farther than their own automobiles.

People are used to blaming tailpipe emissions for smog, but few people know that their cars pollute water as well.

Polynuclear aromatic hydrocarbons (PAHs) are a series of chemicals that come from the combustion of fuels and end up in waterways. In low levels, PAHs are toxic to fish and wildlife. Higher doses are potentially cancerous to wildlife and humans.

Heavy metals can cause a variety of health problems in both humans and wildlife. With every stroke of every piston, and every push on the brakes, metals are ground off automobiles—settling in road dust, hitchhiking in fugitive oil.

Brake linings contain copper. Catalytic converters emit zinc. Tire dust—the 25 million tons of rubber that wear off American tires every week—contains zinc. Federal Highway Administration studies show concentrations of heavy metals were two to four times higher in highway runoff than in general urban runoff.

Supertankers crash and pipelines break, but urban runoff is the largest source of oil and grease pollution. Officials estimate that 50 million gallons of oil disappear from automobiles in California each year—burned in exhaust, dripped on the roadway or dumped by mechanics—nearly twice as much oil spilled by the Exxon Valdez.

The nature of this pollution helps to explain why new solutions are needed for old problems. A panel of experts who studied urban runoff in 1994 for the State Water Resources Control Board concluded that pollution control strategies should include efforts to design new neighborhoods to encourage walking, bicycling and other alternatives to the automobile. When considering transportation options, the panel said, the water quality benefits of electric vehicles should be considered.

The automobile, of course, isn't the only water polluter on the urban scene. A surprising

A surprising source is individual gardens—the more natural part of the cityscape. Gardeners use up to 10 times more toxic chemicals per acre than farmers. The typical gardener uses 5 to 10 pounds of chemicals on their lawn each year.

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source is individual gardens—the more natural part of the cityscape. Gardeners use up to 10 times more toxic chemicals per acre than farmers. The typical gardener uses 5 to 10 pounds of chemicals on their lawn each year. Some scientists believe contaminated worms are contributing to the die-off of songbirds.

Even before residents move into a neighborhood, the pollution begins when earth movers scrape away vegetation and make the soil vulnerable to erosion. Construction sites are a major source of sediment, which impairs water quality and carries other pollutants.[2]

Some cities, especially older ones, have traced considerable pollution to sanitary sewers illegally hooked up to storm drains, malfunctioning septic systems and leaking sewer lines.

Midnight dumpers of spent solvents, lubricants, paint and other wastes into stormdrains are another problem that technology and regulations alone can't fix—but a watchful public, rigorous monitoring and vigorous enforcement can.

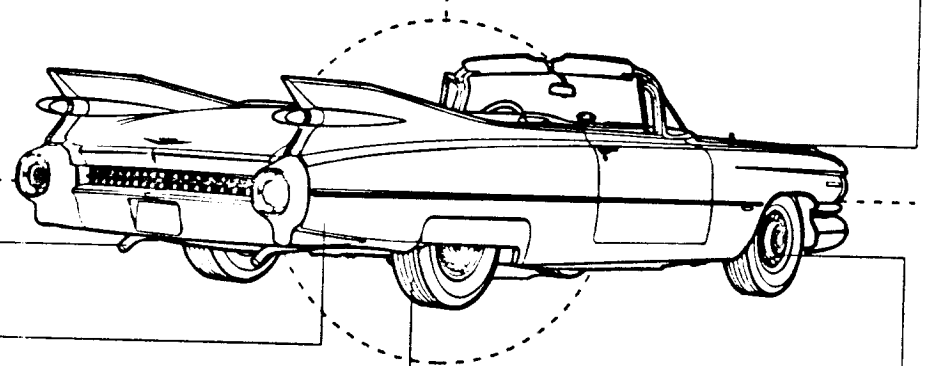
To continue refining solutions, research must continue. To gather more evidence linking specific environmental damage to specific pollutants. To determine which control methods are doing the most to prevent runoff from getting polluted. To find still cheaper ways of keeping water clean.

Tailpipe:

Lead has been taken out of gasoline, and waterways are significantly less loaded with lead due to this emission reduction. Nitrous oxides and zinc are still emitted through catalytic converters. Once in the air, rain carries these pollutants from clouds into water.

Engine:

Grease, antifreeze, coolant and other fluids contain tiny metal particles and other toxics that leak from engines onto roadways. Rain washes these pollutants into creeks and bays.



Body

Ferrous oxide and other metals from rust and flaking paint washed to ocean

Tires:

Rubber, steel and zinc are worn off tires, then washed off roads into waterways.

Brake Pads:

Brake pads were made of asbestos until concerns regarding airborne particles and disposal in factories prompted industry-wide change. Brake pads now contain copper, lead and zinc, metals that are released onto roadways in the fine black dust of eroded pads and washed into the ocean.

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POLLUTION IN THE ENVIRONMENT

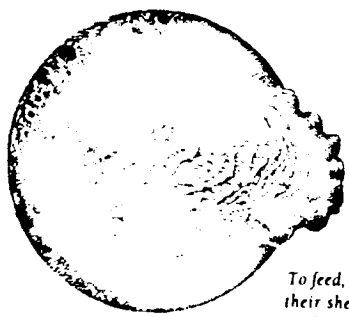
Combating polluted runoff requires scientists, policy makers and the general public to know the enemy. They are a fascinating lot. In some forms and concentrations, most are useful, some are even necessary for life. When reshaped and cast aside, they can become poisons.

HEAVY METALS

Most of the time, metals aren't considered pollution. They are natural minerals, manipulated for centuries for many beneficial purposes. In minute quantities, many heavy metals are essential to human health. But modern technology has made metals prevalent in forms easily absorbed by plants and animals, where they can accumulate to toxic concentrations.

National studies have identified metals as the most frequently detected pollutant in runoff, often exceeding standards set to protect fish and wildlife. Lead and zinc have been found in 94 percent of water samples, copper 91 percent, chromium 58 percent, and arsenic 52 percent.[21] Studies of South San Francisco Bay have found more metals in urban runoff than in treated wastewater.[22]

Metals are contained in vehicle exhaust and leaked oil, paints and wood preservatives. Flushed into streams, they bind to sediments such as sand and silt, and settle out, where they are consumed by snails and worms grazing on organic matter. Metals can also dissolve or oxidize, making them easily consumed by clams and oysters as they filter plankton and other microorganisms out of the water. The metals are passed up the food chain when bigger animals eat smaller ones—and can eventually make it onto the dinner table.



To feed, oysters open their shells and trap tiny particles on sticky gills. Food and pollutants are collected simultaneously and stored within the oyster's cells to be consumed on up the food chain.

Despite reduced metal discharges, researchers say metals persist in sediments, as well as mussels and other bottom-dwellers in San Francisco Bay.[23] In low doses, metals induce diseases and reduce reproductivity. In higher concentrations, heavy metals cause cancer, nerve disorders, and birth defects in humans.

NUTRIENTS

Nutrients are another example of good things in the wrong places causing big trouble. The most common nutrients are nitrogen and phosphorous. Natural sources include sediment and plant debris. Fertilizers are by design nutrient-rich, while some industrial waste and treated sewage also are loaded with nutrients.

Nutrients dissolve in water or attach to

Metals are passed up the food chain when bigger animals eat smaller ones—and can eventually make it onto the dinner table.

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Researchers were surprised to find diazinon in the rain falling in Sacramento, Stockton and Davis. The pesticide was sprayed on nearby orchards shortly before storms.

DON'T FEED THE ALGAE

It's bad for business. Clear Lake has never been clear, but it was never this mucky either. That muck is costing tourist-related businesses at the lake northeast of San Francisco more than $7 million a year.

Clear Lake is thought to be the oldest lake in North America, and its naturally shallow bottom makes it vulnerable to algal blooms that can cover the surface and foul the air.

But University of California researchers believe the algae problems have been greatly aggravated by decades of destructive land use patterns upstream, which has sent waves of naturally-occurring nutrients into the lake.

Nitrogen and phosphorous feed the algae, which then dies and rots, chasing off lake-lovers by the thousands.

Researchers also believe the most cost-effective way of keeping the nutrients out of the lake would be to restore the streambanks and wetlands above the lake—reducing erosion and the algae's food supply.

sediments. In water, nutrients perform as they do on land—they encourage growth. Pulses of nutrients can cause rampant algal blooms, such as those that have plagued Newport Bay and Clear Lake. The algae can compete with fish and other aquatic forms for oxygen.

Nutrients and organic matter also decay in water, consuming water and stressing the entire ecosystem. In Stockton, scientists with the Central Valley Regional Water Quality Control Board have linked fish kills to pulses of polluted runoff.*

SEDIMENT

Erosion is as old as rain. But erosion has been greatly increased by modern land uses. Sediment washes off from tilled fields, construction sites, roadwork and hillsides stripped bare by wild fires and timber cuts.

While farms and harvested forests are big sources of sediment, 10 to 20 times as much sediment can erode off a construction site of equal size. The erosion from a parcel can increase 35 to 40 times when the land is disturbed by construction.**

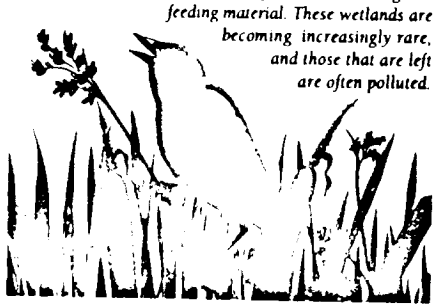
Sediment clogs streams and covers salmon spawning grounds. Sediment can literally choke fish by clogging gills. Sediment reduces sunlight needed by tiny aquatic plants, decreasing the food supply for animals. Sediment also harbors other pollutants, including metals, pesticides and nutrients.

PESTICIDES

Just as pesticides are designed for a variety of uses, they move through the environment in a variety of ways.

Some pesticides quickly decompose or evaporate, depending on the temperature and availability of oxygen. Other pesticides dissolve in the water and are consumed by plants and animals. Still other pesticides bind to sediment and settle to the bottom. Persistent pesticides can accumulate in the tissues and organs of fish and other animals.

Red-winged blackbirds must breed in freshwater marshes that provide sedges, cattails and reeds needed for shelter, nesting and feeding material. These wetlands are becoming increasingly rare, and those that are left are often polluted.



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DIAZINON

Diazinon does its job well. Thousands of Californians confidently use more than 400,000 pounds a year of the insecticide around their homes to get rid of ants and other insects—especially when rains drive pests from their usual places.

But diazinon is just as effective in killing off tiny animals that are the first essential links in the food chain.

Scientists with the Central Valley Regional Water Quality Control Board have detected diazinon in urban creeks around Sacramento and Stockton at levels lethal to daphnia flies and minnows, two species used to gauge environmental damage.

Researcher Val Connor was surprised that the concentrations didn't decline after the first rains—and were persistently lethal well into the wet winter of 1994-1995. The same tests detected other toxics, so far unidentified, at concentrations lethal to aquatic insects in three of eight Sacramento creeks that were tested.

But researchers were even more surprised to find diazinon in the rain falling in Sacramento, Stockton and Davis. Researchers say the pesticide was sprayed on nearby orchards shortly before storms, and is a likely explanation for the insecticide-laced rain falling on nearby neighborhoods.

Diazinon has also been detected in several creeks draining urbanized Bay Area watersheds, including Adobe, Barron, Matadero, and San Francisquito Creeks in Santa Clara County, and Strawberry, Cordinices and Sausal Creeks in Alameda County.

Pesticides are occasionally found in concentrations lethal to the small plants and animals that form the basis of the food chain. Pesticides also have been detected at "sub-lethal" concentrations that can cause disease, cancer and reproductive failure in fish and humans.

Some fish in rivers and bays accumulate enough persistent pesticides to trigger health warnings, such as the DDT that has contaminated white croaker fish in Santa Monica Bay.

OIL & GREASE

Oil and grease demonstrate well the paradox of polluted runoff. Oil and grease wash off virtually every street. But concentrations are higher from parking lots, busy intersections and some industrial sites, revealing the need to understand sources when devising solutions.

Oil and grease can also be the most visible sign of pollution in runoff. But while the oil sheen casts rainbows in the gutter, hydrocarbons also bind to sediment and accumulate in tiny animals.

The dangers of massive spills are obvious, though scientists are less sure about the consequences to wildlife from long-term exposures to small doses of oil. PAHs are toxic to fish at low concentrations, and have triggered cancers in laboratory animals. Hydrocarbons have been linked to tumors and parasites in striped bass.

SOAPS & DETERGENTS

Soaps and detergents, even those that are biodegradable, are toxic to fish at extremely low concentrations. Washing cars in home driveways, scouring parking lots and gas stations, washing skyscrapers and rinsing plazas—all these activities dump large quantities of dirty water into storm drain systems. The problem is two-fold: the detergents are toxic, and are designed to scour away oil, metals, dirt and other pollutants.

California Department of Fish & Game tests

Tests show the effects of common consumer products on trout. Soaps and detergents have been found to be extremely toxic to trout in laboratory experiments in very low solutions, well below the concentrations of actual use.

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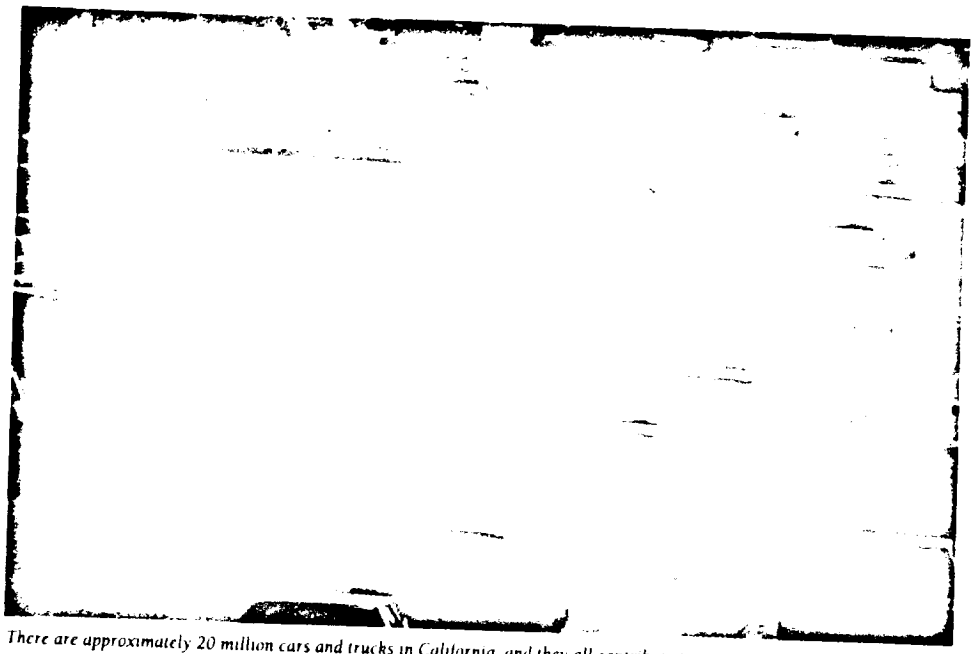

There are approximately 20 million cars and trucks in California, and they all contribute toxics to our waterways.

show the effects of common consumer products on trout. Soaps and detergents have been found to be extremely toxic to trout in laboratory experiments in very low solutions, well below the concentrations of actual use.[31]

PATHOGENS

Bacteria contained in animal and human waste are commonly detected in very high concentrations in storm runoff. These and other pathogens are thought to pose a health threat at certain beaches, especially after storms.[32]

Bacteria and viruses get into streams from poorly maintained septic systems, broken sewer lines, ill-kept stables and pet wastes. They are easily washed downstream.

Urban runoff often threatens recreational uses; bacteria and viruses give swimmers sore throats, rashes and nausea.

Los Angeles County beaches were closed five times in 1992 because of polluted runoff. And publicity about bacteria is largely behind the drop in visitors to Southern California beaches in recent years—from a high of 79 million a year to 48 million.[33] In San Francisco Bay, bacteria has contaminated shellfish to the point that human consumption is discouraged.[34]

There is a significant need to establish clearer cause-and-effect relationships and identify more accurate pathogen indicators.

THE HIDDEN STORM OF 1995

Salinas and Monterey farmers lost an estimated $20 million worth of crops in March when water poisoned by toxics and bacteria flooded the fields. Some of the toxics were unable to be identified: mysterious drums of hazardous materials were found broken and floating around Monterey Bay.[35]

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WHAT CAN BE DONE?

Polluted runoff will only be resolved in communities committed to solving the problem: Figuring out the unique characteristics of their pollution. Plotting the best combination of tactics. Learning from their mistakes.

Common sense and economics dictate that the first steps be preventative—a combination of public education and responsible action, physical devices, enforcement and restoration.

The most effective strategies rely on individual and institutional actions. Individuals must make cleaner choices in how they maintain their homes. Institutions must do better planning and maintenance. Flood-control projects can be designed to reduce erosion and filter runoff. Highways, parks and golf courses can be maintained cheaper and cleaner with fewer chemicals. To make sure the investment is paying off, communities must monitor and evaluate programs to make sure they are doing the right things right.

For decades, the public has required industry to reduce pollution. Now, individuals and communities must make the same commitment to clean water.

PUBLIC AWARENESS

Stenciling storm drains is only the first lesson in public education. Other connections must be made so people can make responsible decisions: How to properly use garden, automotive and other household chemicals, and how to properly dispose of leftovers. How to maintain automobiles, prevent erosion, compost yard waste and pick up after animals.

Some of the most successful education is, naturally enough, occurring in classrooms—where polluted runoff is being taught as part of the same environmental curriculum that teaches about neighborhood streams and wildlife habitat, reducing waste and recycling.

Successful awareness efforts also encourage neighbors to invest time in community-wide improvements: Teaching neighbors who didn't get the message. Reporting illegal dumpers. Taking part in restoration projects. Persuading community officials and business owners that fighting pollution is worth the trouble.

COMMUNITY HOUSEKEEPING

Leftover chemicals have to go somewhere, so communities that don't want them in landfills or creeks must provide convenient and safe disposal sites. Some communities are aggressively sweeping streets to keep toxic road dust out of storm drains. Some communities are cleaning out storm drains, catch basins, and other places where pollutants linger on the path to streams and bays.

STRUCTURAL

Some source controls are structural, such as sand filters that are being installed on parking lot storm drains and grassy swales that serve to slow down, filter and percolate runoff into the ground. More communities are requiring retention basins in areas of redevelopment and new construction. Communities that have been looking at new neighborhood designs—to reduce traffic and air pollution—now see design as a way to improve water quality as well.

TECHNICAL IMPROVEMENTS

A decade ago, asbestos was taken out of vehicle brake linings. Lead is now being taken out of gaso-

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Common sense and economics dictate that the first steps be preventative—a combination of public education and responsible action, physical devices, enforcement and restoration.

line, and heavy metals are being phased out of paint. These and similar efforts reduce the amount of dangerous pollutants literally broadcast throughout California's communities.

Can new, less-toxic formulae do the same for antifreeze, pesticides, cleansers and other consumer chemicals? Can brake linings be made without copper? Will California's electric car mandate reduce water pollution as well as air pollution?

ENFORCEMENT

Prevention requires enforcing anti-littering laws and anti-dumping laws. It requires vigilant monitoring to detect new sources of pollution, particularly illicit ones.

Requiring businesses to take preventive measures must be followed up with inspections. Illegal sewer hookups to storm drains need to be found and dismantled. Potential sources of illicit dumping need to be monitored. Pollution fines can be used to fund awareness campaigns for the public and industry.

RESTORATION

Replanting streamsides can reduce erosion, and the sediments and nutrients that wash into streams. Recreated marshes and vegetated channels can filter sediments and the pollutants they carry.

Restoration can also improve wildlife habitat, increase recreational aesthetics, and create a sense of ownership on the part of neighbors. State officials believe restoring stream banks should be a priority in many strategies to curb polluted runoff.

TREATMENT

Some sources of pollutants are are discrete enough to make treatment possible. Others are serious enough to warrant treatment despite the costs.

For instance, horse stables can be required to capture their runoff to keep bacteria from entering storm drains. But to make beaches safe and restore public confidence, the worst storm drains may have to be outfitted with ozone treatment systems.

While it is impractical to send all runoff to the sewage treatment plant, research may ultimately show that treating the most polluted runoff may be the best way to keep streams clean.

PHOTOGRAPH: ALAMEDA CO. URBAN RUNOFF CLEAN WATER PROGRAM

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Nature may provide treatment as well. In Fremont, where Crandall Creek flows into San Francisco Bay, researchers at the Demonstration Urban Stormwater Treatment (DUST) Marsh have documented the ability of marshes to filter metals and other pollutants before runoff reaches the bay. They also have discovered that vegetated channels upstream of the marsh were equally effective in slowing the water and trapping the sediment that carried copper and zinc downstream.

But the questions remain: Is it safe to allow the pollutants to accumulate, will they increase to dangerous levels, and will they make their way into fish and wildlife living in the marsh?

These uncertainties have lead researchers to an additional conclusion: That it would be better to keep the pollutants from getting into the water in the first place.

THE WATERSHED FIX

The complexity of polluted runoff defies the pollution strategies of the last 20 years—where each polluter was required by law to reduce polluted discharges to a certain degree.

Some communities have realized that their success relies on the success of communities upstream.

LOGO: CITY OF LOS ANGELES AND HEAL THE BAY

FIRST FLUSHES

The air always smells great after the first rain of the season. Tree leaves look greener and sidewalks are clean. But it is only because the dirt and grime went somewhere else.

Researchers in the West, where rain is seasonal and sporadic, have found that the first rains after a long dry spell can produce runoff especially loaded with pollutants. They call it the "first flush."

This evidence can help communities devise the best strategies for keeping streams clean. Street sweeping and storm drain cleaning, for instance, may be most important just before the first rains of autumn.

But studying first flushes have also taught researchers just how complicated polluted runoff can get.

For instance, the pollutant load in runoff is not only higher during the first storm of the year, but during the first part of every storm. And while many pollutants are washed away during the first minutes of a storm, some pollutants, such as oil, are slowly scoured off streets and provide a steady source of pollution.

That evidence supports the case for prevention—working to make sure the oil and water don't mix in the first place.

When it comes to polluted runoff, local isn't a city or county, it is the watershed.

Communities can pool resources to resolve the worst problems in their watershed first, no matter where they are. They can share public education efforts, monitoring and research duties to make sure the programs are cost-effective, and to guide refinements to their strategy.

The watershed approach should not be an excuse for blaming pollution on someone else. But sorting out how everyone's pollution hurts everyone else is a necessary step to efficiently cleaning up streams and bays to everyone's benefit.

The complexity of polluted runoff defies the pollution strategies of the last 20 years—where each polluter was required by law to reduce polluted discharges to a certain degree.

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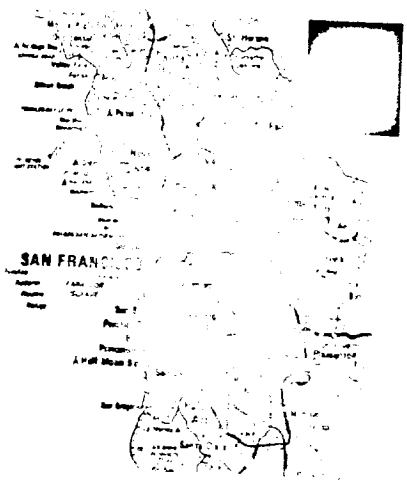
THE REGIONS

Five out of six Californians live in four of the largest urban watersheds: The San Francisco Bay Area, the Central Valley, the greater Los Angeles and San Diego areas. By the year 2020, when the state's population is expected to close in on 50 million, six out of seven Californians will live in these four regions.

The challenge is to clean up runoff even as cities grow. Already, local governments, non-profit groups and universities are working to better understand the problem and craft solutions that reduce the sources of pollution and restore streams. The following section provides some examples of these current efforts. A few contacts are mentioned here, a more complete list can be found on the enclosed Contacts sheet.

San Francisco Bay



The Watershed

The San Francisco Bay basin drains 3,870 square miles. But runoff from local streams, combined with treated sewage, makes up only 10 percent of the water flowing into the Bay. The vast majority of the Bay's inflow comes from Central Valley rivers. So Bay Area residents have at least two watersheds to think about: The Bay Area basin and the larger Central Valley basin that drains 40 percent of California.

The City of San Francisco has constructed a $1.35 billion underground system to capture and store runoff so it can be treated. The elaborate system of tunnels and tanks ringing the city was needed because San Francisco has a single system for collecting both sewage and rain water. Before the system was built, storm runoff (or even condensation from a heavy fog) overwhelmed the sewage system, and the highly polluted overflow spilled into the Bay.

Pollutants and Problems

- 30 to 70 percent of the toxic loading in the San Francisco Bay comes from polluted urban runoff.
- Metal pollution is a concern, particularly in the South Bay. Copper, chromium and zinc are toxic to mussels, clams, fish and birds, although more research needs to be done to determine the long-term consequences of the contamination. Studies conducted in Alameda County show that much of the metal getting into the Bay—including 75 percent of the chromium and 64 percent of the zinc—comes from polluted runoff. About two-thirds of the metals in polluted runoff

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comes from residential areas. Studies in Santa Clara Valley documented similar trends.

- Fish in the Guadalupe River contain mercury levels exceeding federal health standards. Fish in Suisun Marsh have high levels of arsenic, copper, silver and zinc. The state has issued health warnings to limit consumption of striped bass from the Bay and Delta, Lake Berryessa, Clear Lake and Lake Herman.

Local Heroes

- Mandi Billinge, environmental education consultant, helps teachers around the Bay Area design action projects to stencil storm drains, and restore creeks and bay lands. (510) 486-8345
- Susan Evans, teacher at Springstown Junior High School in Vallejo, inspires her 150 students to participate in coastal cleanups, stencil projects, and promotes environmental education in national teacher magazines. (707) 556-8620
- Jeff Hicks, youth outreach coordinator at The Lindsay Museum, runs Watershed Watchers, a volunteer-based group that maintains a biological inventory of urban creeks in Contra Costa County. The group teaches local high school students how to collect scientifically-valid data and how to train elementary school students in these techniques. (510) 935-1978 x45
- Kathy Kramer, education director at the San Francisco Estuary Institute, trains teachers to lead children in environmental projects: how to sample water, identify creek life, stencil storm drains and feel pride in their neighborhoods. (510) 231-9539
- Trish Mulvey, a full time activist/volunteer for bay water quality, watershed protection and a self-described "troublemaker," is president of Save San Francisco Bay Association, vice president of Friends of the Estuary, co-founder of CLEAN South Bay, and on the board of Greenbelt Alliance. (415) 326-0252

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Research/Non-Profits

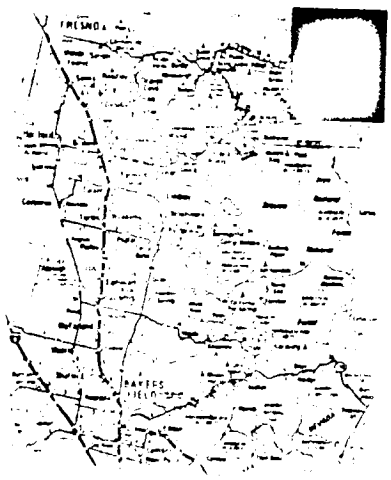
- Bay Area Stormwater Mgmt. Agencies Assn., Geoff Brosseau (510) 286-0615
- BayKeeper, Michael Lozeau, program director (800) KEEP BAY
- Save San Francisco Bay Association, Barry Nelson, director (510) 452-9261
- Urban Creeks Council, Ann Riley (510) 540-6669
- Woodward Clyde Consultants, Francesca Demgen (510) 874-1731

Keep Your Eye On

- BayKeeper et al lawsuit (filed October 1994) charging U.S. with washing toxics into the Bay from a storm drain at Hunters Point (800) KEEP BAY
- Development of a region-wide volunteer creek monitoring network as a pilot for a state-wide network. Gwen Starrett (916) 657-0518

PHOTOGRAPHY: ELY RINTELN

Central Valley/Sierra



The Watershed

The modern history of the Central Valley and Sierra is dominated by mining, agriculture, and efforts to put rivers to work in pursuit of those ventures. As a result, the region's water quality problems have been dominated by mercury, arsenic and other metals from mines, and sediment, pesticides and salts from farm fields. But the valley and foothills are now rapidly urbanizing. The challenge is to improve water quality in the face of increasing development which is expected to further pollute streams.

Increasingly, communities such as Sacramento and Fresno, that by law must clean up urban runoff, are pushing for watershed solutions to clean up the worst sources of pollution in the 44,000 square miles that drain into the Delta.

Problems and Pollutants

- Most valley cities are near rivers. As the pace of development increases, cities are looking for ways to control the increased runoff and

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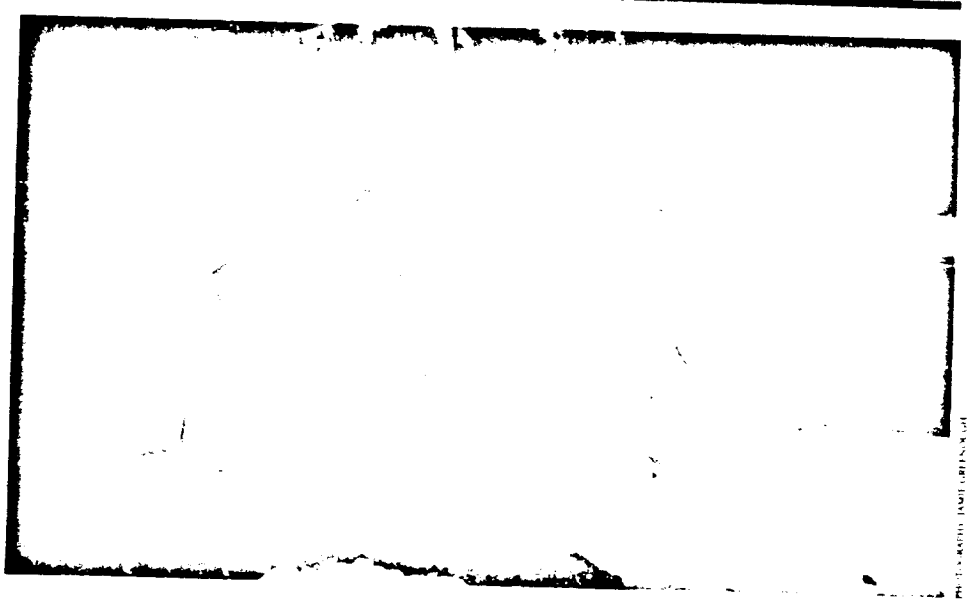
The valley and foothills are now rapidly urbanizing. The challenge is to improve water quality in the face of increasing development.

the pollutants they carry. Detention basins and constructed wetlands are being used to try to solve more than one problem at a time.

- Fish in the Feather River have exceeded the FDA warning level for PCBs and in the San Joaquin River for chlordane, DDT and toxaphene. Mercury levels have exceeded FDA warning levels in the American River, Feather River and Don Pedro Reservoirs.
- The Fresno Metropolitan Flood Control District operates a series of retention ponds that capture runoff and percolate it into the groundwater aquifer, the source of drinking water for much of the city. While the system is efficient with water, it also gives residents a reason to keep runoff clean. The district is constantly monitoring runoff and cleaning sediment out of basins to make sure pollutants don't get in the groundwater. But the success of those efforts rest in part on the diligence of residents to keep runoff clean.
- The largest source of pollution to Lake Tahoe is polluted runoff from urban uses around the alpine lake—principally nitrogen and phosphorous carried into the lake by eroding soils. The pollution has significantly reduced the water clarity at the world famous retreat. An ambitious program is being put into place that eventually calls for every private property owner to reduce the pollution flowing off their land.

Local Heroes

- Jane Steel, president of the Sacramento chapter of the Urban Creeks Council, has organized dozens of volunteers to clean debris from streams, plant native vegetation, work with



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homeowners in flood plains, and work with school teachers. Efforts are highlighted by Creek Week each April. (916) 482-8377

- Jamie Greenough, science mentor and forestry activist, uses the California science education framework to cross grade levels, teaching kids about their own watershed, Lake Tahoe, in a hands-on way. Kids learn their playground is their watershed by working with scientists in the field, collecting real data, and making a difference. They testify at public meetings, and have made a film. (916) 541-4923

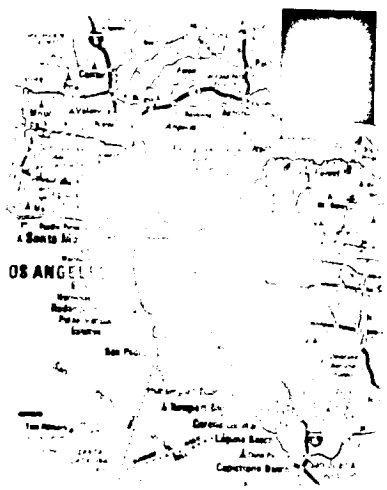
Research/Non-Profits

- Arcade Creek Parks and Recreation District (916) 482-8377
- Friends of the River, Sacramento (916) 442-3155
- League to Save Lake Tahoe, Rochelle Nason (916) 541-5388
- San Joaquin River Parkway & Conservation Trust, Fresno (209) 248-8480

Keep Your Eye On

- Regional Water Quality Control Board researchers are studying pesticides in urban runoff. In addition to diazinon, they are finding persistent high levels of the herbicide diuron, which is used to control weeds along roadways. The chemical has shown up in Sacramento creeks in levels in exceedence of the maximum levels established by the National Academy of Sciences for the protection of fish and wildlife.
- CalTrans is putting together plans to control runoff from the major highways that bisect the valley. There is more traffic on these roads, which reflects the increased development of the area.

Los Angeles/Orange County



The Watershed

Urban development has completely redefined runoff on the South Coast, accelerating flows into channelized streams that ultimately carry significant contaminants.

- 90 percent of the Los Angeles River is channelized. 60 percent of the San Gabriel River is channelized. 65 percent of the Santa Ana River is channelized.
- Many of the smaller creeks have been converted to culverts. The City of Los Angeles has 55,000 storm drains and 1,000 miles of pipes.
- Every day, 10 to 25 million gallons of water flow into Santa Monica Bay during the dry season. After a typical storm, the daily flow can rise to 10 billion gallons.

Pollutants and Problems

- In 1989, the Natural Resources Defense Council estimated that 8 inches of rain washes 150,000 pounds of lead and 500,000 pounds

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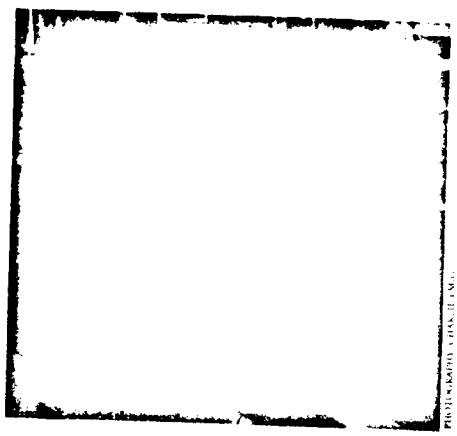
of zinc into Santa Monica Bay. Runoff accounts for one-fourth, and is the largest source of pollutants into the Bay.

- Runoff into Santa Monica Bay is considered to be among the dirtiest in the nation. Studies done for the restoration project showed that runoff in the Los Angeles area had higher concentrations of pollutants than in 90 percent of U.S. cities surveyed in the 1980s.
- Health warnings caution against eating fish from Harbor Park Lake because of high chlordane and DDT levels. Fish in the San Gabriel River contain elevated levels of copper, lead, nickel and silver. Because of DDT, PCBs and other contaminants, the list of recommended consumption limits for fish caught from coastal piers is long, especially near the Los Angeles and Long Beach harbors.

Local Heroes

- Terry Tamminen, Santa Monica BayKeeper. Terry was instrumental in providing documentations and photographs to NRDC for their successful 1994 suit, forcing CalTrans to live up to federal runoff guidelines. (310) 305-9645
- Matthew Shreeve is a Boy Scout who chose catch basin stenciling as his Eagle Scout public service project. He recruited several troops and stenciled all of Manhattan Beach in one month...on the weekends. (310) 546-6549
- Jim Danza is a board member of Friends of the Los Angeles River, and recently developed a comprehensive management plan for the river which includes first-ever provisions for river stormwater management. (310) 590-8070
- Peter Martinez, a volunteer with Los Angeles Conservation Corps, led an amazing crew of storm drain stencilers that stenciled the City of San Pedro in two weeks. Peter isn't quite sure how many drains he's stenciled, but his work extends throughout the San Fernando Valley and south central Los Angeles.



Research/Non-Profits

- American Oceans Campaign, Lisa Weil (310) 576-6162
- City of Los Angeles, stormwater division, Chuck Ellis (213) 847-5206
- Friends of the L.A. River, Martin Schlageter (213) 223-0585
- Heal the Bay, Mark Gold, executive director (310) 394-4552
- Los Angeles Conservation Corps, Bruce Saito (213) 730-4244
- Natural Resources Defense Council, Gail Fueur (213) 934-6900
- TreePeople, Andy Lipkis, president (818) 753-4600

Keep Your Eye On

- Los Angeles County is applying for a new runoff permit, and will have to take further actions to reduce pollution.
- CalTrans is required by court decisions to control pollution running off Los Angeles freeways, streets and maintenance yards.
- The Santa Monica Bay Restoration Plan will be implemented in coming years, yielding

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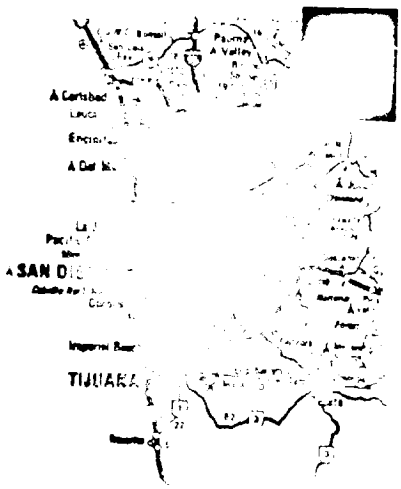
new research, control measures and better water quality.

- NRDC is suing the county of Los Angeles for failure to implement adequate monitoring controls and best management practices and is suing the Port of Long Beach and 55 of its tenants under an industrial stormwater permit, one of the first suits of this kind.

San Diego



The Watershed

The San Diego Bay and the north part of San Diego county are drained by a series of rivers that are short by California standards—the San Luis Rey, San Diego, Santa Margarita and Sweetwater rivers. In undeveloped areas, the rivers have been heavily mined for sand and gravel. In urbanized areas the streams have been channelized and are vulnerable to illegal dumping. But with significant portions of the rivers still having natural banks, there is a great potential for restoration.

Pollutants and Problems

- Erosion of exposed soil at construction sites has caused extensive damage in some portions of the watershed. The problem is aggravated by the region's steep topography and usually dry climate. Grass doesn't quickly grow back to protect soils from occasional cloud bursts.
- Fish in the San Diego River have exceeded the FDA action level for chlordane. Fish caught throughout the region have contained high concentrations of arsenic and cadmium.
- The region's climate—usually dry and temperate with sporadic heavy rains—has raised particular concerns about the consequences of "first flushes." Researchers are trying to determine just how much of the water quality problems associated with runoff occur in the first hours of the first storm of the season. The results could shape their efforts to control pollution.

Local Heroes

- Teacher Christine Calabria at Central School in National City teaches her students about their role in the watershed. She shows them how chemicals they use around their home can get into streams and what they can do differently to keep streams clean. (619) 477-4155
- Teacher Margaret Godshalk and her students at Kimball School in National City have adopted Paradise Creek, which runs near the school. They use the grounds of the school as a classroom and, like their classroom, they clean it up. (619) 477-1129
- Teacher Jose LaMont Jones at Gompers Secondary School in San Diego has created a science lab for students using Chollas Creek to learn about water quality and the plants and animals that can live in a healthy stream. (619) 263-2171 x242

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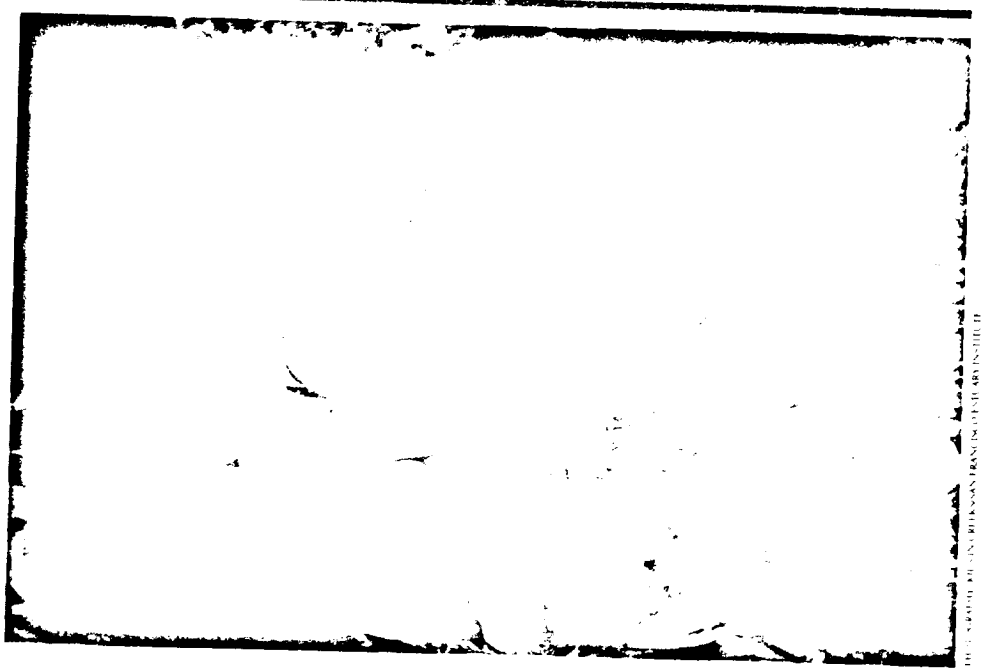
Fish in the San Diego River have exceeded the FDA action level for chlordane. Fish caught throughout the region have contained high concentrations of arsenic and cadmium.

Research/Non-Profits

- Environmental Health Coalition, Libby Lucas (619) 235-0281
- Kinnetic Laboratories, Liz Fletcher (619) 438-8968
- Brian Mooney, environmental consultant (619) 578-8964
- San Diego BayKeeper (619) 299-4484
- Surfrider Foundation (619) 792-9940
- Woodward-Clyde, Carol Forrest (619) 294-9400

Keep Your Eye On

- San Diego has a new BayKeeper, Ken Moser. His job is to reduce pollution by being a watchdog on the water, eyeing polluters, documenting the consequences of pollution, and working with businesses, neighborhoods and the military installations that front the bay.
- In the summer of 1995, San Diego County, 18 cities and the San Diego Unified Port District, which are all part of a single stormwater pollution permit, are expected to receive a new permit from the San Diego Regional Water Quality Control Board, outlining additional efforts that will have to be made to reduce pollution in runoff.
- The regional water board is planning to expand its runoff sampling in the near future, from San Diego Bay to Mission Bay and lagoons in the north county shoreline.



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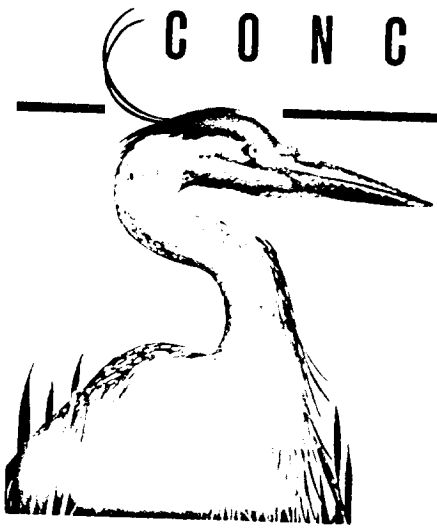
CONCLUSION



Water pollution has been a more formidable challenge than Congress thought when it vowed in 1972 to eliminate all polluted discharges by 1985 and set an "interim" goal of protecting fish and wildlife by 1983.

Crafting water runoff regulations has been politically and technically tough.

Federal authorities have not been given the same financial resources for cleaning up runoff that they had for sewage treatment plants. State and municipal agencies are working to build local partnerships with industry and non-profits that support efforts to comply with federal regulations.

And with the pollutants so complex and diffuse, it is not certain that technology and social awareness will meet the challenge.

Hard questions await policy makers and the public, whose opinions greatly influence policy decisions. Among them:

- *Will scientists have to prove economic harm before cleanup efforts become a priority?*
- *Will land-use patterns and development designs be required to minimize the physical and chemical changes that cities now cause to streams?*
- *Will prevention and restoration efforts persuade people to rethink how they tend to their homes, how much they are willing to pay for pollution-reduced cars, whether they will politically support watershed management and neighborhood stewardship?*

Some of those decisions will have to be made by everyday people every day. Their choices will in large part rest on whether they understand the connections between housekeeping and their health, gardening and game fish, automobiles and the serenity of their favorite beach.

The duty to keep runoff clean cannot be delegated. The future of California's waters no longer rests in the hands of the regulators alone. Restoring the water—and the health and bounty it yields—requires responsible actions that are common to all and exempting of none.

Restoring the water—and the health and bounty it yields—requires responsible actions that are common to all and exempting of none.

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3 Valene Connor. Memo. Central Valley Regional Water Quality Control Board. "Toxicity and Diazinon Levels Associated with Urban Storm Runoff." Sacramento. February 15, 1994.

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11 Carol M. Browner. Address to the Water Environment Federation Conference in Anaheim, CA. October 4, 1993.

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This project has been funded in part by the United States Environmental Protection Agency using grant funds under Assistance Agreement C9009531-90-0 to the State Water Resources Control Board and by Grant Agreement No. 3-111-252-0 for the implementation of the Nonpoint Source Management Program. The contents of this document do not necessarily reflect the views and policies of the United States Environmental Protection Agency or the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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The Lindsay Museum fosters a living connection between people and wildlife in order to create a deeper commitment to the welfare of the natural world. Through educational programs, wildlife rehabilitation, non-releasable wild animals and exhibits, the Museum strives to involve individuals of all ages from every cultural and economic background in learning to care for the earth.

The Lindsay Museum 1931 First Avenue, Walnut Creek, CA 94596 510-935-1978

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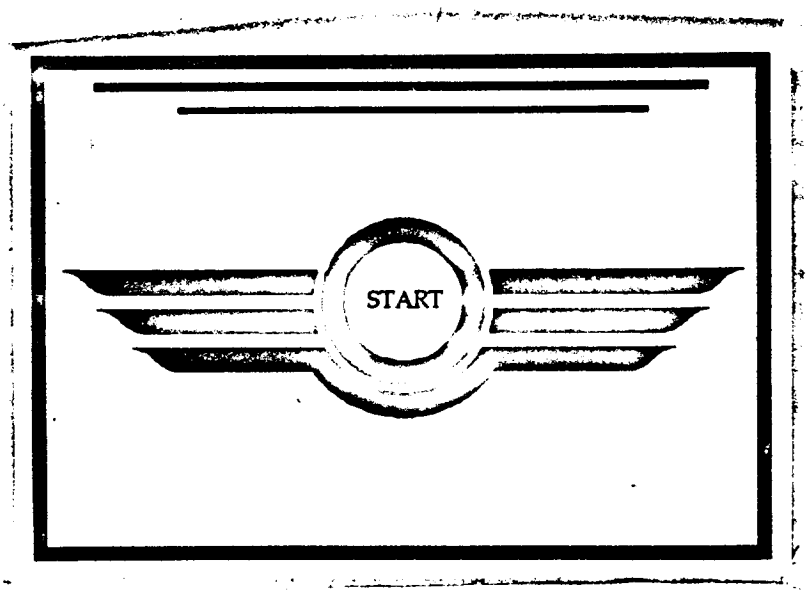

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CARLOS URRUNAGA

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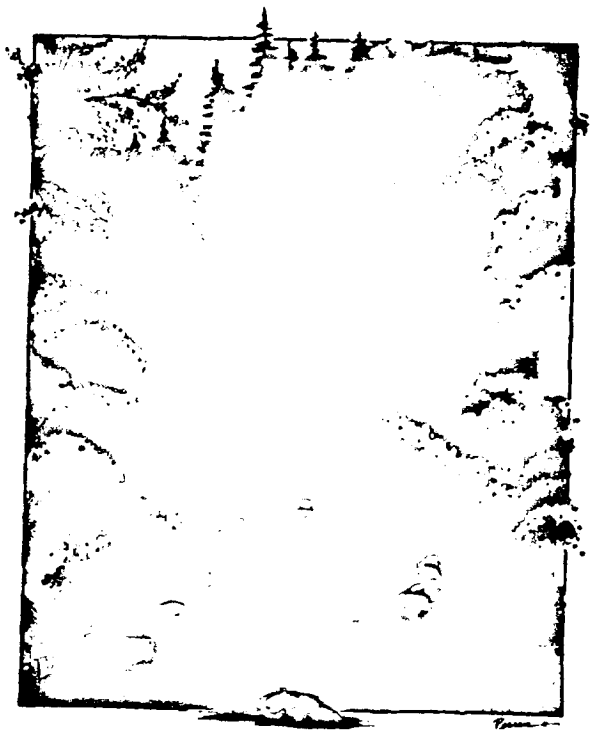

CALIFORNIA'S RIVERS AND STREAMS
WORKING TOWARD SOLUTIONS

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STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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CALIFORNIA'S RIVERS AND STREAMS
WORKING TOWARD SOLUTIONS

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PREFACE

Healthy rivers and streams are essential for a prosperous California. These waters define the treasured California landscape, they supply water for the well being and livelihood of all Californians, and they are the environment for our fisheries and the basis of the food web for wildlife. Yet it is the pursuit of the proverbial "good life" which threatens these waters. Such is the challenge all Californians face in balancing our present needs and uses of water with the long-term prosperity of the State and our quality of life and environment. While various levels of government are called on to protect rivers and streams, the most effective way to do so is through the fullest expression of the public's will. Accordingly, this State Water Resources Control Board (State Water Board) report is dedicated to strengthening public resolve in support of a coherent and comprehensive protection program for the State's rivers and streams.

Sacramento River

This report focuses on how Californians affect water quality through some of our most significant and widespread activities. Such activities can result in the unwitting pollution of our waters. The recent prolonged drought has given us firsthand experience of the difficulties in putting a limited water supply to good and proper use.

While the issues covered in this report are viewed by some as problems and by others as concerns, one thing is certain--they are challenges. In the true California tradition, as challenges are met, new opportunities will emerge. We encourage you to become more familiar with the challenges facing the State's rivers and streams and to join State Water Board and California Regional Water Quality Control Board (Regional Water Board) efforts toward a California resolve to preserve and enhance these waters.

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OVERVIEW

This document depicts some of the most common pollution problems which the State and Regional Water Boards deal with today. It also describes recent steps toward the rehabilitation of water quality in our rivers and streams.

Several themes about water pollution control in California's rivers and streams recur in the ten chapters of this report. First, most of the single-source, well-defined kinds of pollution, including sewage from cities and factories, have been identified and many of them remedied. Our focus is shifting to the diffuse sources--runoff, drainage, seepage, and silt--that may arise over large areas from multiple land uses and political jurisdictions. These "nonpoint" sources represent the accumulation of scores of small contributions. Here the principal technical challenges are to identify the pollutants, trace their sources, and develop new control methods.

Second, this new focus emphasizes pollution prevention--elimination of the problem at the source--rather than "end of the pipe" treatment aimed at removal of pollutants. Most current pollution problems originate over large areas and are complex in their physical and chemical character. Thus it becomes essential to keep pollutants from reaching the water right at the start because treatment to remove them is an expensive and potentially endless task.

The third theme is the need to deal with water quality through a watershed approach. Many of today's pressing problems--whether owing to pesticides, storm water, erosion, livestock, or all of the above--have sources scattered throughout each water basin. This means that the physical unit, the whole river basin, must become the management unit.

The need for watershed management invites a fourth theme: cooperation among affected interest groups. Since drainage basins support diverse land uses and checkerboards of ownership and administration, the owners have to work together to identify common objectives and the means to attain them. In order to succeed, both priority-setting and specific protective actions must be local matters involving the residents of each water basin.

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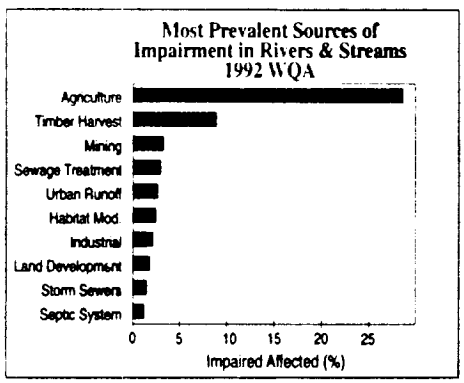
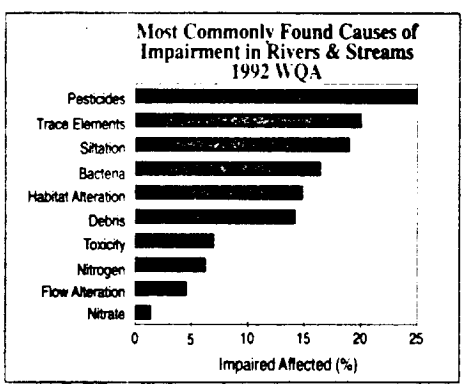
Those are the broad themes. This report focuses on several specific problems and their sources identified by the State Water Board's Water Quality Assessment (WQA) as the most prevalent sources of impairment to rivers and streams. Most of these problems arise from common and widespread land uses, notably mining (Chapter 1), urbanization (Chapters 3 and 9), logging (Chapter 5), and agriculture--including crop production (Chapters 2 and 9), dairies (Chapter 6), and free-ranging livestock (Chapter 7). Chapters 4 and 6 explore pollution that factories and sewage treatment facilities sometimes create. Chapter 8 describes the unique situation at the border with Mexico where a lack of sewage treatment is a serious problem.



The WQA shows that these pollution sources contribute a wide variety of contaminants that cause impairment. Chief among them are heavy metals (Chapter 1), pesticides (Chapter 2), silt (Chapters 5, 7 and 9), nitrates and ammonia (Chapters 6 and 7), disease microorganisms (Chapters 3 and 8), and other chemicals toxic to aquatic life (Chapters 3 and 4).

The last chapter (10) provides a region-by-region summary of the water quality of selected rivers and streams for each particular Regional Water Board. The chapter highlights each region individually and provides a summary of the general categories of sources or causes of impairment. The information provided is taken from data in the WQA. The data identify the proportion of river and stream miles with good, intermediate, impaired, and unknown (or unassessed) water quality. The WQA database is used in part to report to the U.S. Environmental Protection Agency (USEPA) about the quality of the State's waters and identifies waters not meeting water quality standards. These data represent the best information available, however, they are estimates and do not represent exact figures. The last page is a pictorial index which highlights the rivers mentioned in the report and gives the topics discussed and page numbers for easy referencing.



This text is not a stream-by-stream catalog of California's water quality. The pollution issues illustrated in nine examples are not the only ones facing the State and Regional Water Boards. However, they show the direction of our efforts, describing past State Water Board activities and accomplishments, as well as a summary of present challenges, and a glimpse into the future.

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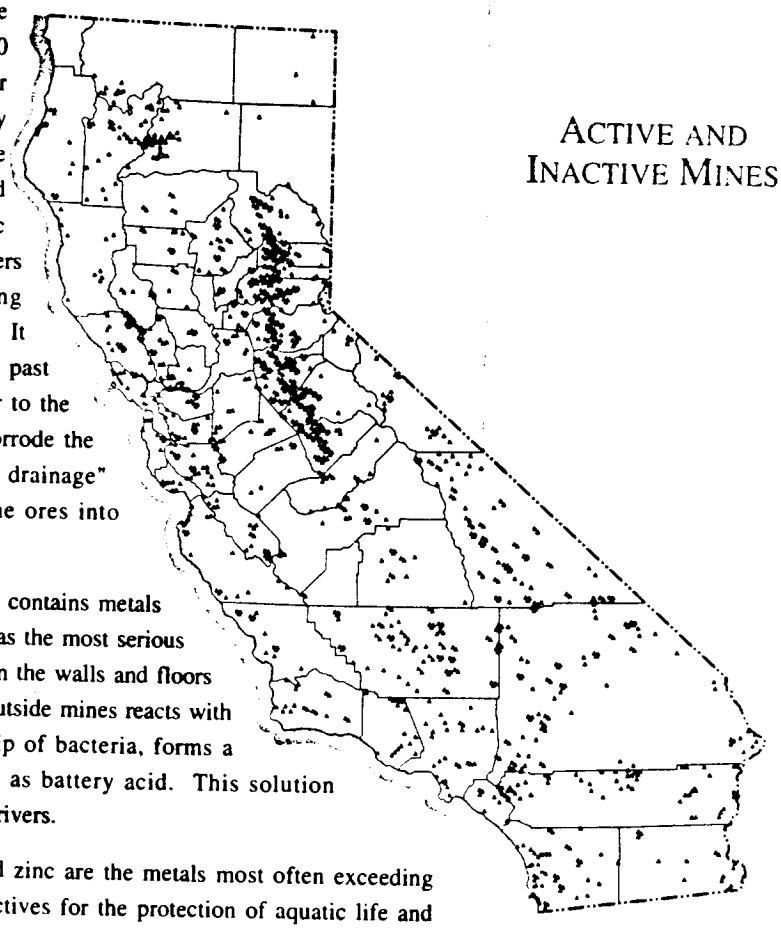
CHAPTER 1

MINE DRAINAGE: A LETHAL LEGACY

California has thousands of inactive and abandoned mines. Of these, 20 are known to cause major environmental damage and that may be just the tip of the iceberg. These mines contain gaping holes and fractures through which toxic substances spill into streams and rivers killing aquatic life and threatening human health. How did this happen? It was the hardrock mining of decades past that first exposed the earth's interior to the weather. Air and water began to corrode the mine's interior, forming "acid mine drainage" which leaches pollutants from mine ores into streams.

Acid mine drainage which frequently contains metals in toxic concentrations is recognized as the most serious mine pollutant. Pyrite (fool's gold) on the walls and floors of mines and in piles of waste rock outside mines reacts with water and oxygen and, with the help of bacteria, forms a solution which can be as corrosive as battery acid. This solution dissolves metals and carries them into rivers.

Cadmium, copper, lead, mercury, and zinc are the metals most often exceeding water quality criteria. Mercury objectives for the protection of aquatic life and human health are occasionally exceeded in the Sacramento River. About 95 percent of the copper, zinc, and cadmium measured in the Sacramento River is thought to originate from inactive mines. Some of these metals accumulate in fish and in high concentrations these metals halt reproduction or cause death. Fish kills have occurred downstream of leaking mines.



ACTIVE AND INACTIVE MINES

Approximate location of some of the abandoned and active mines throughout the state

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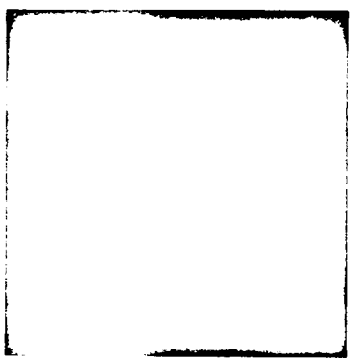
Mine discharge is a statewide problem. Rivers flowing to San Francisco Bay contain mercury and acid drainage from mines in the Coast Range Mountains. The Sierra foothills are dotted with copper and zinc mines that spill metal-laden acidic water.



Iron Mountain Mine

Shasta County has a number of large problem mines including Iron Mountain about four miles northwest of Redding which produces some of the most acidic water in the world. Iron Mountain Mine discharges more metals to surface waters than any other single source in the nation. About a ton of copper and zinc is discharged daily into Spring Creek Reservoir just downstream of Shasta Lake.

Shasta County mine sites discharge acidic and metal-laced runoff directly to Shasta Lake or to the Sacramento River. Drainage from these mines contains enough copper to impair water quality 200 miles downstream in the vicinity of Sacramento and still further downstream in San Francisco Bay. The San Francisco Bay Regional Water Board has identified high levels of copper as a major water quality problem for the Bay and has identified acid mine drainage as one of the principal river sources needing to be controlled. In addition to the copper coming from abandoned and inactive mine sites, copper coming from other sources such as agriculture, storm water, industry, and public sewage plants may have to be reduced further.

Once it begins, acid mine drainage continues to form at rates up to a million times greater than what would naturally occur from weathering, making it extremely difficult to control. Mine clean-up costs are high--in some cases cost estimates exceed $50 million, and there are no guarantees of success. The State and Regional Water Boards recognize the need to correct the problem and wherever possible recover clean-up costs from the mine owners. But often owners cannot be traced or have no money and the taxpayer is faced with the bill.

Clean-up technology does exist, but it is costly, is labor intensive, and must be maintained over a long period. Seldom is one single clean-up method effective. More often several technologies must be used together. Each mine requires an individualized approach. A clean-up strategy might include a combination of concrete plugs, lime injection wells, neutralization ponds, treatment plants, and surface caps.

The surface cap prevents rain from percolating through the ground and into the mine workings. Downstream from a mine, treatment plants are commonly used to

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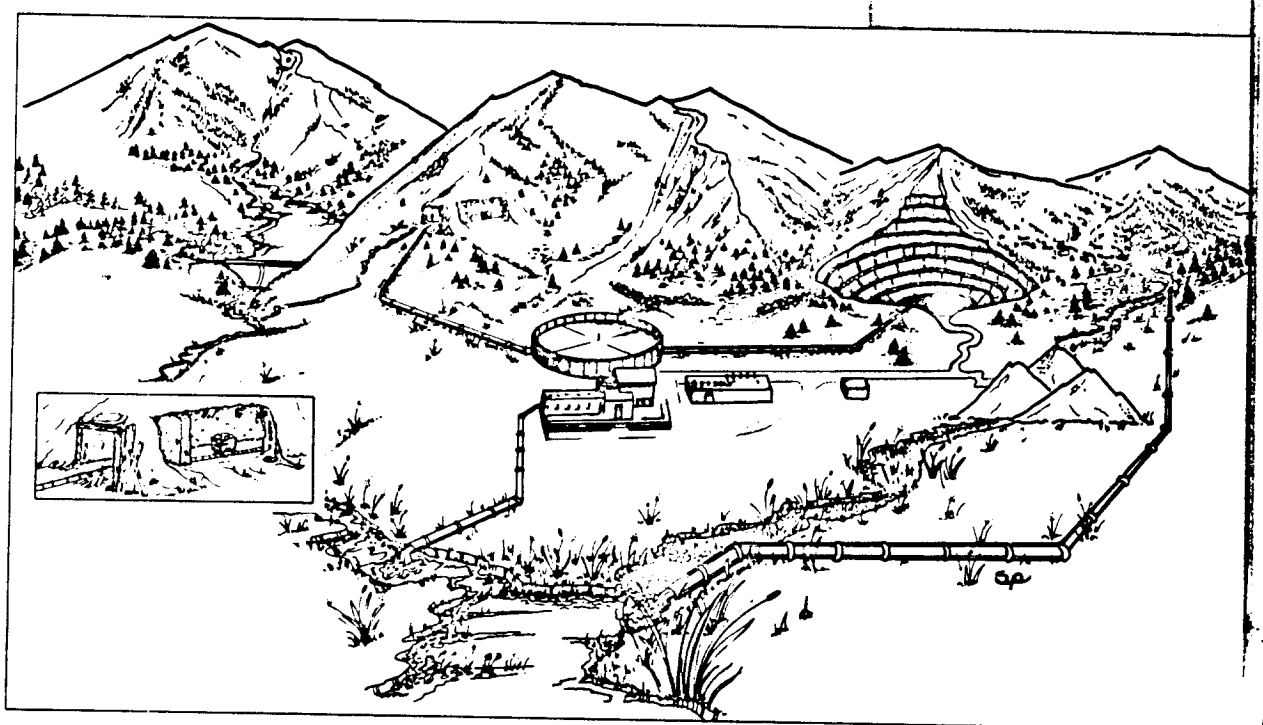

Technologies Used To Control Mine Waste

Technologies to control pollution from inactive mines fall into 2 categories:

- *PREVENTION--preventing the formation of acid mine drainage by diverting local streams away from reactive material, covering reactive mine waste, mixing reactive mine waste with limestone to buffer acid, disposing of reactive mine waste under water to eliminate reaction with air, impounding mine drainage to keep it from entering surface waters, and sealing the mine portal to flood the mine thus suppressing the formation of acid mine drainage.*
- *TREATMENT--treating mine drainage before it enters surface waters including chemical precipitation and ion exchange, construction of wetlands, and evaporating mine discharge in surface impoundments. Note: all these treatment technologies produce sludge which must be disposed of in an environmentally sound manner.*

treat acid mine drainage. Concrete plugs result in flooding of the underground workings which prevents pyrite exposure to oxygen and theoretically stops acid formation. But plugs frequently leak, making this method unreliable. Another idea is to inject lime through surface-drilled wells to neutralize the acid as a mine is flooded. Revegetation and man-made or natural wetlands are also used to treat acid mine drainage. Trees and shrubs absorb rainwater, reducing moisture seepage. Wetlands fortified with everything from composted vegetation to horse manure have been used to consume metal-laden, acid mine drainage, reducing the acidity and retaining the toxic metals in the wetland.

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The known pollution from existing abandoned mines is already one of the largest water quality problems in the State. Additionally, as the many unstudied abandoned mines are investigated, more such problems will undoubtedly surface. As investigative work sheds light on the true magnitude of pollution from abandoned and inactive mines, a mine pollution abatement program is being crafted.

There are, however, major obstacles to overcome before significant progress in controlling pollution from abandoned mines can be realized. In drafting the laws governing pollution control, the situation for abandoned mines where there is no responsible party to hold accountable was not considered. Therefore, laws such as the Clean Water Act or the rules governing superfund site cleanup contain requirements for full attainment of water quality standards. At abandoned mine sites, the obligation to attain standards is often prohibitively expensive. In some cases, there can be no assurance that mitigation has the capacity for full compliance with standards. In most cases, the State would prefer to take corrective actions based on cost effectiveness without a guaranty of attaining standards. In this way, the majority of the pollution from most sites could be controlled.

State Water Board is attempting to remove the legal barriers that prevent mine pollution cleanup by changing those state and federal laws which impose liabilities for mine cleanups. By working with USEPA and other federal agencies, a comprehensive mine cleanup strategy is starting to evolve. Strategy elements will include an inventory of all the mines, identifying their location, singling out those causing problems, and then deciding which to fix first. Because mine cleanups are technically complex, staff intends to establish a technical advisory committee to review and approve such proposals. Participation in an international technology exchange provides important information on state-of-the-art technologies used in other parts of the world.

Although the cleanup of abandoned and inactive mines is a massive endeavor, meeting this challenge holds the promise of solving one of California's major surface water quality problems--a problem as old as the State itself.

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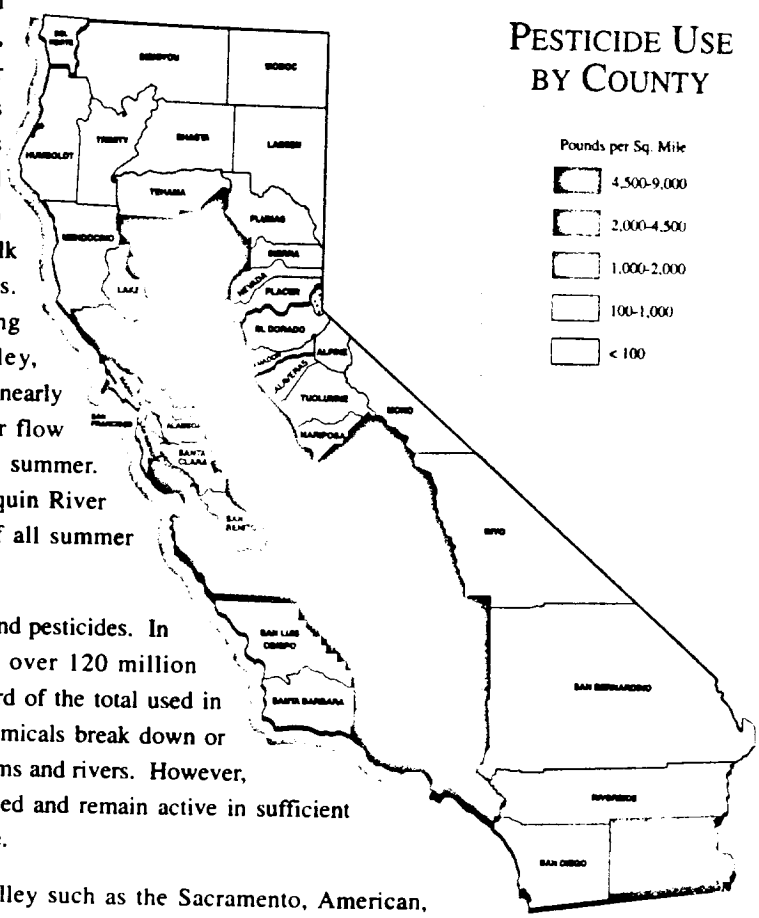
CHAPTER 2

AGRICULTURAL PESTICIDES: CONTROL IS THE KEY

Because the major growing season in California is also the dry season, most crops require irrigation. Water not used by crops evaporates, seeps underground, or returns to rivers and streams. Runoff from irrigated land usually channeled into drainage canals can make up the bulk of stream flow during dry periods. For example, in the rice-growing areas of the Sacramento Valley, agricultural drain water comprises nearly one-third of the Sacramento River flow during peak rice irrigation in early summer. Similarly, portions of the San Joaquin River consist largely of irrigation runoff all summer long.



Total pesticide use includes agricultural, commercial and residential use.

This runoff often carries fertilizers and pesticides. In 1990, California growers applied over 120 million pounds of pesticides, nearly one-third of the total used in the United States. Some of the chemicals break down or are neutralized before reaching streams and rivers. However, other pesticides are not fully degraded and remain active in sufficient concentrations to threaten aquatic life.

The larger rivers in the Central Valley such as the Sacramento, American, Feather, and lower San Joaquin provide major spawning and rearing habitats for fish such as salmon, steelhead trout, striped bass, shad, and sturgeon. These species' young depend on small invertebrates--mostly insects and tiny shrimp--for food. Certain orchard and field pesticides sometimes occur in streams and rivers at levels that can kill or seriously impair these food sources and the young fish themselves.

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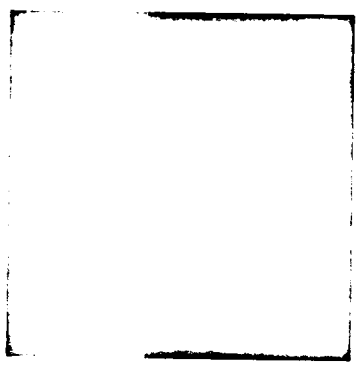
The potential adverse effects of agricultural chemicals were realized in the early 1980s when massive numbers of adult fish were killed in the agricultural drainage channels of the Sacramento Valley. The fish kills were linked to two rice herbicides, Ordram and Bolero. A collaborative effort between the Central Valley Regional Water Board, the Department of Pesticide Regulation (at that time a part of the Department of Food and Agriculture), and the rice growers was developed to control the discharge of these chemicals. By instituting restrictions on the timing of the release of the rice field water that had been treated with the chemicals, the fish kills were stopped.



Pesticide spraying in fields.

As part of the effort to identify and control these pesticides, an impact on drinking water supplies was identified. Water from the agricultural drains enters the Sacramento River and is carried downstream into the Sacramento River/San Joaquin River Delta. Water taken from the Sacramento River used for drinking water for the citizens of Sacramento was found to contain concentrations of the pesticides that created foul tasting water. Growers agreed to hold the water on their fields for longer periods of time before discharging. This reduced the herbicide levels, eliminating the toxicity to aquatic life and improving the drinking water.

The impacts of pesticides on the aquatic life in the Sacramento River and the agricultural canals remains a concern. Many of the food species for fish are very sensitive to agricultural poisons and even small amounts of agricultural chemicals can severely limit food supplies for fish. Today the Regional Water Boards are using bioassay tests to screen waters for toxic effects. This "early warning" procedure shows whether certain test animals can survive, grow, and reproduce normally in stream water samples carrying irrigation runoff. Since 1986, such tests have examined waters from numerous streams in the San Joaquin, Sacramento, and Imperial Valleys. Streams in other farming areas including the Salinas Valley also will be tested.

These tests show that a number of the State's streams in agricultural areas are frequently toxic to aquatic life. Up to 30 percent of recent measurements in the Feather, Sacramento, and Mokelumne River Basins, and in Imperial Valley channels have revealed toxicity. Portions of the San Joaquin River in Merced and Stanislaus Counties have tested toxic 40 to 50 percent of the time. While the levels of chemicals are generally too low to kill fish outright, they can harm aquatic life by inhibiting reproduction and reducing food supplies.

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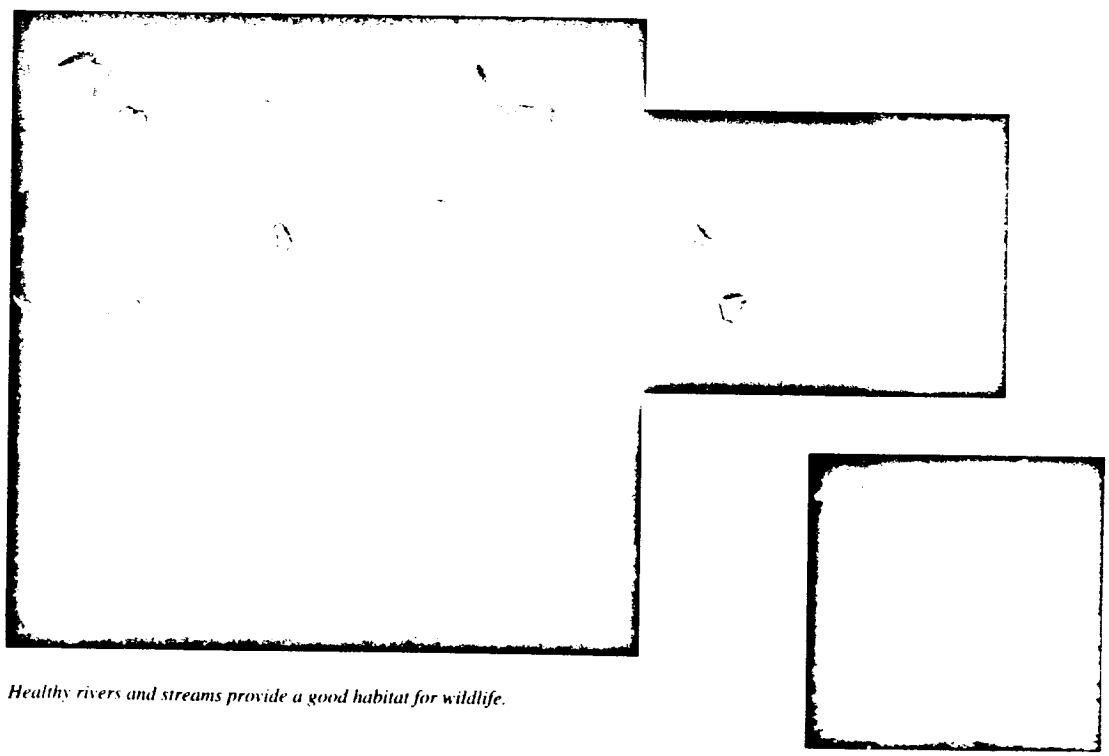
Such findings present the Regional Water Boards with a new challenge: to identify exactly which ingredients in each stream are toxic and to determine their site of origin. Dozens of pesticides applied to dozens of crops must be screened. Cooperation between the Department of Pesticide Regulation, County Agricultural Commissioners, chemical manufacturers, and growers are essential for accurate information--sites, times, amounts of each chemical applied--which may reveal the source of toxicity.

This cooperative approach should lead to new methods to keep pesticides from harming life in the State's waters. As with the case of rice herbicides, adjusting chemical selection, timing, application method, and release of drain water may help to reduce toxicity from other crops. Alternative approaches must also fit crop cultivation, pest prevalence, water needs, and weather conditions into a practical pest control scheme. Many chemicals are washed from fields along with soil so that ongoing efforts to reduce soil erosion can serve a double purpose.



Healthy rivers and streams provide a good habitat for wildlife.

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Prevention of toxicity also may be attained by keeping drain water out of streams, for example, through water conservation, water recycling, and use of evaporation ponds. But withholding water reduces stream flow as well as toxicity. In some cases, irrigation runoff actually creates streams as well as crucial streamside habitat for wildlife. This marsh and streamside vegetation serves as shelter for birds and animals, while the mosaic of surrounding croplands provides them with feeding grounds. The combination of food and shelter can maintain a great diversity of wildlife species.

Pest control practices need to achieve both crop protection and conservation of fish and wildlife. Everyone benefits when chemicals stay on their target crop, soil stays in the field, and clean water runs in the streams.

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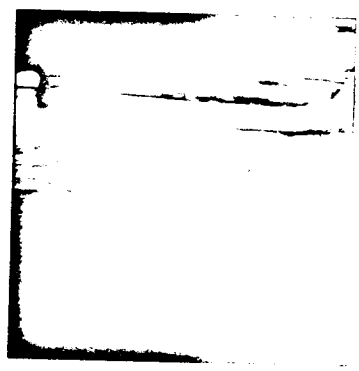
CHAPTER 3

URBAN RUNOFF: CITY LIFE CAN BE HARMFUL TO A RIVER'S HEALTH

Most cities in California operate a dual system for handling used water. Water from our homes and businesses is carried off by sanitary sewers to wastewater treatment plants, while an entirely separate network of drains diverts storm water quickly off city streets to prevent flooding of streets and sewage treatment plants. It transports runoff directly to the nearest water body--usually rivers--but sometimes lakes or bays. Few realize that storm drains, once known as "storm sewers", do not carry storm water to a treatment facility nor do they remove pollutants before funneling them downstream. Thus they may pose threats to drinking water, aquatic life, and the recreational and economic uses of those waters.

Storm drains are particularly useful in large, steeply sloped basins supporting many cities. Urban areas contain up to 90 percent hard surfaces such as rooftops and pavement where water collects quickly and runs off. Many cities have developed intricate networks of culverts, maintenance holes, catchbasins, and concrete channels to prevent flooding and watercourse changes from disrupting urban development along flood plains.



Rain water washes street pollution into storm drains which carry it to rivers

Though channels tame storm flows through urban areas, the cost is dear. Concrete storm drains prevent percolation for well-water recharge (an important source of drinking water) and deny habitat for plant and animal life and human recreation. These channels also discharge storm water debris directly into rivers, lakes, and bays. Problems occur when storm water picks up harmful amounts of pollutants and delivers them to these waters.

In urban areas, raindrops scavenge dust and pollutants from the air in their journey to the ground. The first rainfalls of the season flush out many kinds of materials accumulated on the ground during dry weather--oil, grease, coolants, garden fertilizers, pesticides, pet droppings, and even traces of hazardous substances stored in containers outside manufacturing plants (see next page).

Storm drains also collect dry weather runoff from lawn overwatering, car washing, construction work, and at times illegal dumping. Additionally, some storm drains convey legally permitted wastewaters, accidental sewer overflows, and other, less

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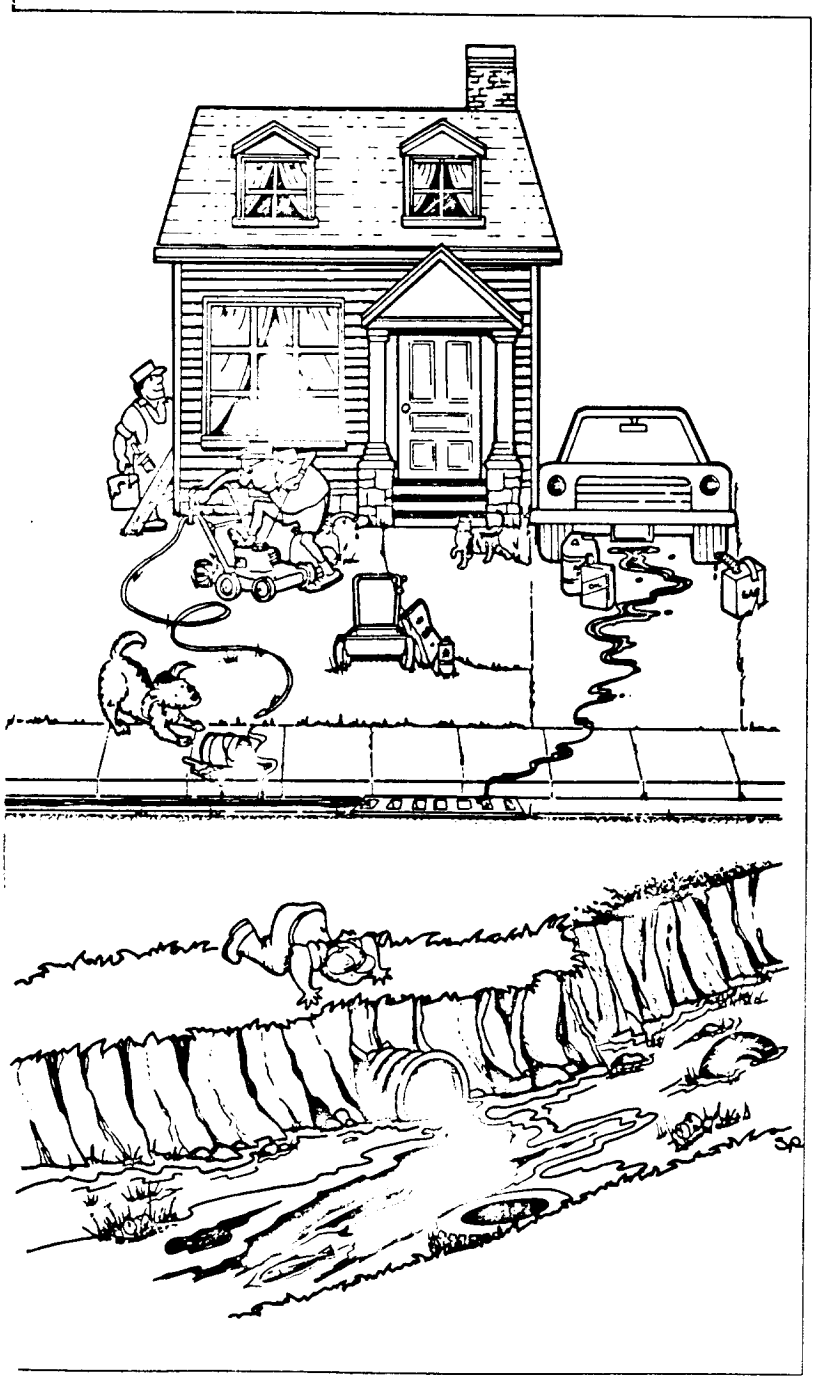

Many household activities release pollutants that are washed into storm drains

common wastewaters. It is not surprising, therefore, that the catacombs hidden beneath city streets serve as major conduits of contaminants to downstream waters.

The Los Angeles/Rio Hondo/San Gabriel River drainage system contains the nation's second largest urban area, and the ninth largest drainage area--414 square miles of watershed. Mazed with hundreds of miles of concrete-lined channels, this massive network accommodates irregular bursts of rainfall across the area and billions of gallons of water and tons of solid materials caught up in the runoff. In Santa Monica Bay alone, 70 storm drains discharge untreated urban runoff into the ocean. Because of the number of drains and the nature and variety of sources of pollutants, identifying and controlling the various types of nonpoint source pollution and urban runoff are not easy tasks.

Although required by the Clean Water Act for years, management of urban runoff and storm water quality has languished over the last decade and a half, in part because of the tremendous complexity of dealing with this multi-faceted pollution source. However, following the 1987 amendments to the Clean Water Act, a regulatory Storm Water Program has emerged and storm water permits are being developed across the nation to address and regulate this problem.

In 1990, the California Regional Water Quality Control Board, Los Angeles Region, Surface Water Regulatory Section, developed one of the nation's first storm

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water runoff permits. This permit requires Los Angeles County and its 89 cities and other agencies to control pollution from urban runoff. As measures required under the storm water permit are implemented over the next few years, significant reduction in bacteria along the beaches and near storm drains is expected as well as many other water quality improvements.

A pilot program being tested in the City of Santa Monica involves treatment of urban runoff in storm drains. The City of Santa Monica has been treating the water with varying doses of ozone, a gas used to disinfect drinking water. Initial results have shown that the ozone breaks down many toxic organic compounds and kills most of the harmful bacteria. However, heavy metals (e.g., zinc, copper, and lead) in the runoff are not affected by this process and different methods will be needed if trace metals must be removed.

The positive results from this study have spurred the City of Santa Monica to consider building a full-scale ozone treatment plant, complete with trash removal capability for dry-weather flows and for the initial flush of wet season storm water runoff. Water not routed to reclamation would be screened, disinfected, and released to the ocean. Backwash would be periodically collected and transferred to city sanitary sewers for full treatment.

While Santa Monica has not yet estimated the costs and benefits of building a full-scale plant, tourism continues on the Santa Monica coastline with an average of over 40 million visitor-days a year. This beneficial use alone may justify construction of a storm sewer treatment plant.

Meanwhile, techniques for preventing these compounds from getting into the drains rather than treating the water after it is in the drain are being sought. The reduction of lead in street runoff as a result of the removal of lead from gasoline over the last decade offers a precedent for other materials known to be carried downstream. This approach, pollution prevention, has been the basis for the many grass-roots volunteer efforts to increase public awareness in reducing pollution of urban runoff. Two pollution prevention practices believed to have a potential for dramatic improvement are proper disposal of oil and grease and reduced use of lawn pesticides and fertilizers.

Another major effort by the Regional Water Boards to address urban runoff pollution is to expand their public outreach and education efforts. One of the Regional Water Boards' goals is to educate citizens on impacts to the environment of urban runoff. All 87 of the municipal entities (cities, water districts, and counties) which are co-permittees of the Los Angeles County Storm Water and

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Urban Runoff Discharge National Pollutant Discharge Elimination System (NPDES) permit are required to conduct public outreach programs to address proper disposal of household chemicals, pest control chemicals, and general waste disposal. The public outreach requirement of the NPDES Municipal Storm Water Permit is considered one of the most important elements in reducing pollutants to the storm drains. There are hundreds of these programs statewide educating the public about pollution of storm drains. Education and pollution prevention are much more cost effective than treatment of the polluted water. Classroom presentations, public workshops, and the distribution of environmental literature are part of this program. For example, neighborhood campaigns now stress alternatives to pesticide use in lawns and gardens and suggest landscape designs that control erosion.

Managing runoff in a highly urbanized area such as Los Angeles will clearly require a team effort. Residents must become aware of water quality issues in their own communities and get involved. The bottom line is that each of us plays an important role in reducing runoff from our own neighborhoods and cities. Education and participation is the key to bringing about changes.

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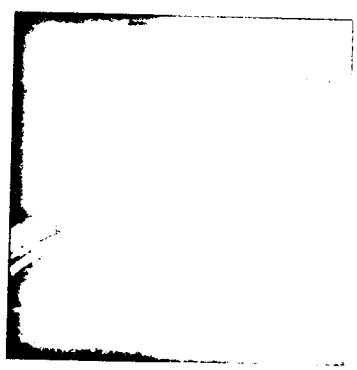
CHAPTER 4

TOXICITY: SEWAGE COMES CLEAN, ALMOST

The wastewater produced by most of California's homes, businesses, and industries travels through a maze of subterranean pipes to sewage plants, where it is treated, cleaned, and disinfected to a high standard. Indeed, treatment has improved greatly in the last 30 years, essentially eliminating most public health problems, algal blooms, and fish kills. But recently the State and Regional Water Boards have recognized a more subtle set of problems--even after treatment, sewage may still contain chemicals in concentrations that harm aquatic life. These chemicals may not kill fish and shellfish outright but can stunt their growth, reduce fertility, or cause deformities. These effects can ultimately limit populations and communities of aquatic plants and animals.

Toxicity is detected by exposing test plants and animals to the wastewater (see next page). Test species chosen to represent the resident aquatic life are hatched and raised in samples of wastewater that have been mixed with local fresh or salt water simulating conditions near the discharge pipe. Their growth and development is compared to that of like organisms reared in clean laboratory-grade water. The types of organisms commonly used to test the toxicity of freshwater include minnows, shrimp (water fleas), and green algae.

For the past few years, major municipal sewage plants and industrial facilities with their own treatment plants have begun toxicity testing with the wastewater they discharge to streams in California. These tests indicate that the effluent from one-third or more of these facilities can harm aquatic life at least some of the time.



Sewage treatment plant in Orange County

When toxicity is repeatedly detected in a treatment plant's wastewater, the Regional Water Board requires the treatment plant to seek the chemical culprit and take steps to remove or neutralize the offending substance. Initially, the wastewater is separated or partitioned into two groups which are chemically distinct. Each group is evaluated using one or more test

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SELENASTRUM
freshwater algae, plant species

CERIODAPHNIA
Cladoceran, invertebrate species

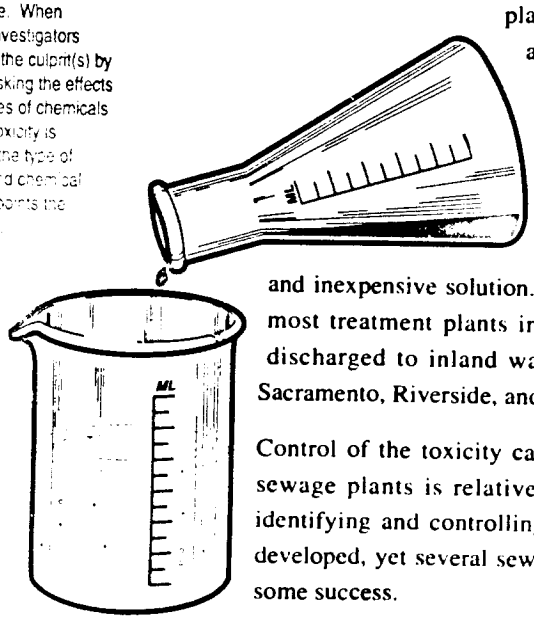
PIMEPHALES
fathead minnow, vertebrate species

organisms. The portion that shows toxicity is again separated into distinct chemical groups and tested. The scientists follow the toxicity through as many partitioning steps as are needed to identify a specific chemical that is causing the toxicity in the wastewater. One can imagine how difficult this job might be by considering all the different kinds of chemicals that are dumped down the drain.

The next step is to figure out if that substance can be treated either by removing it from the wastewater or by neutralizing it. If treatment is not an option, then the source of the chemical must be identified. In some cases the decision to look for sources is made even if a treatment option is available because control at the source is more effective or cheaper than continuous treatment at the sewage plant. Tracking down sources, particularly in a large municipal sewage system, can be as difficult as identifying the toxic chemical.

Two chemicals found in treatment plant discharges, ammonia and chlorine, have been shown to present toxicity problems, especially those that discharge to small streams or confined bodies of water. Ammonia, a natural byproduct of sewage, can be treated and converted to less harmful chemicals. The sewage treatment plants serving Riverside, Ontario, and Chino have adopted this advanced treatment for ammonia control (see Chapter 6), as have certain plants in the San Francisco Bay, San Diego, and Los Angeles areas, among others.

Initially, toxicity tests determine if a discharge is lethal to the test organisms or causes significant changes in their growth or their ability to reproduce. When toxicity is found, investigators attempt to identify the culprit(s) by systematically masking the effects of certain categories of chemicals and seeing if the toxicity is eliminated. Once the type of pollutant is identified, chemical detective work pinpoints the specific compound.



Chlorine, routinely added to wastewater for disinfection, can also prove dangerous to aquatic life. But chemicals such as sulfur dioxide neutralize chlorine's toxic properties, and this is a relatively simple and inexpensive solution. This dechlorination step is being used by most treatment plants in California where chlorinated sewage is discharged to inland waters including the cities of Santa Rosa, Sacramento, Riverside, and Central Contra Costa County,

Control of the toxicity caused by ammonia and chlorine at certain sewage plants is relatively straightforward. The techniques for identifying and controlling other sources of toxicity are still being developed, yet several sewage plants and industries already have had some success.

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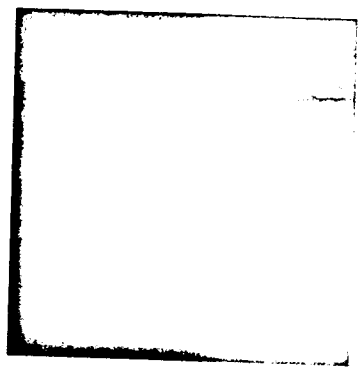
Recently the Central Contra Costa Sanitation District determined through the use of some sophisticated chemical and physical manipulations that toxicity in its wastewater was due to a pesticide commonly used on lawns and gardens. This same pesticide, diazinon, has been implicated in toxicity at municipal sewage plants in other parts of the country as well. Among other steps, the District has undertaken an education program in its service area on the proper use and disposal of home-use pesticides and has instructed dozens of pest control businesses in its service area on the proper disposal of wash water from spray equipment.



Paper mill near Sacramento River in Anderson

In 1987, the Stockton Regional Wastewater Control Facility began toxicity testing on its effluent. After concluding that it posed a threat to invertebrates in the San Joaquin River, the treatment plant operators discovered that the toxicity coincided with pesticide applications to their aeration ponds. These pesticides were used to control chronic gnat infestations.

In order to reduce the threat to the aquatic environment without encouraging a gnat population explosion, the facility switched to a different method of pest control, using bacteria to interrupt part of the gnat growth cycle. Here again a municipal treatment plant took steps toward enhancing the quality of local waterways.

Industries also conduct toxicity testing and search for the chemical culprits. Through such procedures and clever detective work, for example, a San Francisco Bay area steel company discovered that the culprit was the defoamer component in a detergent they used. This company simply and efficiently eliminated the toxicity problem by changing the formulation of the detergent. Similarly, one fraction of a Bay Area oil refinery's wastewater tested toxic but after filtration through activated carbon, toxicity disappeared.

Finally, at a paper mill along the Sacramento River near Red Bluff, operators discovered that the mill wastewater contained dioxin, an extremely toxic chemical. After considerable sleuthing, they found that dioxin was generated when oils used to control foam in the pulp-making process mixed with certain pulp bleaching agents. The company appears to have virtually eliminated dioxin from the paper-making process by switching to a different defoamer.

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During the last two years, several groups of toxic substances including ammonia, chlorine, pesticides, metals, surfactants, and defoamers have been clearly identified as the source of toxicity in wastewater discharges. Over the next decade, more wastewater treatment plants will recognize and correct toxicity problems working with the State and Regional Water Boards to better protect California's aquatic life.

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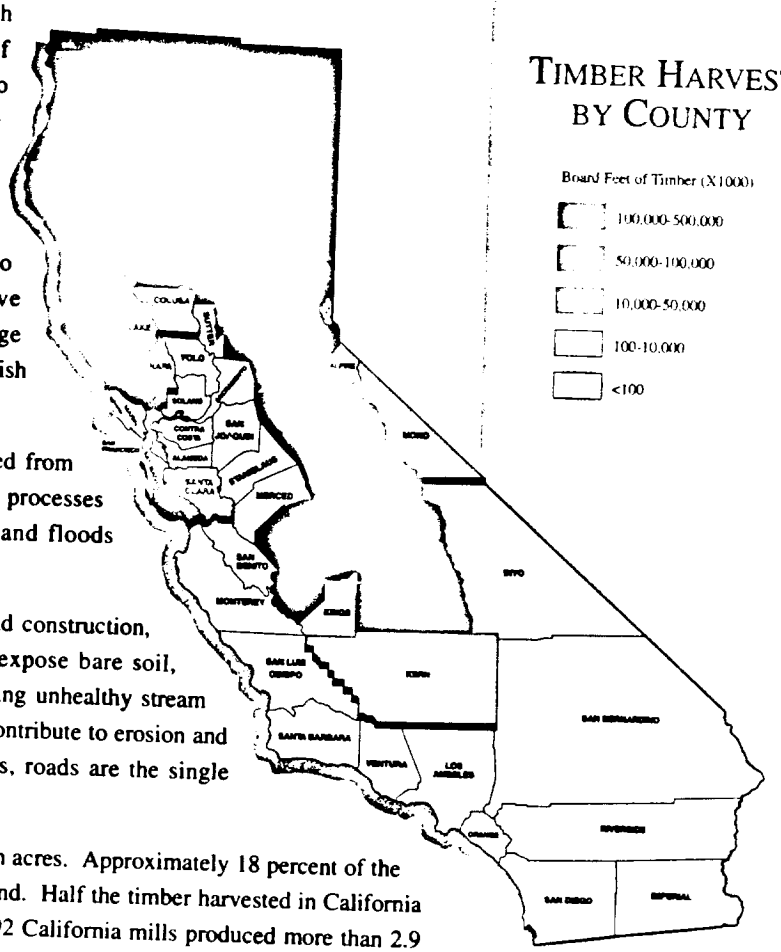
CHAPTER 5

EROSION: IT'S MORE THAN DIRT

On a scenic drive along the North Coast, travelers view the beauty of California's ocean beaches and stop to walk through its favorite forest, the Redwoods. While enjoying sounds of rippling streams and visions of bountiful salmon, the visitor may walk unaware of a major threat to nature's beauty--sediment. Excessive sediment can cause significant damage to rivers and streams and to valuable fish habitat.

Sediment is the soil and debris washed from surrounding land into water. Natural processes such as surface erosion, landslides, and floods contribute to sedimentation.

Certain activities, such as logging, road construction, grazing, and surface mining tend to expose bare soil, accelerating sedimentation and promoting unhealthy stream conditions. Other land uses may also contribute to erosion and sedimentation. In many forested areas, roads are the single largest cause of excess sedimentation.



The majority of timber harvest activity is focused in northern California

California's forest land totals 101 million acres. Approximately 18 percent of the land in California is productive forest land. Half the timber harvested in California is from the North Coast Region. In 1992 California mills produced more than 2.9 billion board feet of softwood lumber.

The same area that is home to the rich forests has historically been excellent fish spawning habitat. The rivers contain deep pools which provide areas where fish can rest and remain cool. Filling of these pools limits the amount of resting area as well as the ability of fish to migrate upstream to spawn and the ability of juvenile salmon to escape downstream. The pools are filled when large, heavy sediment

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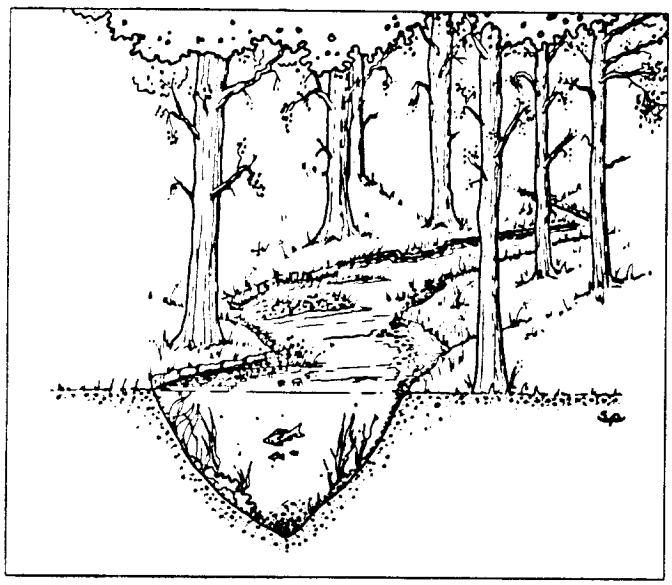
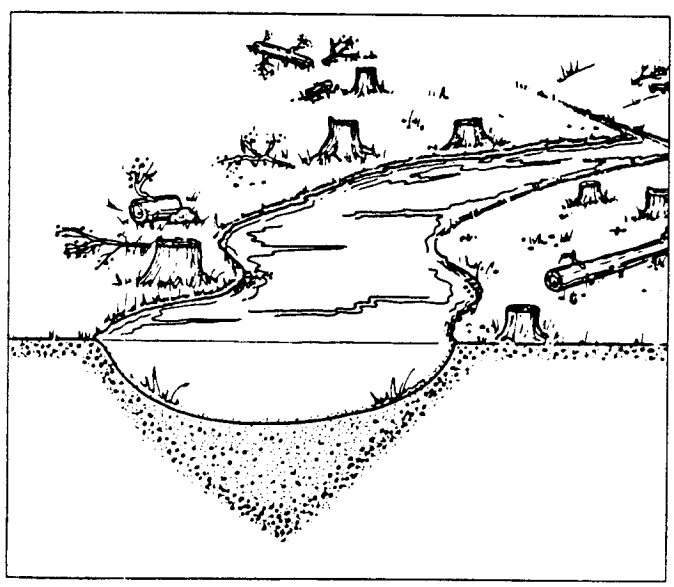


Stream with riparian vegetation



Changes in streambed due to removal of vegetation

particles roll and drag along stream bottoms during high water flows and come to rest in the deeper parts of the stream. Sediment deposits fill streamways forming wider, shallower streams where there once were deep pools.

Finer sediment consists of silt and clay particles which remain suspended in water longer before settling out. Suspended sediment may irritate fish gills and cause other physical damage to fish.

Steelhead trout and salmon spawn in rivers and streams, hollowing out nest depressions in the stream gravel, then laying and covering their eggs with layers of gravel. They require clean gravels with adequate water flow, usually just below a deep pool; there cool, oxygen-rich water flows through the gravel and bathes the eggs. Salmon also seek a place with ample food and boulders where young fish can hide from predators. Within a year or less, most young salmonids migrate to ocean waters. If home streams are navigable, in two to five years they will return to spawn and renew the cycle.

Unfortunately, excessive sand, silt, or clay destroys this cycle, filling gravel spaces, eliminating underflow, and discouraging fish from spawning in the area. Eggs already laid may be buried in the sediment and suffocate. Newborn fish and the smaller organisms on which they feed cannot emerge through the sediment layer and die.

From the 1880s through the 1930s, timber harvest operations often left logs in stream bottoms. In many instances logging debris

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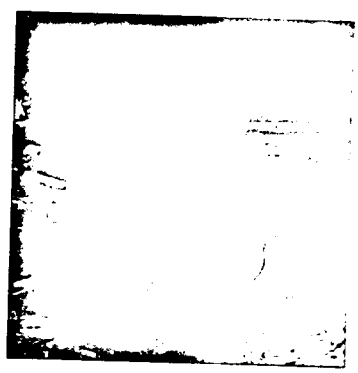
buried creeks and streams, clogging channels with soil and wood slash. The effects of these past timber practices still remain today, and some streams will take decades to recover. For the most part, recovery depends on a stream's flushing capability. Where stream flushing occurs irregularly, recovery may take centuries.

Soil exposed due to logging

Sediment is not easily collected or removed after being deposited in streambeds. Therefore, approaches to prevent sedimentation have been attempted as a key to protect vulnerable rivers. In 1973, growing concern over California rivers and streams led to legislation requiring the Board of Forestry (BOF) to regulate logging practices. In 1983, the State Water Board certified a Water Quality Management Plan for National Forest System Lands which was developed by the U.S. Department of Agriculture, Forest Service (USFS). In 1986 a BOF and State Water Board Review Team examined timber practices in the State and concluded that noncompliance with timber harvest rules was the major reason for sediment problems related to timber operations. In response, the BOF increased inspections and adopted more rules to protect watercourses and lakes, covering activities such as design, construction, maintenance of logging roads and landings, site preparation, cumulative watershed effects, sensitive watersheds, and harvesting and erosion control. However, putting all of these mitigation measures into practice takes time.



Sediment and logging debris clogs river

Now both the USFS and BOF have adopted forestry practices and regulations to protect fish and drinking water. One regulation provides extra protection for areas especially susceptible to damage from timber operations. Many waterways in the North Coast Region as well as the Sierra-Nevada are recognized through this process as sensitive areas; for example, the Mokelumne watershed, Scott River, and Mattole River. Another practice is to schedule timber harvests at times least likely to cause damage to sensitive streams. Many road systems in forested areas need alteration. Relocating roads which contribute to excessive sedimentation is often feasible, and strategically placing roads to serve several areas can minimize the amount of road in a given area. Closing old decaying roads and minimizing road construction can also reduce degradation.

Addressing each drainage system holistically on a watershed scale, prioritizing vulnerable watersheds and developing methods to lessen the effects of timber

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operations in those areas may offer the best solution to this problem. We need to better educate the public on the effects of sedimentation and encourage cooperation between public agencies and private property owners. Public education can achieve understanding and sensitivity to different needs and values.

In Plumas County, for example, Pacific Gas & Electric Company discovered sediment buildup in several hydroelectric reservoirs. The company successfully conducted a broad education campaign aimed at fostering public stewardship of the land. Over 14 public agencies responded and many local citizens became environmentally conscious and economically motivated.

This approach is commonly known as Coordinated Resource Management and Planning (CRMP). This method can produce agreements among diverse entities on natural resource issues including water quality. Through CRMP, private landowners and resource management professionals together identify issues and establish actions to solve problems. In California, cooperation with USFS, California Department of Forestry (CDF), county jurisdictions, and private land owners is essential for desired improvements.

Sedimentation impacts are not limited to forested areas. Naturally high siltation rates occur in areas with combinations of heavy rainfall, steep slopes, and low vegetation cover. This can be made more severe by road building activities. The San Lorenzo River, for example, occupies a broad watershed in the Santa Cruz area. Homebuilding in the 1960s and 1970s produced excessive sediment in the river resulting in a loss of steelhead trout. In response, the County declared a moratorium on homebuilding. Involved citizens organized river restoration projects in an effort to save the fish. Realizing the importance of controlling siltation, the County adopted several erosion and grading ordinances, including prohibitions on grading hillsides during winter months and similar restrictions on slopes of greater than 30 percent.

Today, the area is considered "built out", and home building no longer poses a threat. The reduction in siltation has brought about beneficial changes and a local awareness of what excessive sediment can do. Now emphasis focuses on landslide prevention with less concern over road building and maintenance. The remaining concern is to ensure that erosion control ordinances are vigorously implemented and that local citizens continue the practices necessary to keep their rivers healthy.

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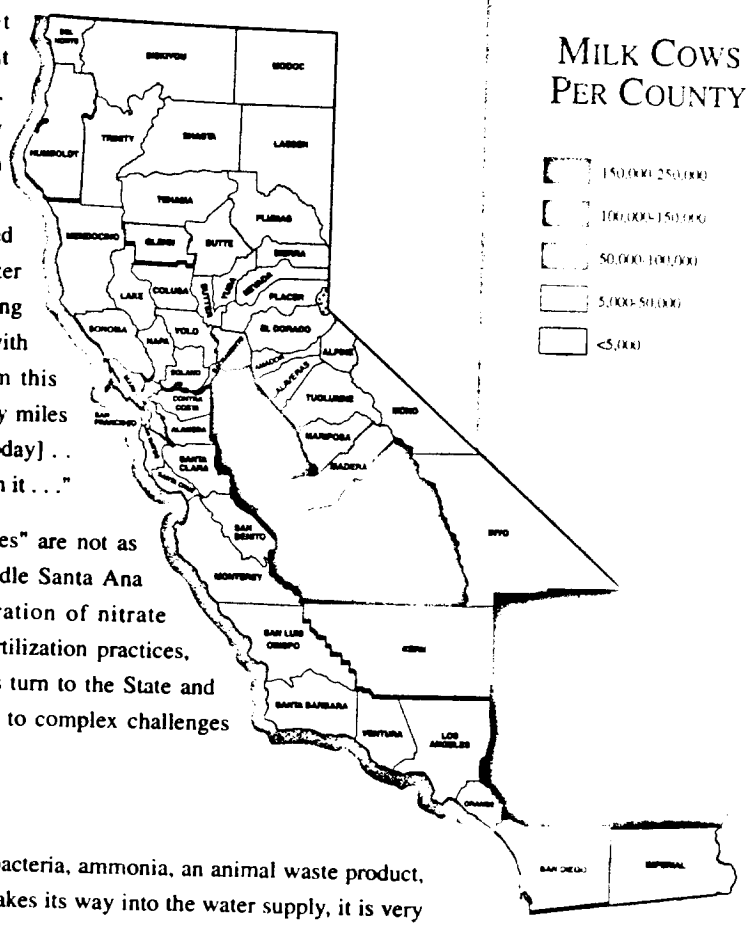
CHAPTER 6

NITRATE: FINDING ANSWERS FOR THE SANTA ANA

In southern California, hot, dry summers are offset by mild, wet winters contributing to an excellent environment for agriculture. Recognizing this, a Mormon colony set up residence in San Bernardino in about 1840. Farmers planted wheat, beans, peas, and vineyards, and raised cattle which roamed the valley. A letter to Brigham Young offers the following description: "The rancho connected with the valley is about thirty miles from this place [Los Angeles], and about twenty miles from a good ship landing [Newport today] . . .There are excellent water privileges on it . . ."



Today these "excellent water privileges" are not as pristine as they once were. The middle Santa Ana River suffers from a high concentration of nitrate coming from dairy runoff, historic fertilization practices, and sewage treatment plants. Citizens turn to the State and local water boards to provide answers to complex challenges facing the Santa Ana River.

What is nitrate and why is it harmful?

In the presence of oxygen and certain bacteria, ammonia, an animal waste product, is changed into nitrate. Once nitrate makes its way into the water supply, it is very difficult to remove.

High nitrate levels can upset aquatic life and even threaten human life. Where water high in nitrate and other nutrients is ponded or held for extended periods behind dams, microscopic plants called algae "bloom" grow wildly and die almost as quickly, depleting the oxygen dissolved in the water that fish need to live.

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In drinking water supplies, the "blue baby syndrome" can result from high levels of nitrate. Nitrate is altered by metabolism to a compound which affects the oxygen-carrying capacity of the blood; infants with this problem are oxygen-deprived and actually turn blue.

Nitrate enters the river in part from the large dairy industry located in the Chino area about 30 miles east of Los Angeles. But there are other sources too. Since those who have the "excellent water privileges" have taken essentially all the flow from the upper Santa Ana River, the middle river is made up of treated wastewater and rising ground water. That ground water carries high nitrate levels from historically excessive application of nitrogen fertilizers in the first century of agricultural development.

The Santa Ana River's headwaters lie high in the San Bernardino Mountains. In the valley below, river flows naturally percolate into the ground water supplying the wells of all the towns and cities along the way. In Orange County, the local water district actively diverts the river and percolates essentially all of it for eventual extraction and use as drinking water.

Since the river--including dairy runoff and wastewater--is used in this way, nitrogen control is a top priority of the California Regional Water Quality Control Board, (Santa Ana Regional Water Board). Wastewater treatment plants must lower nitrogen levels in the effluent. Four treatment plants (in Riverside, Rialto, Chino, and Ontario) are already practicing some nitrogen control; in November 1991, the Santa Ana Regional Water Board ordered Colton and San Bernardino to upgrade their facilities by 1995. The cost to modify all six treatment plants is between 150 and 200 million dollars which averages three to four dollars per month per customer. River visitors benefit from improved recreational water quality.

Dairies continue to be a major source of nitrogen and other salts in the Santa Ana River watershed as they are in many parts of the State. Chino Basin, home to over 250 dairies and about 400,000 cows, is west of Riverside. Large amounts of manure with few ways to get rid of it result in piles, large and small, dotting the area. When it rains, chemicals in the manure including salts and nitrate percolate into the ground tainting the underground water supplies. These waters also rise to the surface and add their flows to the river.

How much salt flows from these ground waters into the Santa Ana River? A 1990 Santa Ana Regional Water Board report concluded that "97 percent of the salt load added to the ground water was from agriculture" and "88 percent of that load was

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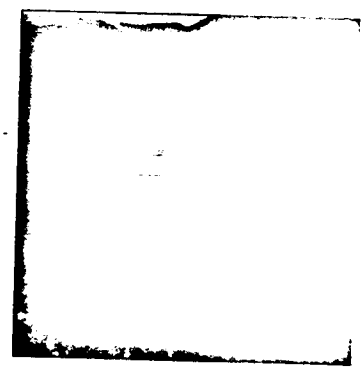
from the dairies alone". Surprising? Not when you realize that last year, over 600,000 tons of manure was produced in this area!

The Santa Ana Regional Water Board recognizes the importance of the dairy industry to the community as a whole, and thus has developed a strong, positive working relationship with two of the major dairy organizations in San Bernardino County. Since the dairies often use their own home-grown manure as fertilizer for the alfalfa and other animal feeds they grow, nitrate can also reach the ground water from this source. Manure typically contains too much salt and not enough nutrients, compared to commercial products; the Santa Ana Regional Water Board therefore limits the use of manure for growing these crops. Where manure is spread on the land simply as a means of getting rid of it, the application rate is strictly controlled to avoid water quality problems.

Dairy cows spend their days in the corrals where they often stand or lie in accumulated manure, so they must be thoroughly washed before each milking. The Santa Ana Regional Water Board insists that this washwater, laden with nitrate and manure, be disposed of on the dairy property using berms to prevent surface runoff. In the dry season, at least, this water is kept away from the river.



Dairy cows

Inspections and voluntary annual reports from the dairies to the appropriate Regional Water Board constitute a reasonable monitoring program for the industry. The best time to inspect dairies is during the rainy season when inadequately sized washwater ponds may spill over and berms are put to the test. The Santa Ana Regional Water Board's goal is to inspect each dairy each year.

In its annual Dairy Management Report, each dairy describes the details of its operation including the number of animals, the amount of manure produced, and the dairy's manure disposal practices. By sending out reminder notices, the Dairy Council aided in collecting these reports last year; every dairy turned in its report on time.

Other steps to lighten the river's salt load include construction of a co-composting facility in the area. This facility will combine sewage sludge with dairy manure creating a soil amendment that is better than either alone. Some will be exported from the region effectively exporting salt as well. Also in the planning stage are

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several more ground water desalters funded in part by the Agricultural Drainage Loan Program--a California State program. In these desalters ground water rich in nitrate and other constituents is pumped up through well networks, then treated until suitable for drinking. The salts themselves are discharged to the region's brine line which carries the salts from inland areas to the ocean.

Identification of increasing levels of nitrate in the Santa Ana Region and ways to control the problem means, finally, that corrective steps are at hand. By obtaining cooperation from dairies and local water districts, the Board accomplished much. All those involved--on both sides--who helped build communication and relationships between the organizations are to be applauded.

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CHAPTER 7

OPEN RANGE LIVESTOCK: THEY CAN MUDDY THE WATERS

In the lush meadows and pastures that fill the stream valleys of the east side of the Sierra-Nevada, ranches with roaming livestock are an important industry. In the heat of summer, these animals naturally congregate near water to drink, eat, and cool down. But where their access to streams is unrestricted and grazing management is slim, livestock may damage streams in several ways.

First, they can muddy the water, both by walking in streambeds and by trampling the banks. As we have seen (Chapter 5), the resultant erosion and siltation chokes aquatic life. Siltation can kill fish directly, impact fish spawning, or even destroy the insects fish eat for food.

Second, increased animal manure in streams raises the nitrogen level and may increase bacteria levels in the stream with the same results seen at poorly managed dairy farms (Chapter 6). Nitrogen stimulates algal growth, and the die-off of algae further robs the stream of oxygen. Plant growth in the streams increases because more sunlight is available than in the original, deeper, uneroded channel. Furthermore, some of the nitrogen occurs as ammonia which is poisonous to aquatic life, and its toxicity is made greater by higher temperatures and lack of oxygen. Increased bacteria pollute the water for drinking.

Grazing livestock

Third, all of the above effects--siltation, growth of nuisance algae, loss of oxygen--are exacerbated because livestock remove streamside vegetation. With the streamside vegetation removed, the streambanks more readily collapse and erode. As the streambanks erode, the streams become wider and shallower. With this change in stream shape combined with fewer trees, shrubs, and grasses to shade the banks and water, stream temperatures rise. The warmer temperature drives oxygen from the stream water and puts stress on cold-water fish like trout.

Fourth, the loss of streamside foliage has another, more surprising effect on aquatic life: eliminate vegetation and you may put fish on a starvation diet. This is because streambank vegetation is an important place for insects to live, insects that serve as food for fish such as trout. The net result of all these changes can be serious harm to a mountain or meadow trout stream. The damage strikes both in the water and

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alongside it for, as noted previously (Chapter 2), streambank vegetation in arid California is a mainstay of biological diversity. Where plant cover is lost, so too is a great variety of animal life lost.

This sort of decline doesn't happen overnight. And it may not be noticeable at the outset. Furthermore, in those parts of California where grazing has long been the chief land use it is hard to visualize the riparian habitat that was once there. In places like the Owens River watershed, public and private owners have used the land for livestock grazing for years.

The U.S. Forest Service, Bureau of Land Management, and the Los Angeles Department of Water and Power (LADWP) are the largest landowners, while many private ranchers own smaller parcels in the Owens Valley and lease additional pasture from the public owners. Recently, the Lahontan Regional Water Board began to stress the need for improved grazing management planning, as few of the large non-federal landowners had formal grazing management plans to protect streams from degradation. As a result, recent fencing projects and improved grazing management by LADWP has resulted in improvements in streamside vegetation.

Several practices can help protect streams, yet sustain adequate food supply for livestock. Some of these are aimed at excluding livestock from large portions of sensitive streams. The techniques include obvious ones like fencing the streambank, and more experimental methods such as the use of electronic ear tags that provide a mild shock when the animal comes too close to the stream. Construction of watering holes away from streams has been successful in Colorado and is being used in parts of California. Pasture rotation systems which allow pastures to be rested and provide a period of recovery from intensive grazing are also an option.

Other practices aim at rehabilitation of the watercourse. These include placement of logs or rocks beneath banks, replanting of native vegetation to restore bank stability and prevent erosion, construction of a deeper, narrower channel in degraded streambeds so stream flows last longer into the summer and stream temperatures do not increase as fast, and where feasible restoration of the original stream contour.

Livestock managers need to include restoration and preservation of water quality, streamside vegetation, and fish habitat in their goals. Currently the State and Regional Water Boards seek voluntary cooperation from ranchers to reduce siltation, overuse of streamside vegetation, and other harmful effects. Other industries have shown that the most effective control strategies originate from the practitioners (i.e., ranchers) themselves. Heightened awareness of those activities that impair streams is but the first step toward necessary improvements.

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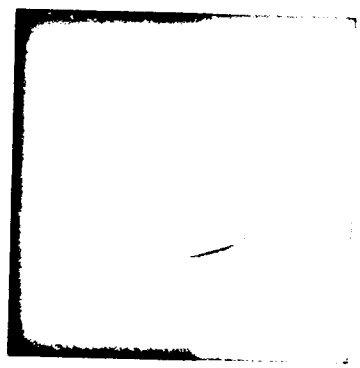
CHAPTER 8

TIJUANA RIVER: IS A SOLUTION IN SIGHT?

The Tijuana River which flows north from Mexico to San Diego County contains untreated domestic and industrial wastewaters from the Mexican border Cities of Tijuana and Tecate. The health of the citizens of both Mexico and the United States is threatened by this discharge, and water quality in the Tijuana National Estuarine Reserve and at the beaches of south San Diego County is degraded.

The combined populations of Tijuana and Tecate are estimated to exceed one million people. Mexico has not expanded its wastewater system fast enough to keep pace with the population growth. Thus, approximately one-third of Tijuana is currently unsewered. The City of Tecate provides no treatment at all for any of its wastewater. By 1991, 13 million gallons per day of raw sewage flowed in the Tijuana River.



Tijuana River near California border

The need for adequate wastewater collection, treatment, and disposal for Tijuana has long been recognized by officials in both countries. In the fall of 1991, Mexico completed construction of a small dam and collection system designed to divert sewage to the San Diego wastewater treatment plant. During dry weather, when the river's natural flows are low and the wastewater collection facilities are working, no sewage flows in the river. During the rainy season, high flows in the Tijuana River mix with the sewage. When the volume of water is too large to treat, the diversion pipeline is shut down and a mix of sewage and rain water flows into San Diego County. The City of San Diego agreed to provide treatment for up to 13 million gallons per day of Mexican wastewater diversions.

However, because of its own population growth, the City of San Diego cannot long continue to treat and dispose of Mexican wastewater. In the near future, all Mexican wastewater will have to be treated in new facilities constructed either in Mexico or the United States.

The existing treatment capacity is no more than 25 million gallons per day for Tijuana and none exists for Tecate. In the next 20 years, populations of Tijuana and Tecate are expected to nearly double and the wastewater treatment and disposal

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needs are anticipated to quadruple. Since 1981, the State and Regional Water Boards have been working with the federal government and local agencies to plan, build, and operate a joint international treatment facility in the United States and a long pipeline for ocean disposal. This team effort is beginning to pay dividends. Planning is nearly complete for a 25 million gallon per day treatment plant to be located in San Diego County which will treat Mexican wastewater. This plant is designed for future expansion to 100 million gallons per day. Treated wastewater from this plant will be discharged approximately three miles out in the Pacific Ocean. Ground breaking for the first phase of the treatment plant occurred July 15, 1994. The entire joint facility is projected to be completed in 1998 and cost $388 million.

There is, however, only so much that facilities on the United States side can do to lessen the impact of Mexican sewage on the United States. It is essential that Mexico upgrade and expand its collection system so that all sewage from Tijuana and Tecate will be routed to the new United States facilities and to existing or future facilities operated by Mexico. In addition, it is imperative that Mexico initiate an industrial waste control program to lessen the toxicity of its wastewater.

For the long term, the joint international facility can be viewed as the first phase of a much larger facility. The very day the proposed treatment plant begins operation, the sewage flows needing to be treated are expected to exceed the capacity of the plant.

These much-needed facilities, however, provide an important foundation upon which to expand sewage treatment and disposal. Along with the need for more funds in the future, there is the need for continued cooperation from Mexico and the United States governments. The State and Regional Water Boards will continue to work closely with all parties involved to plan and construct Mexican wastewater projects that ensure protection of public health and water quality.

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CHAPTER 9

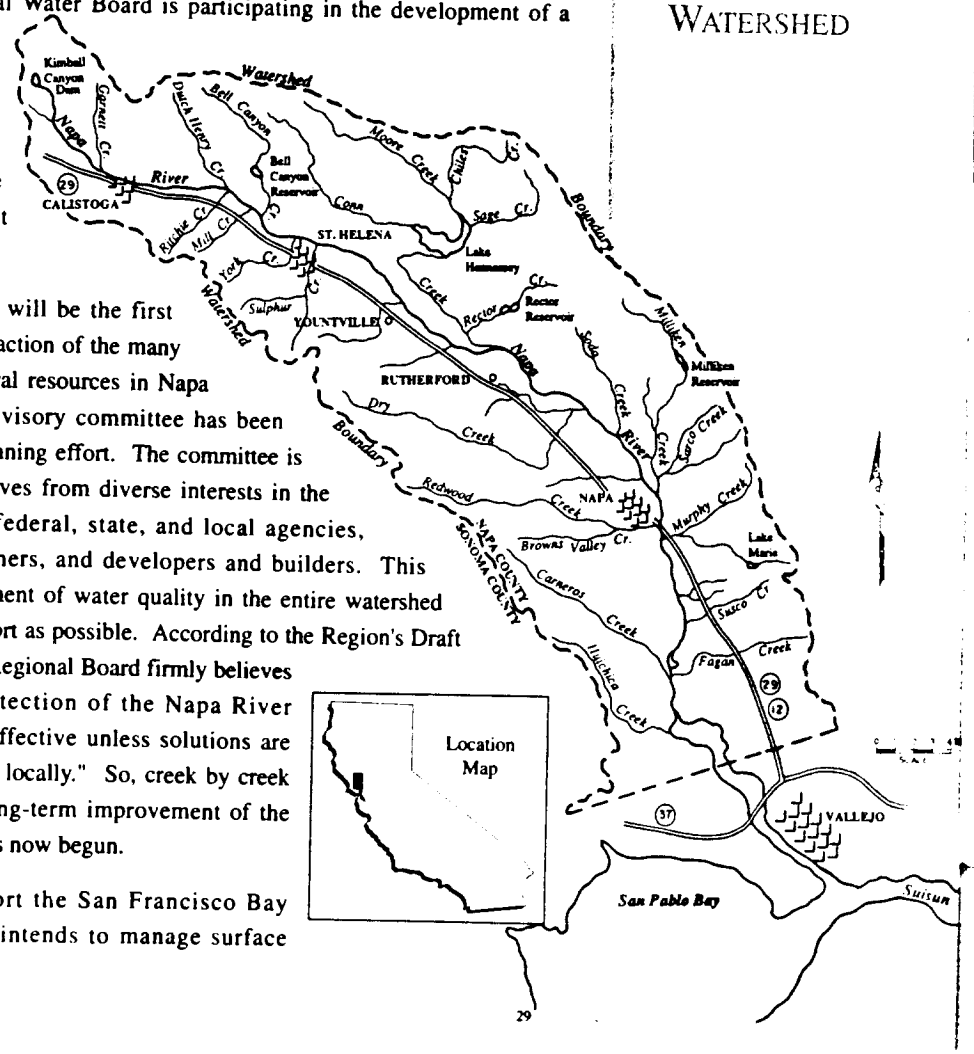
WATERSHED MANAGEMENT: THE ULTIMATE ANSWER?

In August 1992, the California Regional Water Quality Control Board, San Francisco Bay Region (San Francisco Bay Regional Board) pledged to improve the quality of the Napa River with a new and comprehensive approach. Urban and agricultural discharges of pollutants have degraded aquatic habitat in the river, the downstream marsh, and San Pablo Bay estuary. In response, the San Francisco Bay Regional Water Board is participating in the development of a Napa River Watershed Integrated Resource Management Plan, coordinated by the Napa County Resource Conservation District (RCD).

This management plan will be the first examination of the interaction of the many activities affecting natural resources in Napa Valley. A technical advisory committee has been formed to direct the planning effort. The committee is made up of representatives from diverse interests in the watershed, including federal, state, and local agencies, Audubon Society, vintners, and developers and builders. This process allows management of water quality in the entire watershed with as much local support as possible. According to the Region's Draft Watershed Report, "the Regional Board firmly believes that planning and protection of the Napa River watershed will not be effective unless solutions are designed and carried out locally." So, creek by creek and task by task, the long-term improvement of the Napa River watershed has now begun.

In this pioneering effort the San Francisco Bay Regional Water Board intends to manage surface

NAPA RIVER WATERSHED



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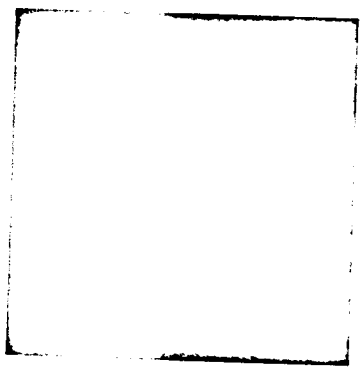
waters by watershed--the land and surface drainage encompassed within a single basin. Historically, water quality problems have been addressed by program; federal and state agencies have historically funded certain projects ordinarily tied to sewage treatment plants. Now most remaining water quality problems concern runoff from diffuse sources, oftentimes difficult to isolate and sometimes expensive to correct. The cumulative impacts of many small, diffuse contributions from various land use practices are evident but until just recently there was no coordinated attempt to reduce these diverse pollution sources.



Vineyards

Sediment buildup from erosion due to hillside construction of vineyards, homes, and dirt roads, and unstable stream banks affects nearly all segments of the Napa River, endangering sensitive fish and invertebrates downstream. In addition to destroying steelhead spawning grounds, this can cause water quality problems such as high nitrogen concentrations, and buildup of metals and pesticides in downstream sediments. In concert these features lead to poor conditions for aquatic life.

Within the last decade, two vineyard practices have helped considerably to reduce agricultural erosion. Grape growers refrained from tilling in steeply sloped vineyards to control weeds and instead cover crops--usually grasses--now grow between vines. Also, when growers prepare fields for new vines they level the soil with painstaking attention to drainage design. The Napa County Resource Conservation District worked with growers on applying the newest technologies in erosion control.

In the past, certain grazing practices in the Napa Valley also lowered the water quality of the Napa River. Herds of domestic animals muddied creekbeds, stirred up sediments, and disturbed stream bottoms. Manure loaded creeks with its accompanying nutrients, stimulated algal growth and severely strained aquatic life. Increased bacterial contamination of the river also lowered its recreational appeal.

Improved livestock management practices promise lower erosion rates. For example, many ranchers limit their animal numbers while rotating animal pasturage and stream access. On a related problem nearby in Sonoma County, dairymen are reducing their fertilizer applications to minimize nitrogen seepage into Stemple Creek. But these techniques are neither universally known nor practiced. There is still a need to expand efforts to reduce rangeland runoff.

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Recently, Napa County citizens recognizing the need to address erosion problems in the watershed convinced local authorities to enact a Conservation Ordinance. This Ordinance confronts a wide array of erosion problems by restricting vegetation removal, requiring setbacks from streams, and promoting use of temporary soil stabilizing measures during construction. The Cities of Calistoga, St. Helena, and Yountville also passed ordinances on property creek set-backs--ranging from 35 to 100 feet--aimed primarily at preventing soil erosion into streams. Additional zoning requirements restrict building on slopes over thirty percent and control temporary soil storage on construction projects. Passage of these ordinances goes beyond community awareness of the problems; it shows genuine commitment to long-term improvements--one vital ingredient for a watershed protection program.

A Napa County ordinance in 1980 established zones along streams in which a permit is required for the removal of any natural vegetation. This sort of ordinance recognizes that vegetation removal can impair water quality in several ways, for example, by speeding the transfer of pollutants such as pesticides, fertilizers, and sediment to streams (see Chapters 5 and 7). The San Francisco Bay Regional Water Board report noted that urbanization, agriculture, and grazing have led to the loss of much streamside vegetation in the Napa River basin, but that there are now several ongoing and proposed projects aimed at reversing the situation through restoration and enhancement of riparian habitat.

In its Watershed Report the San Francisco Bay Regional Water Board outlined four initial tasks: to identify remaining problems and monitoring needs; identify involved agencies and stakeholders in the watershed, including landowners, agricultural groups, industrial groups, and environmental groups; identify potential funding sources; and in conjunction with all stakeholders select criteria for ranking problems and tasks needed to correct them. The proposed restoration and enhancement plan for the Napa River attempts practical solutions to erosion, agricultural runoff, and bacterial contamination through multi-agency, landowner, citizen, and industry cooperation.

One step that local citizens have taken to prevent further pollution has been to project the location, extent, and intensity of population growth and other added burdens to the watershed, such as increased urban runoff. By foreseeing further impacts to the watershed, private and public planners alike can consider actions which will perpetuate good water quality.

For the City of Napa, the formation of a Citizens Advisory Committee on growth direction has been one step toward reconciling land use priorities.

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Napa County's General Plan also shows residents' involvement in managing Napa Valley growth. And the County boasts numerous policies to protect surface waters throughout the area.

Local volunteer groups have taken action at critical sites in the watershed. A cleanup of Napa Creek took place several years ago. Now citizens provide information on local water quality conditions and local residents take steps to revegetate stream corridors and restore deteriorating wetlands to their natural state. The Napa RCD has begun a pilot project in 3 schools incorporating the Adopt-a-watershed curriculum into the schools. The long-term goal of this project is to tailor the Adopt-a-watershed curriculum specifically to the Napa watershed thus educating youth about their local environment.

The potential for achieving long-term solutions from volunteer support is significant. For example, an all-out sign-posting campaign requires much participation and is an ideal vehicle for expanding local awareness of Napa Valley's water quality problems. The California Department of Fish and Game in Yountville has purchased stencilling equipment with symbols to discourage dumping of oil or other pollutants into storm drains. Many will be watching the Napa watershed restoration and enhancement; its progress may provide a model for others to follow.

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CHAPTER 10

REGION-BY-REGION SUMMARY

This chapter provides a summary of the most prominent water quality issues for rivers and streams facing each California Regional Water Quality Control Board (Regional Water Board). Each section includes a brief description of the region, a map identifying a few of the highest priority rivers, and summarized information on the water quality in the form of pie and bar charts.

The first pie chart depicts the water quality of rivers and streams as assessed by the Regional Water Boards in 1991. Each slice represents the percentage of river miles considered good, intermediate, impaired, and those having unknown water quality. The bar chart depicts the relative percent of each source of the pollutants that cause the impairment. The second pie chart below the bar chart names the types of pollutants or other causes responsible for the water bodies being listed as impaired. Only a portion of the rivers and streams in each region have been assessed, chiefly those water bodies that the Regional Water Boards consider high priority. These charts should be considered estimates; however, they represent the best information available.

Although sewage treatment plants, factories, and industrial discharges are sometimes responsible for impairing water quality, few of the sources of impairments come from the end of a pipe. Most result from some type of land use like mining, logging, agriculture, storm and residential water use entering storm drains from urban areas, etc. Some types of pollution are the result of the loss of natural streamside vegetation which increases erosion rates and degrades water quality. In some cases these changes reduce the ability of the water body to support fish and wildlife.

Usually these sources of pollution are the unintentional outcome of the same activities that make or made California a prosperous state. There are no villains, just a lot of work to be done to change practices that have in some cases been done the same way for more than a century.

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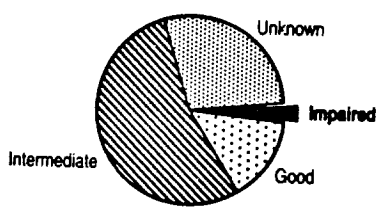
REGION 1

THE NORTH COAST REGION

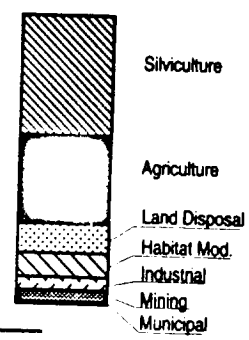
The North Coast Regional Water Board covers approximately 10 percent of the State yet yields about 40 percent of the surface water in the State. The region is characterized by numerous rivers and streams of the highest quality, with vast areas of wilderness and managed forests. Most significant point source discharges are well regulated and significant progress has been made with nonpoint sources. In addition to monitoring point sources and working with resource users to enhance beneficial uses, the primary focus is pollution prevention. While a small fraction of the waters have been assessed, these were generally found to be of good or intermediate quality.

In the North Coast Region only a small portion of the total assessed river and stream miles are impaired (about 84 miles). Due to the large number of smaller tributary streams a large percentage of the total river and stream miles have not been assessed. The economy of the North Coast relies heavily on the timber industry and agriculture. These activities provide jobs, however, they also create changes in the watershed that affect the beneficial uses associated with healthy rivers and streams. Because the area is not densely populated there is relatively small impact from the sources of impairment that are more common to highly populated areas such as storm drains and municipal sources.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

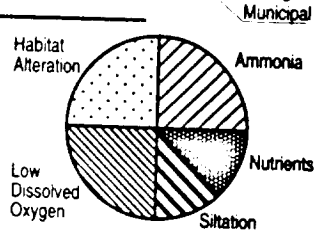


3,085 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



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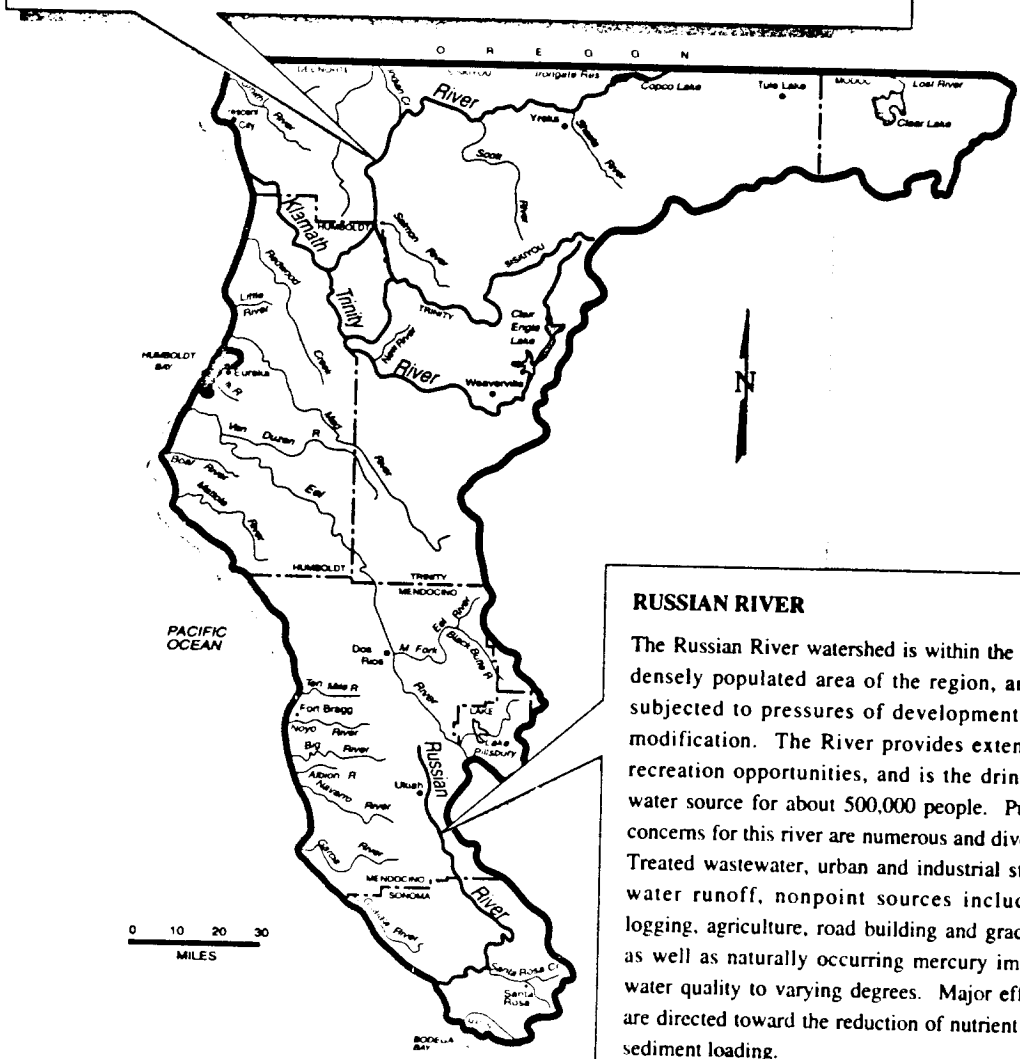
KLAMATH/TRINITY RIVER SYSTEM

Together, the Klamath and Trinity Rivers support the second largest chinook salmon population in California. While the upper part of the watershed supports extensive agriculture in California and Oregon, the balance of the river, below Iron Gate Dam, is designated Wild and Scenic River status. Current and historic land uses, such as mining, logging, road building, and agriculture have modified the physical and chemical qualities of much of the watershed. Severe and rapid reduction in the salmon populations have prompted the elevation of this watershed to the highest priority.



RUSSIAN RIVER

The Russian River watershed is within the most densely populated area of the region, and is subjected to pressures of development and modification. The River provides extensive recreation opportunities, and is the drinking water source for about 500,000 people. Public concerns for this river are numerous and diverse. Treated wastewater, urban and industrial storm water runoff, nonpoint sources including logging, agriculture, road building and grading, as well as naturally occurring mercury impact water quality to varying degrees. Major efforts are directed toward the reduction of nutrient and sediment loading.

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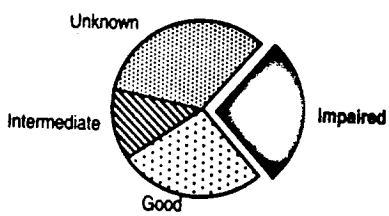
REGION 2

THE SAN FRANCISCO BAY REGION

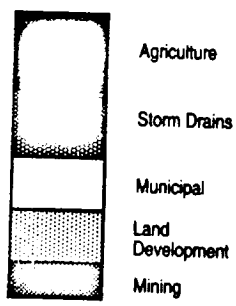
The area encompassed by the San Francisco Bay Regional Water Board is one of the largest urbanized estuaries in the country. Portions of the region also have significant agricultural areas, e.g., the Napa/Sonoma wine region. The rivers and streams of San Francisco Bay Region feed two of California's greatest estuarine assets--the San Francisco Bay Estuary and Tomales Bay. Water quality problems result from the diversion of fresh water inflow from the Sacramento/San Joaquin Delta. Other impacts come from the pollutants generated by the six to seven million people living in the region. This includes point and nonpoint, industrial and agricultural, and urban and rural sources of pollutants.

About one quarter of the assessed river and stream miles are considered impaired. More than half the river miles are considered good or are unassessed. The types of water quality problems facing the Regional Water Board are fairly well balanced between those that are typically considered rural (agriculture and mining) and urban (storm drains, municipal, and land development).

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

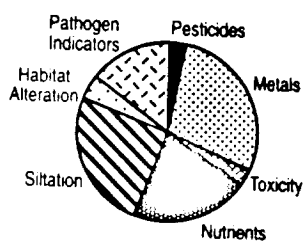


671 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



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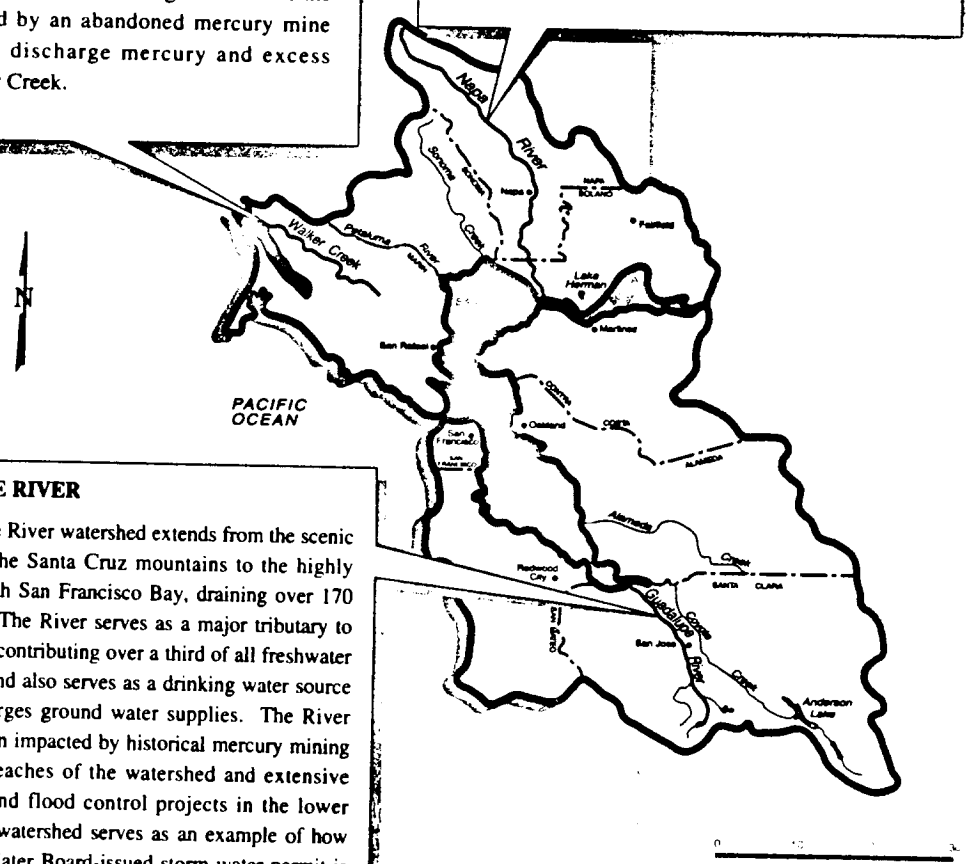
WALKER CREEK

Walker Creek is a major tributary to Tomales Bay--one of the most pristine estuaries remaining in the United States. The Walker Creek watershed supports a remnant run of steelhead trout and salmon. Early on the land was used extensively for logging and farming. Historic grazing and farming practices have lead to excessive erosion and sedimentation throughout the watershed. Today the land is used to support dairies, sheep, and cattle grazing. Dairy waste discharges increase nutrient and coliform bacteria levels, and subsequently reduce the oxygen levels in the streams. The Regional Water Board is working to remediate the impairment caused by an abandoned mercury mine that continues to discharge mercury and excess sediment to Walker Creek.

NAPA RIVER

The Napa River watershed is recognized worldwide for its scenic beauty, premium wineries, hot spring resorts, and rich diversity of fish and wildlife. The Napa River watershed supports a remnant run of steelhead trout and chinook salmon, and is the home for several endangered and threatened species. Erosion from new residential development, vineyards, and agricultural activities have impaired spawning grounds in the watershed and affected water quality. The Regional Water Board has been working closely with local agencies and the community in developing a comprehensive watershed protection management plan which includes developing erosion control strategies associated with residential development and vineyards. The Regional Water Board is also working with local agencies to develop an urban runoff control program.



GUADALUPE RIVER

The Guadalupe River watershed extends from the scenic reservoirs in the Santa Cruz mountains to the highly urbanized South San Francisco Bay, draining over 170 square miles. The River serves as a major tributary to the South Bay contributing over a third of all freshwater stream flows and also serves as a drinking water source where it recharges ground water supplies. The River system has been impacted by historical mercury mining in the upper reaches of the watershed and extensive urbanization and flood control projects in the lower reaches. This watershed serves as an example of how the Regional Water Board-issued storm water permit is facilitating local protection and restoration efforts. In addition, the Regional Water Board through its abandoned mine program has been requiring remediation of mines in this watershed.

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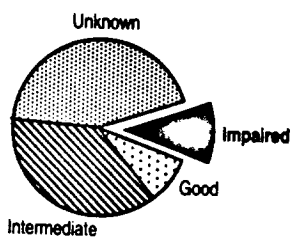
REGION 3

THE CENTRAL COAST REGION

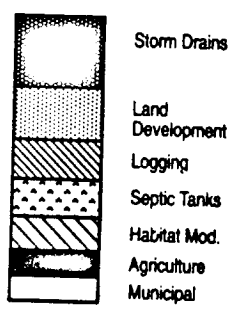
The Central Coast Regional Water Board includes a rugged seacoast, coastal mountain ranges, wide river valleys of prime agricultural land, a high rainfall redwood forest, and extremely arid inland plains. Many of the rivers and streams of the Central Coast have been harnessed by storage reservoirs for municipal and agricultural purposes. Surface water use has been overextended which has resulted in water quality degradation for aquatic habitat, ground water recharge, and other beneficial uses. Competition for adequate quality water will become more intense in the future.

About one eighth of the total river miles assessed are considered impaired. About the same amount of miles are considered good with the majority of river miles assessed as intermediate or unknown. The types of water quality problems associated with the impaired waters are more weighted toward urban (storm drains, land development, municipal) than rural (logging, agriculture).

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



1,976 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

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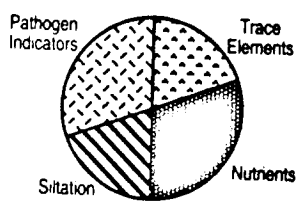

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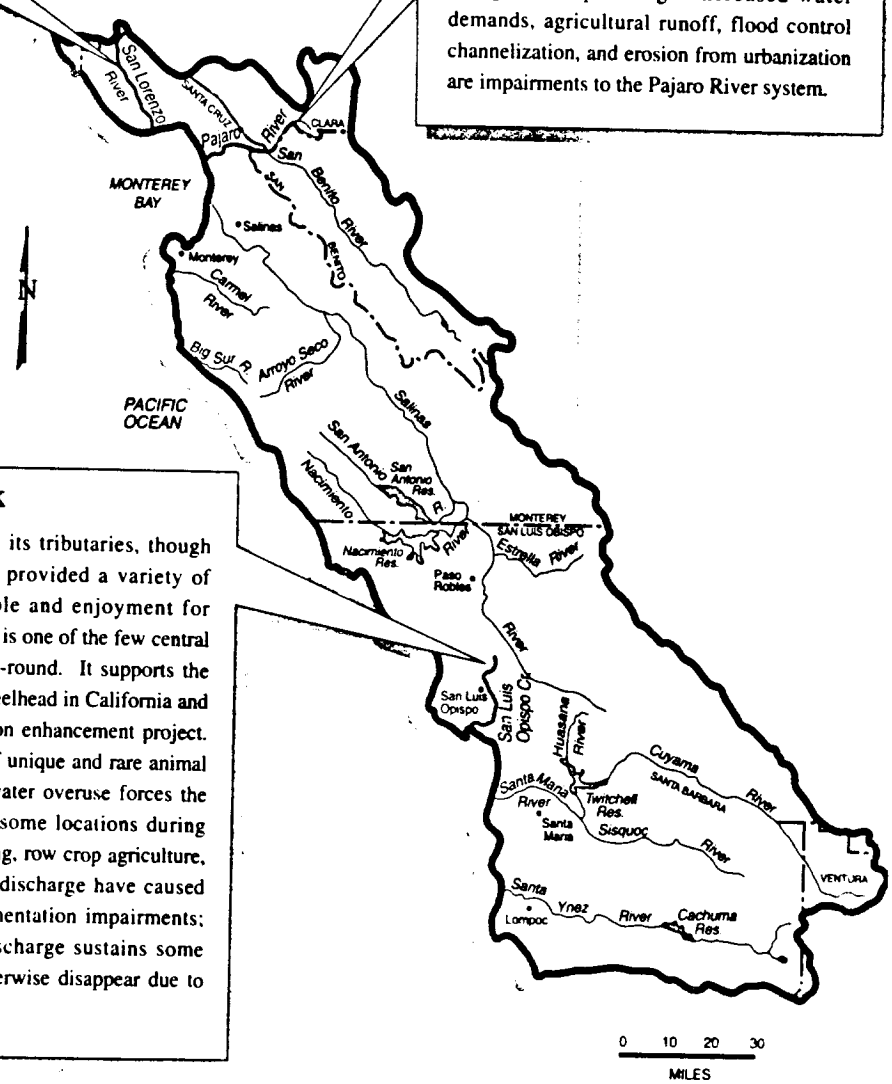
SAN LORENZO RIVER

The San Lorenzo River is a highly used recreational water that supports a popular steelhead fishery. It enhances three State parks and at least two city parks and provides municipal water supply for about 100,000 people. Historic logging and land development have resulted in widespread sediment impacts to the River and many of its tributaries. Failing septic systems have long been a source of nitrate and bacterial impairment to the River.

PAJARO RIVER

The Pajaro River is one of California's major coastal streams. The Pajaro River, with its tributaries, provides habitat, migration routes, and spawning for steelhead, silver salmon, and other native and non-native species. When the River mouth is open, marine species such as striped bass and starry flounder travel into the estuary and adjacent sloughs for spawning. Increased water demands, agricultural runoff, flood control channelization, and erosion from urbanization are impairments to the Pajaro River system.



SAN LUIS OBISPO CREEK

San Luis Obispo Creek and its tributaries, though relatively small, have long provided a variety of benefits for the local people and enjoyment for numerous visitors. The Creek is one of the few central coast streams that flows year-round. It supports the southernmost population of steelhead in California and is home to a successful salmon enhancement project. It is also home to a number of unique and rare animal and plant species. Ground water overuse forces the creek to flow subsurface at some locations during summer months. Cattle grazing, row crop agriculture, and a municipal wastewater discharge have caused bacterial, nutrient, and sedimentation impairments; however, the wastewater discharge sustains some beneficial uses that might otherwise disappear due to lack of adequate water.

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REGION 4

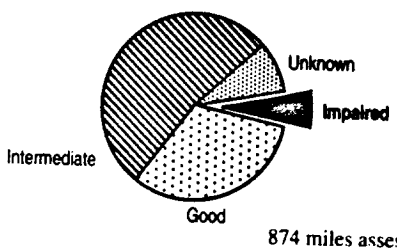
THE LOS ANGELES REGION

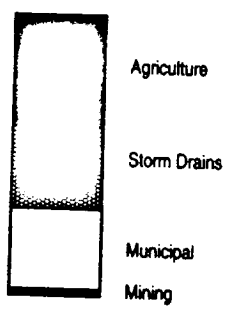
The Los Angeles Regional Water Board is characterized by a mix of pristine mountain streams, highly urbanized foothill and valley areas, and heavy residential and industrial coastal areas with highly used recreational beaches and harbors. All of these different land uses present actual or potential threats to water quality from either point or nonpoint sources of pollution.

In 1991, the Regional Water Board assessed 874 miles of rivers and streams, of which, 55 miles (<10%) were considered impaired and 464 miles intermediate (threatened). About a third of the river miles are considered good, and a small amount unknown.

Although the Los Angeles region is densely populated with the characteristic water quality problems associated with storm drains and municipal discharges, there are also rich agricultural land within the region and these have significant influences on water quality.

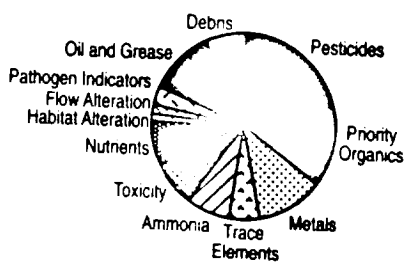
RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT





POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



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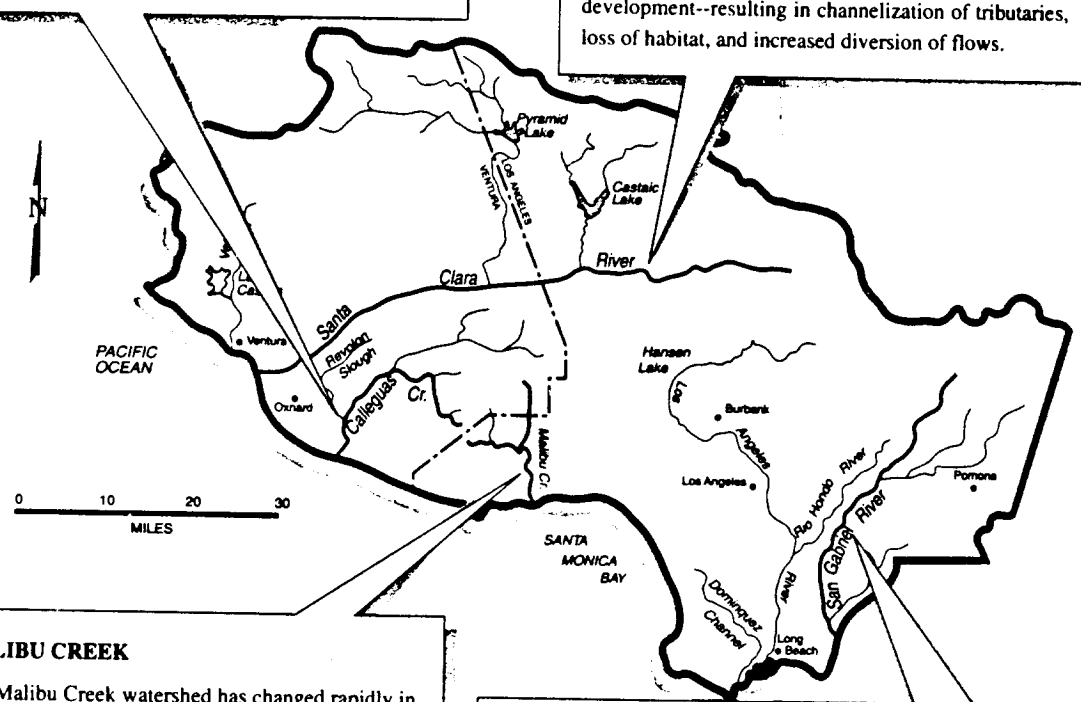
CALLEGUAS CREEK

Calleguas Creek drains a predominantly agricultural area in the Oxnard Plain. Increasing development in the watershed has increased slope instability causing severe erosion and sedimentation. Discharges from sewage treatment plants contribute ammonia, excess nutrients, and other dissolved constituents. Irrigation return flows carry suspended sediment, nutrients, and pesticides. Pesticides have accumulated in aquatic life and sediments.

SANTA CLARA RIVER

The Santa Clara River is the largest river system in southern California and is one of the last major rivers in the region that remains in a relatively natural state. Extensive patches of high quality riparian habitat are present along the length of the Santa Clara River and its tributaries. Because of its size and location, the River serves as an important stopover for migratory birds. This River provides habitat for several endangered and threatened species. Threats to water quality include increasing encroachment by development--resulting in channelization of tributaries, loss of habitat, and increased diversion of flows.



MALIBU CREEK

The Malibu Creek watershed has changed rapidly in the last 20 years from a predominantly rural area to a steadily developing area that has doubled in population to nearly 80,000 residents. Increased flows due to the use of imported water to support the growing population base as well as channelization and urbanization, have caused an imbalance in the natural flow regime in the watershed. Pollutants of concern, many of which are contributed by nonpoint sources, include excess nutrients, sediment, and disease-causing organisms.

SAN GABRIEL RIVER

The headwaters of the San Gabriel River originate along the southern slopes of the San Gabriel Mountains and carry vast amounts of sediment into the San Gabriel Valley and Coastal Plain. While the River and associated habitat in and along the headwaters of the San Gabriel River remain relatively pristine, these areas are heavily used for recreation (picnicking, fishing, and hiking), and some areas are threatened by this intensive use. The middle reaches of the River have been extensively modified to control flood and debris flows and to recharge ground water. Extensive sand and gravel operations are also found along the middle reaches of the River. The lower River is lined with concrete; flow in this stretch is dominated by wastewaters discharged from several municipal treatment plants and urban runoff.

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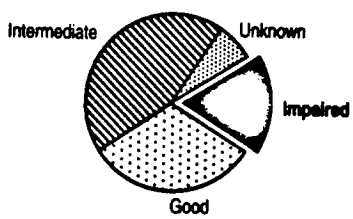
REGION 5

THE CENTRAL VALLEY REGION

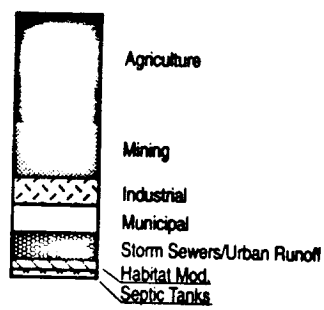
The Central Valley Regional Water Board is the largest of the nine Regional Water Boards, covering about 40 percent of the State. It stretches almost two-thirds the length of California from the Oregon border to the northern tip of Los Angeles County and includes all or part of 38 of the State's 58 counties. Its diversity is exemplified by extensive timber lands, active and abandoned mines, world renowned agricultural productivity from the Sacramento and San Joaquin Valleys and growing metropolitan areas. The main stems of the rivers and streams in the Region have been estimated to be approximately 5,800 miles. Of these, about 5,600 miles have been assessed by the Regional Water Board. Approximately one sixth of the rivers and streams (988 miles) are considered impaired, nearly one third are good, over one third are intermediate and a small fraction are unknown.

Slightly more than half of the impairments are the result of rural activities associated with agriculture and mining. The remaining river miles are impaired by activities that are the result of urbanization including industrial sources, municipal sources and storm drains.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

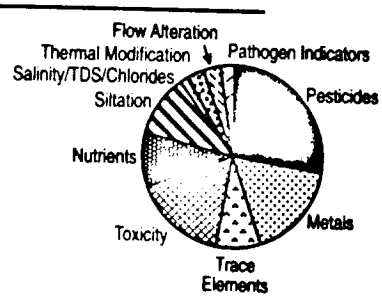


5,594 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



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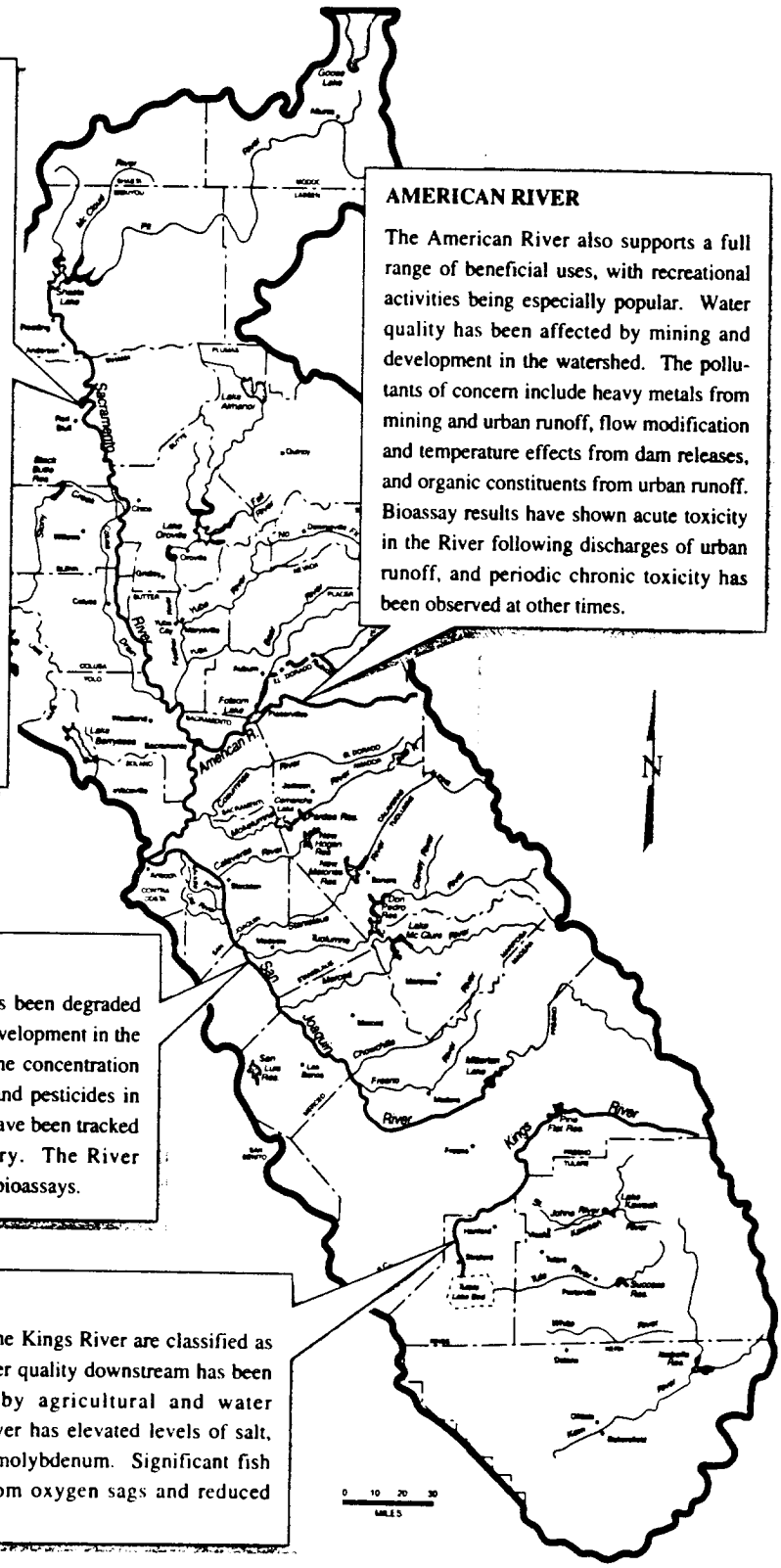
SACRAMENTO RIVER

The Sacramento River and its tributaries supply the majority of the surface water used in the State and supports a full range of beneficial uses, including a rare and endangered species of salmon. The River has been affected by seasonal discharges from mines, agriculture, urban runoff, and water development projects. The pollutants of concern include heavy metals from mines and urban runoff, pesticides from agriculture, flow modification and temperature effects from dam releases, and various organics from urban runoff. Heavy metals in the River cause reductions in the fish and invertebrate populations and have resulted in massive fish kills in the past. Pesticides from the Colusa Basin Drain have been shown to be toxic to striped bass and neomysis.

AMERICAN RIVER

The American River also supports a full range of beneficial uses, with recreational activities being especially popular. Water quality has been affected by mining and development in the watershed. The pollutants of concern include heavy metals from mining and urban runoff, flow modification and temperature effects from dam releases, and organic constituents from urban runoff. Bioassay results have shown acute toxicity in the River following discharges of urban runoff, and periodic chronic toxicity has been observed at other times.



SAN JOAQUIN RIVER

The San Joaquin River water quality has been degraded considerably by agricultural and water development in the watershed. This has greatly increased the concentration of salt, selenium, boron, molybdenum, and pesticides in the River. Elevated levels of pesticides have been tracked down the River and across the estuary. The River periodically tests acutely toxic in routine bioassays.

KINGS RIVER

The upper reaches of the Kings River are classified as Wild and Scenic. Water quality downstream has been heavily influenced by agricultural and water development. The River has elevated levels of salt, selenium, boron, and molybdenum. Significant fish kills have resulted from oxygen sags and reduced flows.

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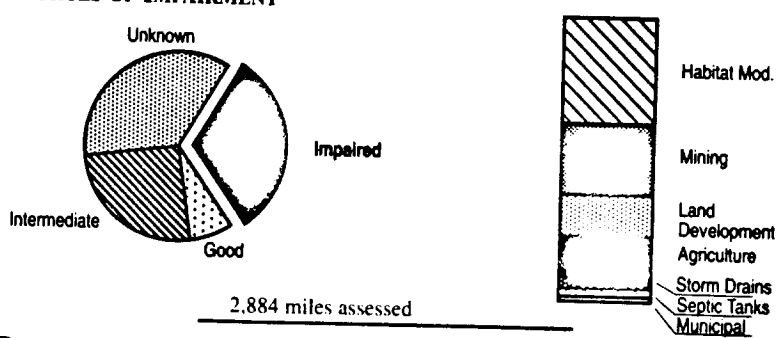
REGION 6

THE LAHONTAN REGION

The Lahontan Region, larger than the State of Maine, includes hundreds of streams. Many mountain streams have naturally excellent water quality; desert streams provide important aquatic and wildlife habitat. Both stream types historically supported rare fish species and subspecies. Many streams in the Lahontan Region receive heavy recreational use. Two streams are State wild and scenic rivers; many others are under study for federal wild/scenic designation. Very few point source discharges occur; some streams are impaired by water diversions or by nonpoint source problems. Most Lahontan Regional Water Board regulatory activities are related to nonpoint source control, including stream/watershed restoration efforts.

About one third of the river and streams miles are considered impaired and another one third is unknown water quality. Good and intermediate waters make up the remaining third. Water quality problems typical of the region result from using the land for livestock grazing or recreation use (habitat modification). Mining and impairments resulting from agricultural practices are also significant. About a third of the impairment is due to the urban pressures of increased populations (land development, storm drains, septic tanks, and municipal).

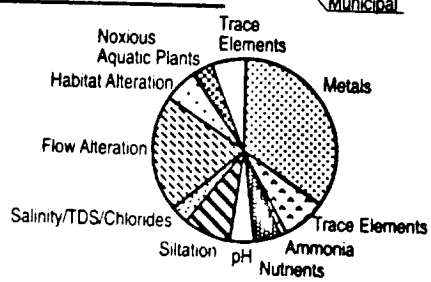
RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



2,884 miles assessed

POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



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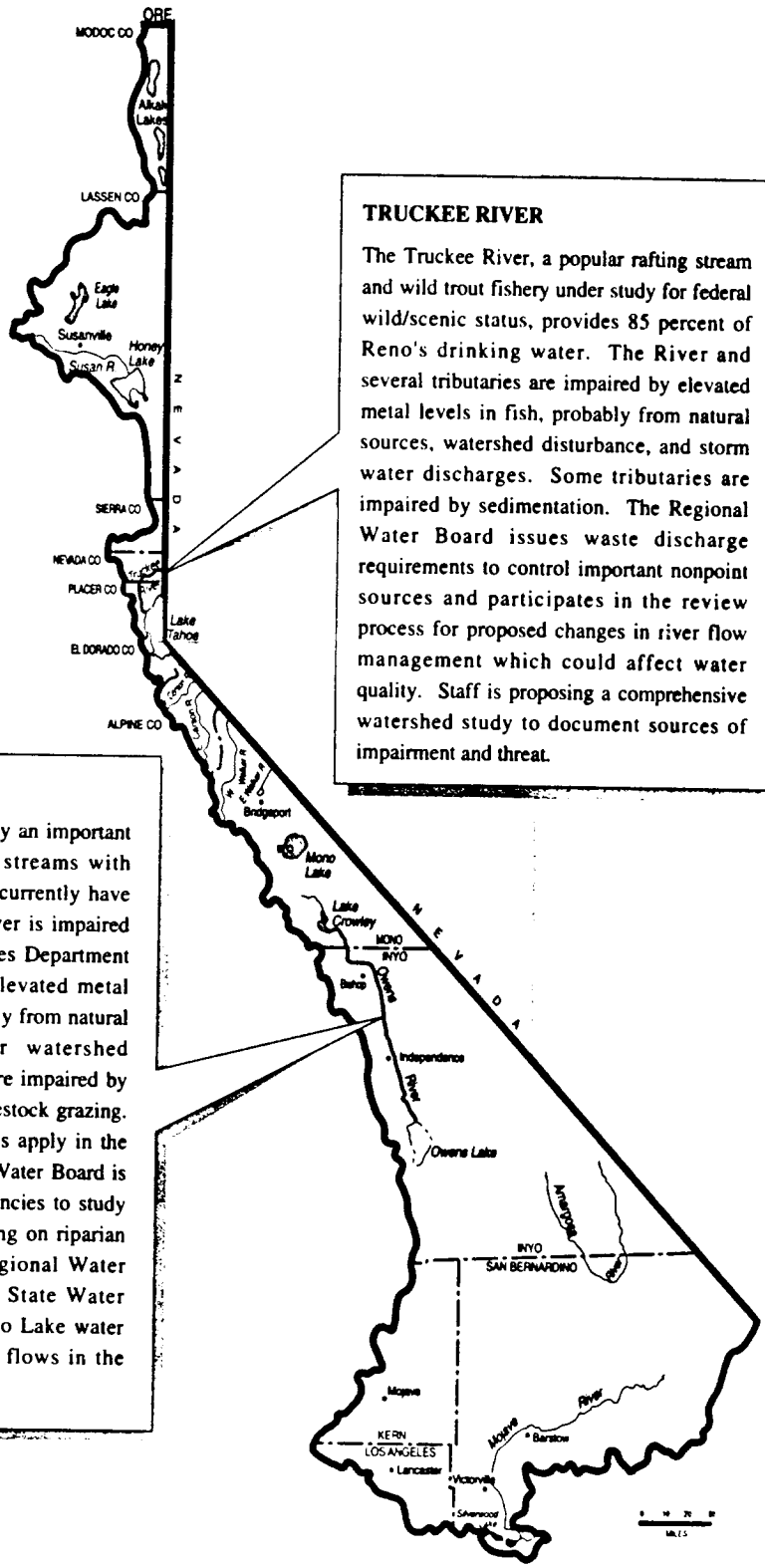

TRUCKEE RIVER

The Truckee River, a popular rafting stream and wild trout fishery under study for federal wild/scenic status, provides 85 percent of Reno's drinking water. The River and several tributaries are impaired by elevated metal levels in fish, probably from natural sources, watershed disturbance, and storm water discharges. Some tributaries are impaired by sedimentation. The Regional Water Board issues waste discharge requirements to control important nonpoint sources and participates in the review process for proposed changes in river flow management which could affect water quality. Staff is proposing a comprehensive watershed study to document sources of impairment and threat.

OWENS RIVER

The Owens River was historically an important trout fishery; many tributary streams with headwaters in wilderness areas currently have heavy recreational use. The River is impaired by diversions by the Los Angeles Department of Water and Power, and by elevated metal levels in fish. Metals are probably from natural sources, mining, and other watershed disturbances. Some tributaries are impaired by habitat degradation related to livestock grazing. Special erosion control guidelines apply in the Mammoth Area. The Regional Water Board is currently working with other agencies to study and control the impacts of grazing on riparian and instream habitat. The Regional Water Board also participates in the State Water Board's review process for Mono Lake water rights which will affect future flows in the Owens River.

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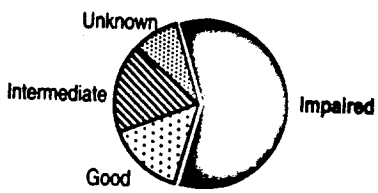
REGION 7

THE COLORADO RIVER BASIN REGION

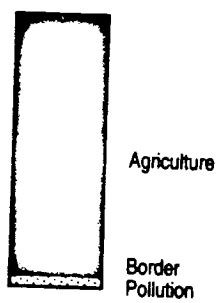
The Colorado River Basin Regional Water Board covers the most arid area of California. Despite its dry climate, the region contains two substantial surface water bodies, the Colorado River and the Salton Sea. The five rivers that flow into and sustain the Salton Sea are, in order of size, Alamo River, New River, Coachella Valley Storm Water Channel, San Felipe Creek, and Salt Creek. The last two are natural, perennial waterways while the first three exist mainly because of their use as conduits for farm runoff flows from the Imperial and Coachella Valleys. Most of the water used to irrigate farmland in this region comes from the Colorado River via canals.

More than half the river and stream miles are considered impaired. This is due primarily to the fact that the Colorado River Basin has limited river miles and many of those are the result of transporting agricultural runoff. Other river miles consist mainly of sewage overflows from south of the border. Good and intermediate waters make up approximately one third of the total river miles.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



2,442 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

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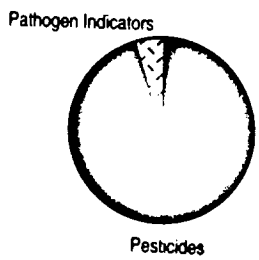

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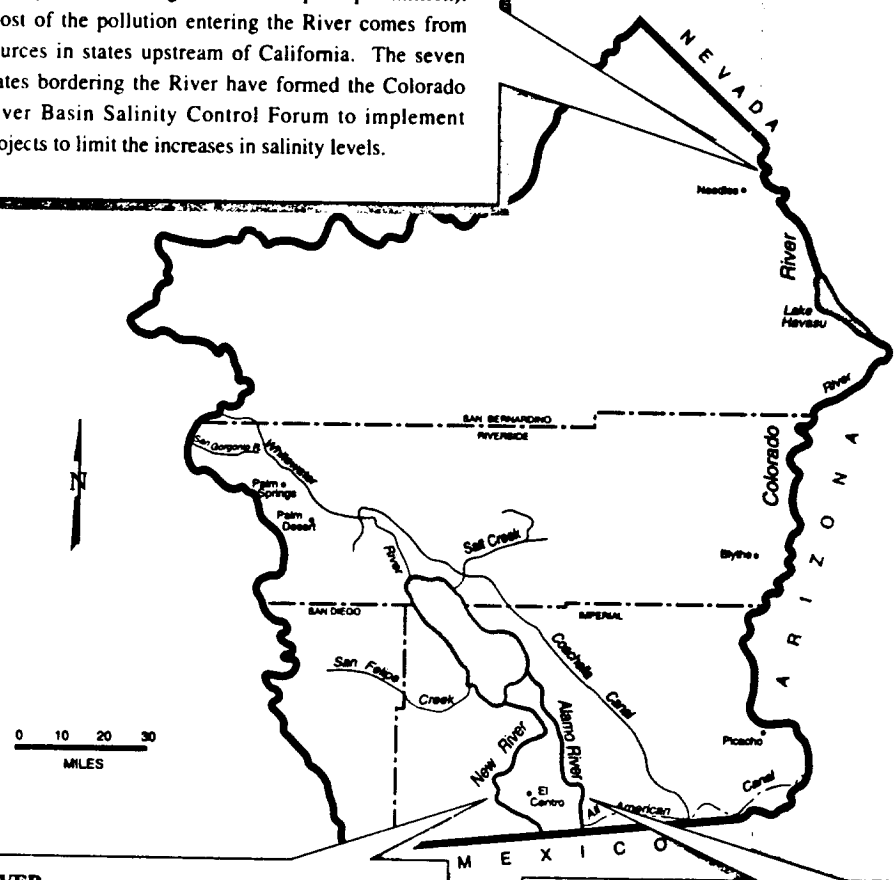
COLORADO RIVER

The lower Colorado River forms the 230 mile long border between Arizona and California. Large amounts of River water are diverted through aqueducts and canals to supply southern California. Water quality in the lower Colorado River is generally good although salinity levels are high (about 700 parts per million). Most of the pollution entering the River comes from sources in states upstream of California. The seven states bordering the River have formed the Colorado River Basin Salinity Control Forum to implement projects to limit the increases in salinity levels.



NEW RIVER

The New River is impaired along its entire 60 mile length from the Mexican border to its mouth at the Salton Sea. The flow crossing the border from Mexico (about 200 cfs) is composed of partially treated and untreated sewage from Mexicali, minor industrial flows, and a large volume of farm runoff from the Mexicali Valley. Another 500 cfs of flow enters the River from farmlands in the Imperial Valley of California and contains pesticides, silt, and fertilizers. The Regional Water Board works with the International Boundary and Water Commission and other State, federal, and local agencies to correct the problem of pollution from Mexico. Efforts to control pollution from Imperial Valley farms are directed by the nonpoint source programs.

ALAMO RIVER

The Alamo River flows for 52 miles from Mexico to the Salton Sea although only a small flow (2-3 cfs) currently comes from Mexico. Most of the flow in the River at its mouth (about 800 cfs) is composed of agricultural return flows from farms in the Imperial Valley with minor amounts of sewage treatment plant effluent and storm water flows. The River is impaired due to pesticides, silt, and Selenium. Fertilizers and bacteria also lower the water quality. Efforts to correct this agricultural pollution are directed by the regional, State, and federal nonpoint source programs.

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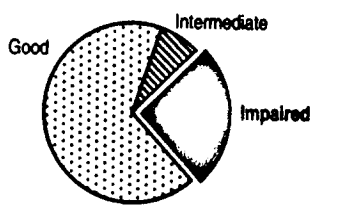
REGION 8

THE SANTA ANA REGION

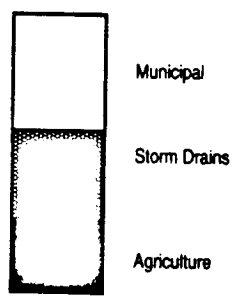
The Santa Ana Region, although the smallest in the State, is one of the most densely populated. The variety of local water resources is impressive: pristine mountain lakes and streams, lowland reservoirs filled with imported water, inland streams made up of reclaimed wastewater or nuisance water and runoff, critically important coastal wetlands, and the Pacific Ocean, with its broad, sandy beaches. Both the reason for development and the source of the problems has been the large population increase. Of the 448 river miles assessed, 109 miles are impaired by nutrients, pesticides, metals and/or pathogens, originating from agriculture, urban areas, and wastewater discharges. The Regional Water Board is focusing its efforts on preventing further degradation where it exists and developing management strategies to improve the quality of the impaired water bodies.

About a quarter of the total river and stream miles are considered impaired. The majority of the river miles are good with a small amount of intermediate river miles. Water quality impairment resulting from municipal and storm drain sources make up approximately two-thirds of the impaired river miles and agricultural type impairments make up the remaining third of the impaired river miles.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



448 miles assessed



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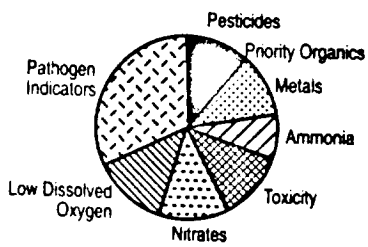

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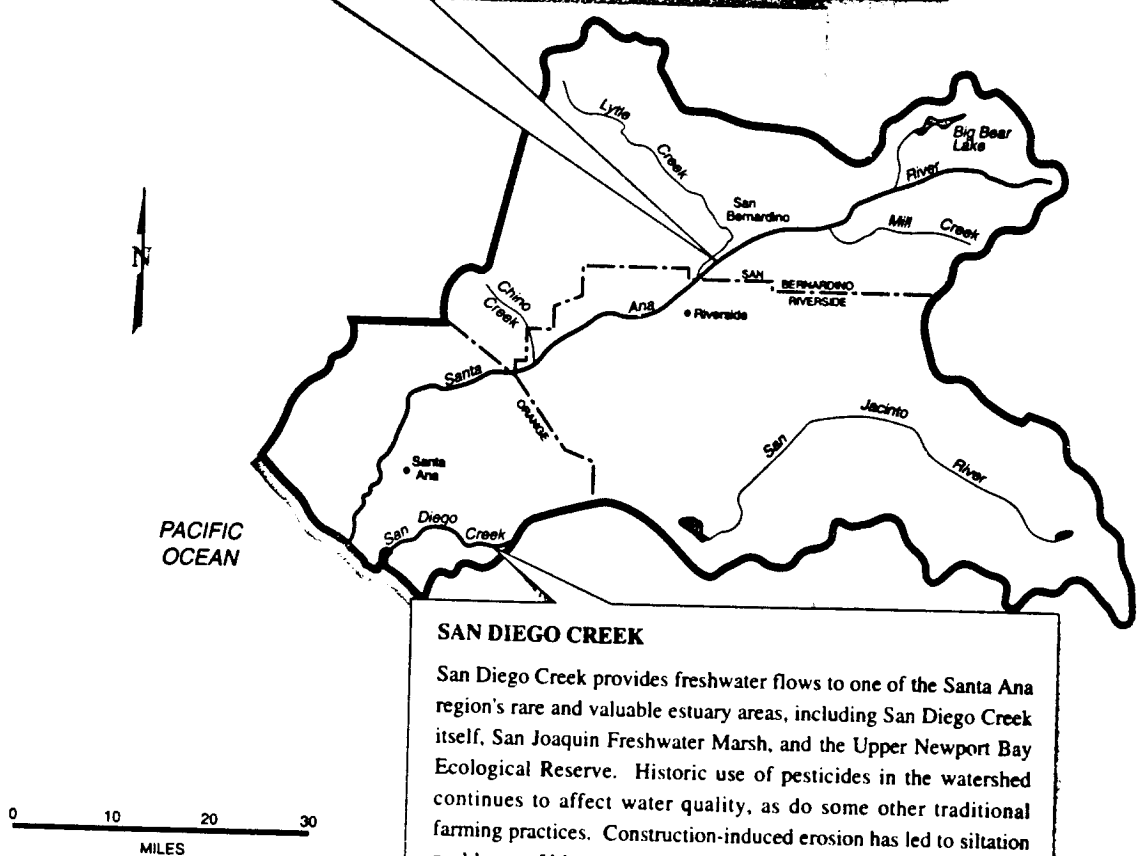
SANTA ANA RIVER

Flows in the Santa Ana River make up more than 60 percent of the municipal water supply of Orange County, thereby helping support its two million residents. The remaining 40 percent is imported Colorado River or State Water Project water. Between its start in San Bernardino and the Orange County recharge basins, the River is home to two native species of fish--the Santa Ana Sucker, which is thought to be threat-ened, and the Arroyo Chub. In addition, local residents frequently enjoy wading in the warm, shallow water, most unaware that the flow is predominantly reclaimed wastewater. Because (1) public health depends on the river being safe to swim in, (2) the quality of the river directly affects the quality of the ground water, and (3) the quality of the aquatic environment must support the native species, the Regional Water Board recently imposed stricter nitrogen standards on the contributing sewage treatment plants. Lower nitrogen levels in the rivers mean improved ground water quality and also less instream ammonia toxicity. Three major sewage treatment plants are not yet in full compliance and runoff from the dairy area still threatens the River, but efforts continue.



SAN DIEGO CREEK

San Diego Creek provides freshwater flows to one of the Santa Ana region's rare and valuable estuary areas, including San Diego Creek itself, San Joaquin Freshwater Marsh, and the Upper Newport Bay Ecological Reserve. Historic use of pesticides in the watershed continues to affect water quality, as do some other traditional farming practices. Construction-induced erosion has led to siltation problems. Urban runoff carries various toxic materials into the creek system, along with dirt, trash, etc. The implementation of corrective management practices is easing these problems. Urban storm water permits are expected to result in further improvements.

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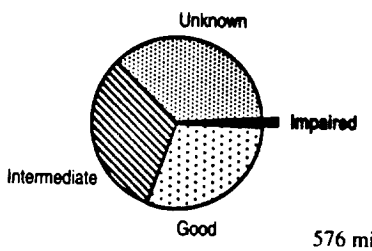
REGION 9

THE SAN DIEGO REGION

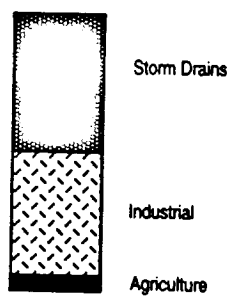
The San Diego Region is characterized by a semi-arid climate, with historically ephemeral inland surface waters. Urbanization of this region, coupled with increasing amounts of imported water is leading to changes in the characteristics of many of the region's streams. Increasing water use is producing an increase in dry weather runoff to the streams. Active management programs need to be designed to maximize the water resource benefits of the increased dry weather runoff, while minimizing all potential detrimental effects.

Only a small percentage of the river and stream miles are considered impaired. The remaining river miles are divided roughly equally into good, intermediate and unknown water quality. The sources of impairment are typically urban (storm drains and industrial). A small proportion of impairments are considered to be the result of agricultural practices.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



576 miles assessed



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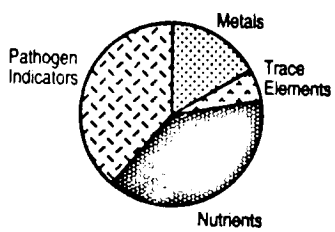

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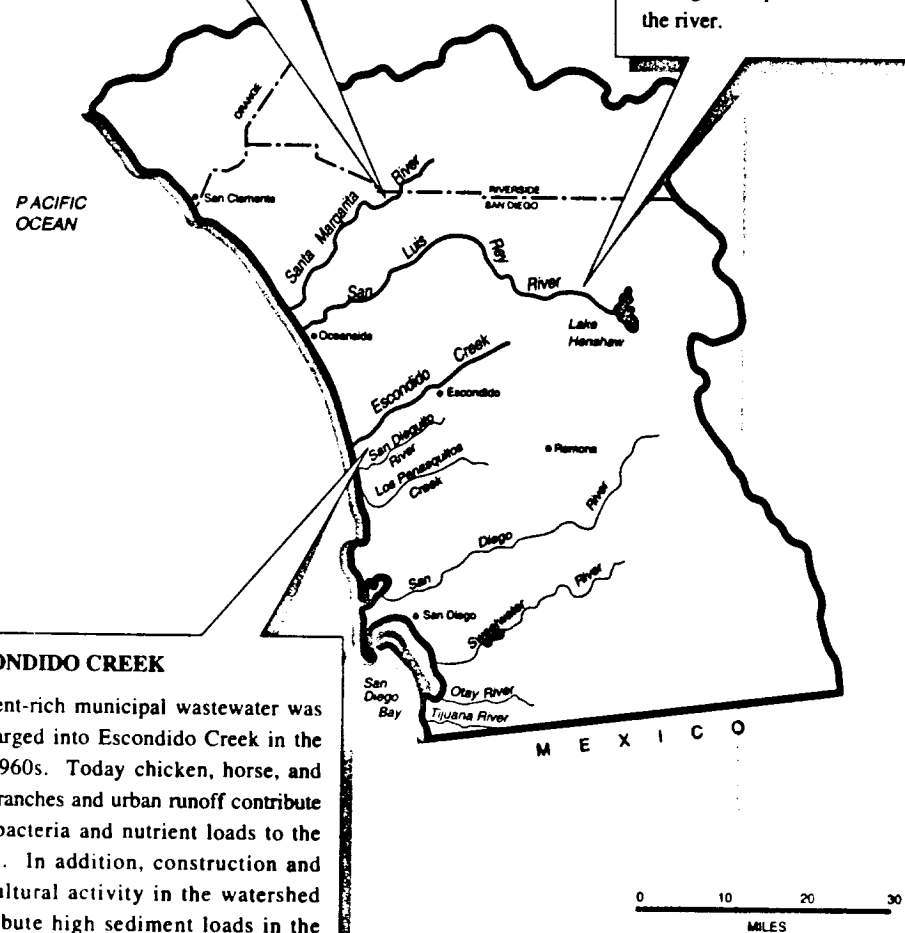
SANTA MARGARITA RIVER

Nurseries of Rainbow Valley have been identified as major contributors to nitrate pollution in Rainbow Creek, and down stream surface and ground waters of the Santa Margarita River Basin. Nursery and stream monitoring is being done to evaluate the impact of irrigation practices at the nurseries. The Santa Margarita River is also severely impacted by sedimentation from upstream construction sites in Riverside County.

SAN LUIS REY RIVER

Plans are underway to inventory existing aquatic and riparian habitat resources, to evaluate water quality, and to determine sources of pollutants. This information will be used to develop a comprehensive aquatic and riparian habitat enhancement and management plan for about 41 miles of the river.



ESCONDIDO CREEK

Nutrient-rich municipal wastewater was discharged into Escondido Creek in the late 1960s. Today chicken, horse, and dairy ranches and urban runoff contribute high bacteria and nutrient loads to the Creek. In addition, construction and agricultural activity in the watershed contribute high sediment loads in the river.

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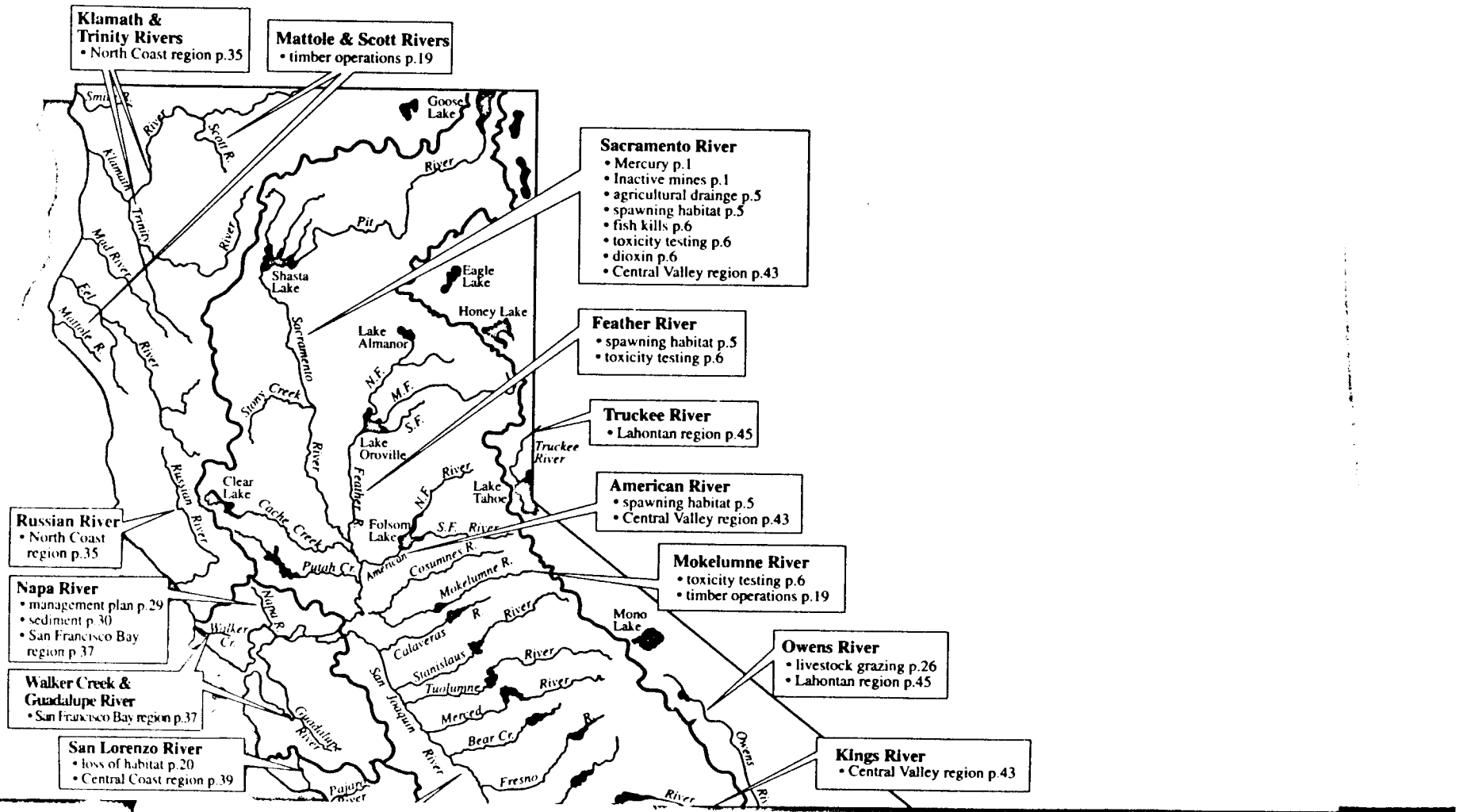
River & Stream Index

This pictorial index shows the rivers discussed in the text in bold print. Under each river name are the topics discussed for that river and the pages where the discussion can be found.



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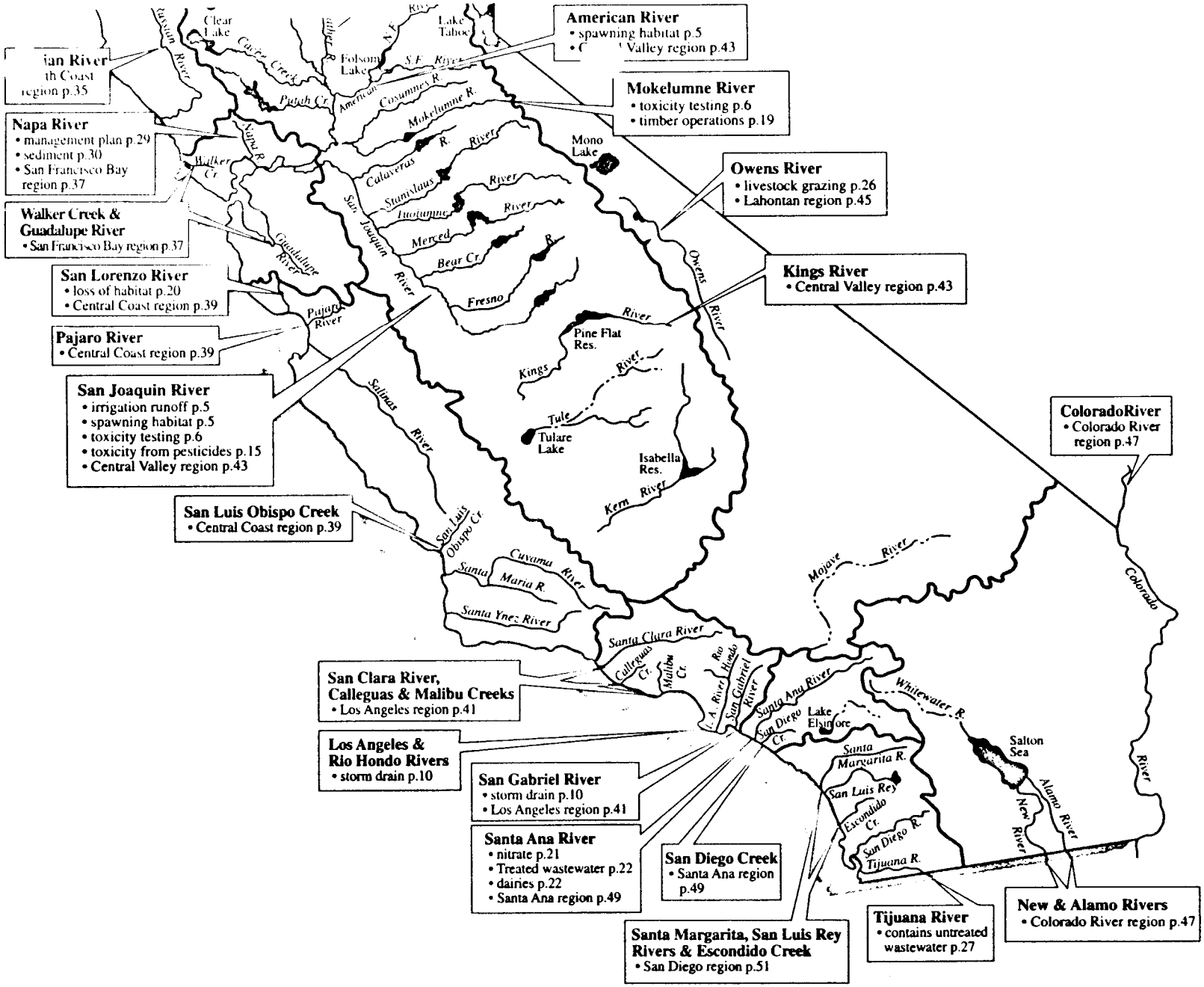
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San Diego Cr.
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San Luis Rey
Escondido Cr.
San Diego R.
Tijuana R.
New River
Alamo River
San Luis Obispo Cr.

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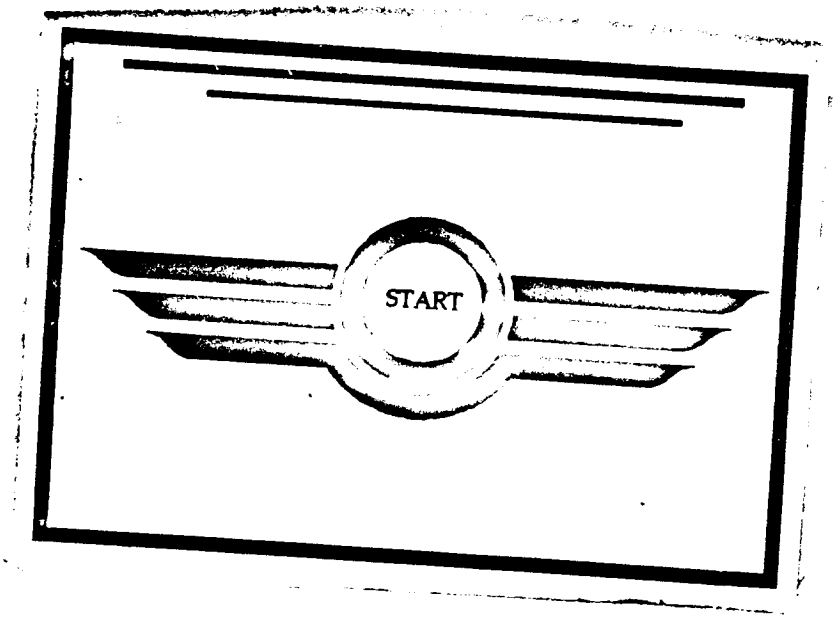

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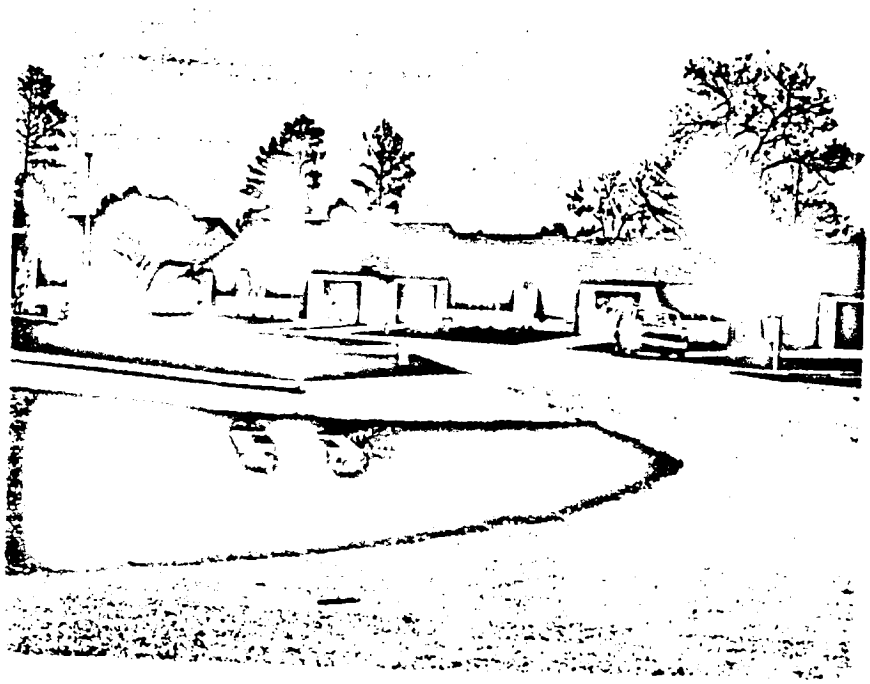
URBAN RUNOFF

TECHNICAL ADVISORY COMMITTEE

REPORT AND RECOMMENDATIONS



Prepared for the State Water Resources Control Board
Nonpoint Source Management Program

November, 1994

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URBAN RUNOFF TAC REPORT

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EXECUTIVE SUMMARY

The Urban Runoff Technical Advisory Committee (TAC) reviewed the management of urban runoff pollution from new development, re-development, construction, existing development, and from roads, highways, and bridges. The TAC recommends that control of urban runoff pollution is primarily the responsibility of local government and that each local government in California should have a comprehensive program to control pollution from these sources. The TAC further recommends that the Regional Water Quality Control Boards (RWQCBs) oversee the efforts by local government. The TAC recommends three enforcement options to ensure that each local government have an effective program--a general National Pollutant Discharge Elimination System (NPDES) storm water permit, an individual NPDES storm water permit, or a Porter-Cologne Section 13225(c) report. Since larger cities and some urbanized counties already are permitted through the NPDES municipal storm water program, the TAC recommends that the RWQCBs coordinate with all the remaining cities and counties to develop enforceable, comprehensive programs. It is recommended that State Water Resources Control Board (SWRCB), working with the RWQCBs, develop a model storm water program so that smaller local governments can more readily adopt a program.

The TAC reviewed the management measures contained in the U. S. Environmental Protection Agency's (USEPA) *Guidance Specifying Management Measures for Source of Nonpoint Pollution in Coastal Waters* [(g) Guidance] and found them to be suitable for implementation in California. In addition, the TAC makes a number of general recommendations on how the SWRCB and RWQCBs and local government can improve management of polluted runoff. Finally, the TAC noted that if water quality is to be improved, it is critical that the other major sources of nonpoint pollution (agriculture, abandoned mines, and forestry) also be aggressively addressed by the SWRCB/RWQCB. the controlled.

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URBAN RUNOFF TECHNICAL ADVISORY COMMITTEE REPORT

FOREWORD

TAC MEMBERSHIP

The Urban Runoff Technical Advisory Committee (TAC) was formed in March, 1994 at the request of the State Water Resources Control Board (SWRCB) as part of their effort to improve management of nonpoint source pollution (NPS). The TAC met once per month, alternating between Los Angeles, Oakland, and Sacramento. The TAC included representatives from state and local government, industry and business, and environmental groups. Several of the members are also members of the State Storm Water Quality Task Force, whose focus is on the National Pollutant Discharge Elimination System (NPDES) storm water permits for urban runoff. The TAC members were volunteers and received no compensation for their participation or travel expenses. A complete listing of the TAC members is included in this report as Appendix E.

RELATIONSHIP OF PROGRAM MANDATES AND APPROACH TAKEN BY TAC

Urban runoff pollution is generated from both point and nonpoint sources. The three key statutes driving urban runoff pollution controls are: 1) Clean Water Act (CWA) Section 402(p) which establishes NPDES storm water permit requirements for certain municipal and industrial storm water discharges; 2) CWA Section 319 which requires the development and implementation of a statewide nonpoint source pollution control plan (i.e., the NPS Program); and 3) Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217 which requires states to implement management measures to control nonpoint source pollution in coastal waters. After consideration of the statutory drivers for urban runoff pollution control, the TAC concluded that while different legal authorities may apply to different situations, the goals of the NPDES, NPS, and CZARA programs are complementary. This resulted in the TAC taking the approach that is described in the following paragraphs. A complete discussion comparing the Section 402 (p) NPDES storm water program requirements and the CZARA, Section 6217 requirements can be found as Attachment D in the Appendix.

There has always been overlap and ambiguity between the programs designed to control urban runoff pollution. For example, runoff may often originate as a nonpoint source but ultimately be channelized and become a point source. Consequently, the effective control of urban runoff pollution must address both point and nonpoint sources. Although the TAC was initially charged with addressing only the non-NPDES sources, the TAC concluded that the State's water quality goals dictate that all urban sources of pollution to waters of the state be more effectively controlled whether or not they are currently covered by a permit program. Additionally, since SWRCB decided not to create a new or separate program for the coastal zone to meet the requirements of CZARA, the TAC considered recommendations for the

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control of urban runoff pollution statewide.

The TAC used the management measures contained in the EPA document *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* [(g) Guidance], as a benchmark to determine if management of urban runoff pollution is being adequately handled in California. This analysis was applied to all urban sources, whether or not they were located within an existing NPDES area or in the coastal zone. The TAC found that current regulation of unpermitted sources (i.e., sources not regulated under Section 402(p)) is either inadequate or inconsistent statewide, and additionally that the current NPDES storm water program for covered sources could be improved. The recommendations of this TAC, therefore, address how unpermitted sources of urban runoff should be controlled and how to improve the existing NPDES system. The recommendations include suggestions for new programs where necessary, but these new programs are not part of a new Coastal Nonpoint Program nor do they apply only to the coastal zone or coastal watersheds.

RELATIONSHIP OF RECOMMENDATIONS TO OTHER NONPOINT SOURCES

The TAC recognized that other nonpoint sources must be managed at a level consistent with the management of urban runoff in a watershed in order to successfully prevent or remedy water quality impairment. The recommended management measures and implementation mechanisms of the Urban TAC represent a consensus of interested parties and are based on the assumption that a consistent or comparable level of action will be recommended for non-urban nonpoint sources. The commitment and success of implementation of urban runoff management actions is dependent on the validity of this assumption.

SECTION 1: INTRODUCTION

A. PROBLEM STATEMENT

Urban development often results in impacts to the land and consequently the water bodies adjacent to the land. The two major changes that result from urbanization are changes in stream hydrology and an increase in pollutant loading. Changes in stream hydrology resulting from urbanization include: increased peak discharges; increased total volume of runoff; decreased time needed for runoff to reach the stream; increased frequency and severity of flooding; changes in streamflow during dry periods due to reduced level of infiltration in the watershed; and greater runoff velocity during storms. Ample evidence also exists about the pollutants that are entrained in urban runoff. The pollutants include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, viruses, and pesticides.

The above impacts and pollutants also result from human activities that occur after urbanization. These impacts are often due to a lack of education and awareness about watershed dynamics and daily activities that generate pollutants that can reach water bodies.

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Impacts from hydrologic changes and from pollutants range from declines in aquatic biological populations (including anadromous fish), to eutrophication, to toxicity in marine organisms (including shellfish), to declines in aquatic vegetation, and to impacts on human health. There are also more subtle impacts, such as changes in water temperature and changes in stream bottom topography due to increased flows, and loss of riparian and wetland habitats.

A final aspect of the problem that needs to be recognized is the impacts of pollutants generated by outside sources. Examples of activities that can exacerbate the urban runoff pollution problem are runoff from agricultural operations that are either outside or within the urban area, atmospheric deposition, and active or abandoned mining operations.

B. EXISTING PROGRAMS

Since urban pollutants originate from a multitude of sources, effective control of these pollutants requires a cooperative effort by many regulatory agencies. Attachment C found in the Appendix provides a summary of existing statutory/regulatory programs that should be considered as part of the State's comprehensive urban runoff control program.

C. APPLICABILITY OF PROGRAMS TO COMMUNITY SIZE

The TAC recommends that urban runoff pollution controls be implemented statewide. However, the TAC concluded that the level of effort and types of controls may need to vary depending on community size. The TAC recommends that communities of all sizes implement programs such as those proposed in Attachment A to address control of urban runoff pollution from new development and construction. Attachment A is the TAC's *Recommendation for New and Redevelopment Controls for Storm Water Programs* and presents a comprehensive program that the RWQCBs should administer to ensure that all local governments are effectively controlling runoff. Also, all communities should aggressively apply pollution prevention practices and implement public information and participation programs. The TAC recommends that only those communities that meet the census definition of urbanized area (i.e.,an area populated by 50,000 persons and/or a population density of 1,000 persons per square mile) be required to fully implement the management measures for existing development.

SECTION 2: GENERAL RECOMMENDATIONS FOR CONTROL OF URBAN RUNOFF POLLUTION

A. POLLUTION PREVENTION HIERARCHY

The control of urban nonpoint source pollution should be approached in a hierarchical manner with pollution prevention given the highest priority. The TAC recommends that nonpoint

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source pollution control can be accomplished most effectively by giving priority to methods in the following order:

1. **Prevention** - implementation of practices that use or promote pollution free alternatives (e.g., implementation of practices such as integrated pest management, or trip reduction programs);

2. **Source control** - implementation of control measures that focus on preventing or minimizing urban runoff from contacting pollutant sources (e.g., controls through land use planning practices or material exposure control practices);

3. **Treatment controls** - implementation of practices that require treatment of polluted runoff either onsite or offsite (e.g., extended detention basins).

B. WATERSHED PROTECTION

The SWRCB/RWQCBs should strongly encourage areawide watershed planning, policy adoption and regional storm water quality control implementation. The TAC defines watershed-based water quality protection as the prevention/control of pollution and management of human activities in a geographically or other defined drainage area to protect, restore, and/or enhance the natural resources and beneficial uses within the watershed. Watershed may be defined on a variety of levels - such as different geographic scales relative to drainage areas and effected municipalities.

C. PUBLIC INFORMATION AND PARTICIPATION

The effective prevention/control of urban runoff pollution requires the aggressive implementation of a public information and participation program (PI/P) within all aspects of implementation. The TAC recognizes that education with an emphasis on pollution prevention is the fundamental basis for solving nonpoint source pollution problems. An effective program includes general and focused outreach programs, education programs, and citizens participation programs.

Target Audiences should include:

1. Government: Educate government agencies and officials to achieve better communication, consistency, collaboration, and coordination at the federal, state and local levels.

2. K-12/Youth Groups: Establish statewide education programs, including curricula, on watershed awareness and nonpoint source pollution problems and solutions, based on a state lead role building upon and coordinating with existing local programs.

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3. Development Community: Educate the development community, including developers, contractors, architects, and local government planners, engineers, and inspectors, on nonpoint source pollution problems associated with development and redevelopment and construction activities and involve them in problem definitions and solutions.

4. Business and Industrial Groups

D. ENFORCEMENT MECHANISMS

1. Regional Boards should ensure effective implementation of municipal storm water programs that include the TAC Recommendations through one of three mechanisms:

a. Water Code Section 13225(c) authority to require reports from local governments on implementation of storm water programs. In this case, no permit would be issued unless there was failure to demonstrate an adequate program; or

b. Individual NPDES storm water permits issued to specific storm water programs, (i.e., the existing program requiring municipal storm water permits for storm drain systems servicing populations greater than 100,000); or

c. A general NPDES storm water permit requiring implementation of a municipal storm water program (i.e., a new program for jurisdictions servicing populations less than 100,000).

2. Through administration of the NPDES Municipal Storm Water Program, RWQCBs should require that each city and county have the legal authority to control sources of urban runoff pollution into their storm drain system(s), waterbodies, and associated habitats. It is recommended that each city and county adopt an urban runoff ordinance which has enforceable provisions and includes the following components:

a. Requirements for new development and re-development, both pre- and post-construction;

b. Requirements for industrial sources, including those covered under the General Permit for Industrial Storm Water Discharges;

c. Requirements for commercial sources, especially those not already covered by the Phase I NPDES storm water permits;

d. Effective prohibition of discharges of other than storm water to storm drain systems; and

e. Good Housekeeping Practices which apply to all public and private properties.

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E. SMALL COMMUNITY ASSISTANCE

The TAC recognizes the difficulties that small communities, both incorporated and unincorporated, face in development and implementation of new programs. Because of staffing limitations and financial constraints, SWRCB/RWQCBs need to provide technical and financial assistance. Technical assistance should include, at a minimum, development of a model municipal storm water program, educational information, and staff training.

The TAC noted that these small community limitations, such as one staff person having many roles and responsibilities, may be an advantage in implementation of a watershed protection program. Because coordination within the planning and public works departments would be easier due to overlapping responsibilities, small communities would be good candidates for implementing pilot watershed programs.

F. COORDINATION OF INSPECTION PROGRAMS

In order to maximize use of limited budgets, it is recommended that each city and county and the state agencies devise ways to utilize existing permitting and inspection programs to help implement Storm Water Management Plans and the State Nonpoint Source Program. In particular, multiple tasks can be done by single agencies. Examples include: building inspectors check for installation of best management practices during building permit inspections; hazardous waste inspectors verify that good housekeeping practices are being followed; and adding an oil leak inspection component to the State smog check program.

G. SIGNIFICANT UNPERMITTED SOURCES

It is recommended that SWRCB/RWQCBs develop a list of sources (land use activities) currently not covered by the Municipal, Industrial, or Construction NPDES storm water permits that may significantly contribute to water quality degradation, and develop programs to ensure that these sources are controlled.

H. ALTERNATIVE TRANSPORTATION

Personal vehicles (their breaks, tires, and internal combustion engines) are a major source of many pollutants in urban runoff. Given this and in the interest of pollution prevention, watershed-based planning, and consistency with current efforts by SWRCB/RWQCBs on the NPDES municipal storm water permit requirements, local governments should look to local transportation/congestion management as a way to reduce nonpoint source pollution. The incorporation of pollution prevention into transportation systems should occur in NPDES permitted and non-permitted areas alike through the planning process and the development of community plans with focus on areas that are experiencing or expecting growth.

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Urban/suburban areas should be designed to maximize the use of:

a. Alternative modes of transportation (e.g., bicycles, roller blades) through construction of dedicated traffic lanes;

b. Mass transit systems (e.g., busses, trains) by requiring easements/rights of way; and

c. Alternative fuel and zero-emission vehicles (or hybrids) by providing fueling recharging stations.

I. ECONOMIC IMPACTS AND INTERSTATE COMPETITION

It is recommended that SWRCB convey to USEPA that USEPA should consider the market implications their programs and recommendations have for California and for competition between states. It is also recommended that regulations be the same for at least the western states, and it would be preferable to have the federal government require other states to meet California's high standards than to have California lower its standards in order to create equal standards for the various states

SECTION 3: RECOMMENDATIONS FOR IMPLEMENTATION OF URBAN RUNOFF POLLUTION CONTROLS BY SOURCE CATEGORY

I. NEW DEVELOPMENT, SITE DEVELOPMENT AND CONSTRUCTION

A. INTRODUCTION

This section of the TAC report addresses the issue of new development, including site development and construction, and covers four EPA (g) Guidance management measures. The TAC reviewed the management measures and adopted each of them as appropriate for implementation in a statewide program, making only a minor revision in one measure (measure B.3 below).

The recommendation for these management measures includes a group of general principles that the TAC feels should be incorporated into a program to control urban runoff. These four principles embody much of the intent of the EPA management measures and are the same principles in the *General Recommendations* section above.

The next section of the report presents the TAC's recommendation on how the implementation process for controlling urban runoff could be improved. This section addresses the gaps that the TAC identified in current implementation and suggests ways in which current implementation can be improved. Much of the substance of these recommendations can be implemented through a program like that detailed in Attachment A that would be overseen by

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the RWQCBs.

In order to assure that implementation will occur, the TAC recommends three options at the state level. Two options utilize current or proposed NPDES permitting. The other option is a program utilizing non-regulatory encouragement, that is, if local governments develop a comprehensive storm water program, the NPDES storm water permit can be avoided. Finally, the TAC recommends tha;t each local government develop and implement an enforceable urban runoff ordinance.

B. EPA (g) GUIDANCE MANAGEMENT MEASURES

1. New Development Management Measure

a. By design or performance:

i. After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solid (TSS) loadings by 80 percent. For the purposes of this measure, an 80 percent TSS reduction is to be determined on an average annual basis,[1] or

ii. Reduce the postdevelopment loadings of TSS so that the average annual TSS loadings are no greater than predevelopment loadings, and

b To the extent practicable, maintain postdevelopment peak runoff rate (and average volume) at levels that are similar to predevelopment levels.[2]

Sound watershed management requires that both structural and nonstructural measures be employed to mitigate the adverse impacts of storm water. Nonstructural Management Measures 2 and 3 can be effectively used in conjunction with Management Measure 1 to reduce both the short- and long-term costs of meeting the treatment goals of this management measure.[3]

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[1] Based on the average annual TSS loadings from all storms less than or equal to the 2-year/24-hour storm. TSS loadings from storms greater than the 2-year/24-hour storm are not expected to be included in the calculation of the average annual TSS loadings.

[2] The TAC concluded that maintaining postdevelopment average runoff volume at levels that are similar to predevelopment levels was essentially impracticable in California.

[3] The TAC expressed concern about the application and implementation of this management measure in California. However, rather than propose an alternative management measure, the TAC recommended acceptance of this measure contingent on the assumption that application and implementation of the TAC's *Recommendations for Municipal Management of New and Redevelopment Storm Water Runoff* (Attachment A) would result in the functional equivalent of implementation of this management measure.

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2. **Site Development Management Measure**

Plan, design, and develop sites to:

a. Protect areas that provide important water quality benefits and/or are particularly susceptible to erosion and sediment loss;

b. Limit increase of impervious areas, except where necessary;

c. Limit land disturbance activities such as clearing and grading, and cut and fill to reduce erosion and sediment loss; and

d. Limit disturbance of natural drainage features and vegetation.

3. **Construction Site Erosion and Sediment Control Management Measure**

a. Reduce erosion and, to the extent practicable, retain sediment onsite during and after construction, and

b. Prior to land disturbance, prepare and implement an effective erosion and sediment control plan or similar administrative document that contains erosion and sediment control provisions.[4]

4. **Construction Site Chemical Control Management Measure**

a. Limit application, generation, and migration of toxic substances;

b. Ensure the proper storage and disposal of toxic materials; and

c. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

C. GENERAL PRINCIPLES FOR CONTROL OF URBAN RUNOFF FROM NEW DEVELOPMENT AND CONSTRUCTION

1. To the extent feasible, preserve, and where possible, create or restore areas that provide water quality benefits, such as riparian corridors and wetlands, and promote the design of new development so that it protects the natural integrity of drainage systems and water bodies.

[4] The TAC amended the EPA management measure by changing the word "approved" to "effective." The purpose was to avoid recommending that all erosion control plans must have a formal approval.

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2. Avoid conversions of areas particularly susceptible to erosion and sediment loss and/or establish development guidance that identifies these areas and protects them from erosion and sediment loss. These areas are characterized by steep slopes, highly erodible soils, periods of intense rainfall, and inability to re-vegetate once disturbed.

3. Require the integration of storm water quality protection into construction and post-construction activities at all development sites. This should include minimizing the use of toxic materials and their proper containment on site.

4. Wherever practicable, maintain peak runoff rates at pre-development levels.

D. MECHANISMS TO IMPLEMENT MANAGEMENT MEASURES CONSISTENT WITH PRINCIPLES

1. Improve the use of the California Environmental Quality Act (CEQA) process through:

a. RWQCBs should distribute to, and request that local governments utilize, a CEQA Checklist that addresses watershed, water quality, and nonpoint source pollution impacts. An example of an appropriate Checklist is the attached *Revised Environmental Checklist* (Attachment B);

b. SWRCB should recommend to the Governor's Office of Planning and Research that it pursue amendments to the CEQA Guidelines to include appropriate revisions to the CEQA Checklist (see (a) above for recommended changes to Checklist); and

c. SWRCB should recommend to the Governor's Office of Planning and Research that it pursue amendments to the CEQA Guidelines to include appropriate revisions to the Applicant's Environmental Information Forms that are compatible with the above CEQA Checklist revisions.

2. SWRCB and RWQCBs should adopt statewide and regional policy addressing the prevention and control of urban runoff pollution.

The regional policies should embrace the *General Principles for Control of Urban Runoff*, and identify policies and practices that should be implemented by local governments for the prevention and control of urban runoff pollution from new development, redevelopment, and construction activities. A regional policy should at a minimum, set requirements for the implementation of a baseline program such as that presented in the TACs *Recommendations for Management of New and Redevelopment Storm Water Runoff* (Attachment A).

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3. All local governments should adopt and implement a storm water runoff control program.

The program should include new and redevelopment management elements based on the attached *TAC Recommendations for Municipal Management of New and Redevelopment Storm Water Runoff* (Attachment A).

4. SWRCB/RWQCBs should identify and provide incentives for local governments to commence watershed planning in order to maximize the use of limited resources and to maximize the benefits of NPS pollution controls.

As part of the regional policy, the TAC recommends that RWQCBs encourage areawide watershed management planning, policy adoption, and regional storm water quality control implementation as a better approach than restrictions and controls on individual development projects. The favored approach has greater potential to achieve watershed protection goals, reduce conflicts with other existing policies, plans and/or requirements, and eliminate apparent arbitrariness and unfairness in dealing with individual development projects.

5. The SWRCB, in a coordinated effort with the RWQCBs, should provide assistance to small local governments for development and implementation of an urban runoff control program.

At a minimum, this assistance should include:

a. *Model Storm Water Program*. Development of a model storm water program that includes: the TAC's *Recommendations for Municipal Management of New and Redevelopment Storm Water Runoff* (Attachment A); a model urban runoff ordinance which has enforceable provisions; and model language regarding protection of water quality from urban sources for inclusion in General Plan documents;

b. *Training*. Development of training programs directed at both government staff and the regulated community;

c. *Public Information and Participation*. Development of generic public information materials for dissemination by the local governments; and

d. *Technical and Financial Assistance*. Funding and assistance for pilot programs (e.g., monitoring programs and watershed planning).

6. SWRCB/RWQCBS should consider reorganization of programs and staffing priorities.

SWRCB/RWQCBs need more staff assigned to review projects at the planning level

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(i.e., CEQA review), nonpoint source pollution issues, and watershed management tasks. This should be accomplished through a reordering of staff priorities, reorganization, and/or increases in staff allocation to the Boards.

E. ENFORCEMENT MECHANISMS

1. SWRCB/RWQCBs should ensure effective implementation of local government storm water programs through one of the following three enforcement mechanisms (see TAC Recommendation E(1) in Section II of this report):

a. Section 13225(c) report by the local government

b. Individual municipal NPDES storm water permit (current program)

c. General municipal NPDES storm water permit (new program)

2. Local Urban Runoff Ordinance

Each local government should have the legal authority to control sources of runoff into their storm drain system(s), waterbodies, and associated habitats. It is recommended that each local government adopt an urban runoff ordinance which has enforceable provisions (see TAC Recommendation E(2) in Section II of this report).

II. EXISTING DEVELOPMENT

A. INTRODUCTION

This section of the report addresses the issue of urban runoff from existing development which is addressed by a single EPA (g) Guidance management measure. The TAC adopted the EPA measure, finding it appropriate and feasible to implement in California. However, the TAC finds that in addition to identifying pollution reduction opportunities, agencies need to equally emphasize pollution prevention. The theme of prevention is raised by the TAC in each of the source categories it has reviewed and analyzed within this report.

B. EPA (g) GUIDANCE MANAGEMENT MEASURE

1. Existing Development Management Measure

Develop and implement watershed management programs to reduce runoff pollutant concentrations and volumes from existing development:

a. Identify priority local and/or regional watershed pollutant reduction opportunities, e.g.,

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improvements to existing urban runoff control structures;

b. Contain a schedule for implementing appropriate controls;

c. Limit destruction of natural conveyance systems; and

d. Where appropriate, preserve, enhance, or establish buffers along surface waterbodies and their tributaries.

C. RECOMMENDATIONS REGARDING EXISTING DEVELOPMENT

1. Recommendations for Local Governments

a. Incorporate watershed information into the planning and management processes, including a requirement to specifically address watersheds in the Conservation and Open Space Elements (or local equivalents) of General Plans.

b. Relate the development of local and areawide storm water programs to known water quality problems and beneficial uses of receiving waters.

c. Municipal storm water programs should determine local water quality goals and focus efforts on the reduction of priority pollutants.

d. There should be an emphasis on education for pollution prevention rather than on regulation.

e. Management practices should emphasize pollution prevention over pollution control; when source control is necessary, nonstructural controls should take priority.

f. Consider use of open space programs to maintain and enhance water quality.

g. Municipal storm water programs should focus initially on O&M activities of public agencies.

h. In order to assist the RWQCBs in identifying industries and construction projects that should be covered by general permits, municipal storm water programs should provide pertinent available information to the RWQCBs.

i. Local governments should advise those industries and construction projects with which they come into contact of the requirement to be covered by the state general permits.

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2. Recommendations for Regional Boards

a. RWQCBs should work with municipal storm water program staffs to educate decision-makers in local governments about Regional Water Quality Control Plans (Basin Plans) and their relationship to storm water programs.

b. RWQCBs should coordinate with local governments regarding water quality concerns and programs.

c. RWQCBs should assist local governments with financial and technical assistance for pilot retrofit projects designed to reduce targeted pollutants.

d. RWQCBs should encourage local governments to cooperate with other groups such as Resource Conservation Districts (RCDs) on watershed management programs.

e. RWQCBs should refer local governments to the *California Storm Water Best Management Practices (BMP) Handbooks* and the (g) Guidance for assistance in creating their own water quality programs.

f. A pilot program should be established by at least one RWQCB to develop small city nonpoint source pollution prevention programs.

g. Upon completion of the small city pilot project, all RWQCBs should work with local jurisdictions to implement nonpoint source pollution prevention programs in small cities and towns not covered by municipal NPDES storm water permits.

3. Recommendations for State Water Resources Control Board

a. SWRCB should revise the California Nonpoint Source Management Plan to incorporate Existing Development practices a, b, d, e, and f from Chapter 4 of the (g) Guidance.

b. SWRCB/RWQCBs should work through the California Board of Education and County Departments of Education to incorporate water quality issues into the curriculum (biology, ecology, geography etc.).

c. SWRCB should examine the possibility of conditioning certain state grants and loans to local governments to require the development and implementation of water quality management programs (possibly including a watershed approach).

d. SWRCB/RWQCBs should encourage state and local government agencies, including special districts, to operate their programs and facilities in a manner that protects water quality by setting examples through the operation of their own facilities and

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programs.

e. SWRCB/RWQCBs should cooperate with air quality management districts in the certification of dust palliatives to control fugitive dust.

f. SWRCB/RWQCBs should cooperate with air quality management districts to identify issues of common concern and to seek solutions which would assist in the reduction of both air and water pollution; for example, SWRCB/RWQCBs should encourage municipalities, counties, and port districts to convert their fleet vehicles to zero-emission vehicles.

g. SWRCB/RWQCBs should encourage the development of water quality awareness programs by the California State Association of Counties (CSAC) and the California League of Cities.

h. SWRCB should consider issuing a simplified General NPDES Storm Water Permit without extensive water quality monitoring requirements for smaller cities and counties in California.

III. WATERSHED PROTECTION

A. INTRODUCTION

The TAC's working definition for watershed-based water quality protection is the prevention/control of pollution and management of human activities in a geographically or other defined drainage area to protect, restore, and/or enhance the natural resources and beneficial uses within the watershed. To the extent practicable, the hydrologic areas or subareas defined by the Department of Water Resources should be used to define watershed boundaries, although a smaller area, such as a tributary stream within a subarea could be an appropriate unit for management purposes.

This management measure requires no specific triggers for implementation. As the framework for water quality protection, the approach should be automatically integrated into all nonpoint source pollution prevention/reduction programs. Although there are no triggers per se for this management measure, each Regional Board should establish priorities among the watersheds within its region for the implementation of nonpoint source pollution prevention programs.

The TAC concluded that implementation of the Watershed Protection Management Measure, in conjunction with those for the TAC's existing and new development management measure proposals, would meet EPA requirements and strengthen the Nonpoint Source Management Plan.

The Technical Advisory Committee recommends the EPA Watershed Protection Management

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Measure be adopted and incorporated into California Nonpoint Source Management Plan.

B. EPA (g) GUIDANCE MANAGEMENT MEASURE

1. Watershed Protection Management Measure

Develop a watershed protection program to:

a. Avoid conversion, to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss;

b. Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota; and

c. Site development, including roads, highways, and bridges, to protect to the extent practicable the natural integrity of waterbodies and natural drainage systems.

C. RECOMMENDATIONS REGARDING WATERSHED PROTECTION

1. **The watershed protection management measure should be strengthened by adding an education element.**

Components of the educational element should include:

a. An educational program for local governments on watershed awareness and planning

b. An educational program for citizens on watershed awareness and oversight

c. An educational program for municipal residential/industrial/commercial facilities (and their associations) which conduct outdoor activities that potentially contribute to nonpoint source pollution

The education program should include comprehensive K-12 programs that involve all science disciplines directly in the watershed. All agencies with responsibility for watershed should be involved along with community groups. These elements could be developed and implemented by municipal programs and/or SWRCB/RWQCBs, the Soil Conservation Service, or local organizations such as resource conservation districts (RCDs), or nonprofit organizations. For example, under agreements with RWQCBs, the Soil Conservation Service and RCDs could assist with training and education of municipalities, community groups, boys and girls clubs, etc.

SWRCB could underwrite the costs of training provided by University Extension or analogous

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courses. In addition, SWRCB should work with licensing boards and other professional organizations to incorporate nonpoint source pollution certification into licensing requirements.

2. Watershed management strategies in NPDES municipal storm water programs:

a. Municipal permits should have watershed specific components.

b. All NPDES permits and Waste Discharge Requirements (WDRs) should be considered for reissuance on a watershed basis.

c. Monitoring programs should be designed to support watershed assessments and planning.

d. Monitoring should include a volunteer citizens' monitoring and reporting program.

e. SWRCB should adopt a central monitoring data base in California.

f. In order to determine where impacts to watersheds are occurring, GIS programs in California should be coordinated.

g. All permit applications and Notices of Intent (NOIs) should be coded by hydrologic subarea.

h. Municipal permittees and RWQCBs should share information, by hydrologic subareas, of all point source permittees, including industrial and construction permittees.

i. Local governments should be encouraged to include watershed information in the appropriate elements of their general plans and to require that watershed consideration be included in environmental documentation.

j. SWRCB/RWQCBs should promote coordination within the existing regulatory framework among state, regional and local agencies regulating pollutant sources impacting air, land, and water.

k. At least one watershed management pilot project based on a hydrologic area should be designated within each areawide municipal permit by a municipal permittee in coordination with the appropriate Regional Board.

3. Non-NPDES municipal permit areas where the mechanism for enforcing programs will evolve from Porter-Cologne and municipal programs:

a. Local governments should be encouraged to develop ordinances to address all sources

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that may cause water quality impairment.

b. RWQCBs with areas not covered by municipal NPDES storm water permits should designate at least one new pilot watershed project based on a hydrologic area not within the jurisdiction of a municipal program. Pilot projects should develop and implement watershed management plans to reduce beneficial use impairment. The criteria for choosing pilot project sites should include consideration of the SWRCB's Water Quality Assessment and should focus on impaired waterbodies. RWQCBs could serve as the coordinating agencies. In this capacity, they would review proposed programs and oversee implementation.

4. Small community considerations

One advantage for small communities in the context of watershed protection may be that it is easier for them to coordinate efforts/planning/strategies among their departments (i.e., street/storm drain maintenance, litter control, parks and recreation, etc.). Because of this they could be good candidates for developing and implementing pilot programs.

IV. POLLUTION PREVENTION

A. INTRODUCTION

This section of the report addresses the issue of pollution prevention which is covered by a single EPA (g) Guidance management measure. The TAC adopted the EPA measure, finding it appropriate and feasible for implementation in a statewide program for the control of urban runoff pollution. The theme of prevention is raised by the TAC in each of the source categories it has reviewed and analyzed within this report.

B. EPA (g) GUIDANCE MANAGEMENT MEASURE

1. Pollution Prevention

Implement pollution prevention and education programs to reduce nonpoint source pollutants generated from the following activities, where applicable;

a. The improper storage, use, and disposal of household hazardous chemicals, including automobile fluids, pesticides, paints, solvents, etc.;

b. Lawn and garden activities, including the application and disposal of lawn and garden care products, and the improper disposal of leaves and yard trimmings;

c. Turf management on golf courses, parks, and recreational areas;

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d. Improper operation and maintenance of onsite disposal systems;

e. Discharge of pollutants into storm drains including floatables, waste oil, and litter;

f. Commercial activities including parking lots, gas stations, and other entities not under NPDES purview; and

g. Improper disposal of pet excrement.

C. RECOMMENDATIONS REGARDING POLLUTION PREVENTION

1. Recommendations for Prevention at the Source

The first stage of controlling pollution of storm water is prevention of pollution at the source. The following recommendations are designed to incorporate that concept into the California storm water program:

a. Pollution prevention programs should be designed to emphasize source reduction.

b. Pollution prevention programs should be related to watershed management.

c. Government agencies should examine municipal landscape/facility maintenance/pest control programs and make necessary modifications in order to prevent contributions of toxic materials to receiving waters.

d. The revised California Nonpoint Source Management Plan should incorporate the pollution prevention Management Measure from Chapter 4 of the "g" Guidance:

2. Recommendations for Educational Programs

The pollution prevention program should be based on a sound public education program. Such a program should be designed to address specific target audiences.

a. Education programs should emphasize pollution prevention and be related to watershed management.

b. Municipal storm water programs should work through local school districts to incorporate water quality issues into the curriculum (biology, ecology, geography etc.).

c. Youth groups, business and industrial groups, environmental organizations and ecology clubs at schools should be included in public service and public awareness programs related to water quality and pollution prevention.

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V. ROADS, HIGHWAYS, AND BRIDGES

A. STATEMENT OF PROBLEM/APPLICABILITY/ADOPTION OF MANAGEMENT MEASURES

The development or redevelopment of surface transportation systems is a complex undertaking that can result in long and short term water quality degradation. Alignments can parallel, adjoin, or cross waterways unnecessarily, increasing the proximity of pollutant sources to surface waters. Alignments in areas of steeper slopes can create large cuts and fills, increasing the potential for sediment erosion. Pollutants can be accentuated by not allowing enough right-of-way for vegetative uptake of total and dissolved solids. Finally, signal timing can accentuate traffic congestion increasing the burden of particulate matter that enters the air and watersheds.

The Management Measures and practices discussed here address the problems of point and nonpoint source impacts on water quality from all phases of roadway and bridge development. In this discussion, roadways include tertiary, secondary, and primary collectors and arterials, as well as inter-regional state highways and state routes in the National Highway System (NHS).

The TAC reviewed the six USEPA management measures identified for roads, highways, and bridges and adopted each of them as appropriate for implementation in a statewide program for the control of urban runoff pollution. All of the management practices in the (g) Guidance are also recommended for inclusion in the program.

B. EPA (g) GUIDANCE MANAGEMENT MEASURES

1. **Management Measure for Planning, Siting, and Developing Roads and Highways Plan, site, and develop roads and highways to:**

a. Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss;

b. Limit land disturbance such as clearing and grading and cut and fill to reduce erosion and sediment loss; and

c. Limit disturbance of natural drainage features and vegetation.

2. **Site, design, and maintain bridge structures so that sensitive and valuable aquatic ecosystems and areas providing important water quality benefits are protected from adverse effects.**

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3. **Management Measure for Construction Projects**

a. Reduce erosion and, to the extent practicable, retain sediment onsite during and after construction and

b. Prior to land disturbance, prepare and implement an approved erosion control plan or similar administrative document that contains erosion and sediment control provisions.

4. **Management Measure for Construction Site Chemical Control**

a. Limit the application, generation, and migration of toxic substances;

b. Ensure the proper storage and disposal of toxic materials; and

c. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface water.

5. **Management Measure for Operation and Maintenance**

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.

6. **Management Measure for Road, Highway, and Bridge Runoff Systems**

Develop and implement runoff management systems for existing roads, highways, and bridges to reduce pollutant concentrations and volumes entering surface waters.

a. Identify priority and watershed pollutant reduction opportunities (e.g., improvements to existing urban runoff control structures); and

b. Establish schedules for implementing appropriate controls.

C. RECOMMENDED MECHANISMS TO HELP INSURE THE IMPLEMENTATION OF MANAGEMENT MEASURES AND BMPs FOR ROADS, HIGHWAYS, AND BRIDGES

a. SWRCB/RWQCBs should work with the Federal Highways Administration (FHWA), Caltrans, and local transportation agencies to ensure water quality protection concerns are addressed in FHWA biannual Regional audits of highway drainage systems.

b. SWRCB/RWQCBs should encourage Caltrans and local transportation agencies to establish standard procedures to ensure adequacy of the storm water pollution

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prevention plans for all public works projects prior to contract advertising for the project.

c. SWRCB/RWQCBs should encourage Caltrans and local transportation agencies to work with the Soil Conservation Service to develop model specifications for bid items on erosion and sediment control features for use in state and local public works contracts.

d. SWRCB/RWQCBs should establish forums to promote the discussion and resolution of policy conflicts (e.g., fire safety, pesticide safety, traffic safety) with local and state agencies in the design of transportation corridors.

e. SWRCB/RWQCBs should work with local, state, and federal agencies to establish minimum storm intensity/duration and frequency standards for sediment control during and after construction.

f. SWRCB/RWQCBs should work with Caltrans, to formalize the representation of Caltrans, and other appropriate transportation agencies at the Interagency Advisory Committee on nonpoint source issues.

g. SWRCB should work with federal and state agencies to promote research on controlling nonpoint source pollution including:

i. Alternative automotive materials (e.g., brake pads);
ii. Effectiveness of treatment systems (e.g., oil/water separators) ;
iii. Effectiveness of maintenance systems (e.g., street sweeping equipment);
iv. Pollutant fate and transport (e.g., aerial deposition and particle size distributions);
v. Regional specificity of predictors (e.g., runoff regression equations for arid climates);
vi. Facilities design for pollutant containment (e.g., truck weigh stations, inspection stations, agricultural inspection stations, run away truck ramps, and border crossings).

h. SWRCB should support an increase in total funding dollars for environmental enhancement grants pursuant to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTE), and encourage local, regional, and state agencies to apply for these grants.

i. SWRCB and USEPA should encourage the regional permits between Caltrans Districts and multiple RWQCBs to ensure consistency and cost effectiveness.

j. SWRCB should encourage Caltrans to use strong mechanisms in their contract specifications to ensure protection of beneficial uses and enforcement for non compliance.

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k. RWQCBs and Caltrans should establish procedures to make available to RWQCB staff, current project updates including monthly lists of District STATUS books, and "Status of Going Contracts" calendars.

l. Caltrans, toll bridge authorities, and local agencies involved in the operation, construction, or maintenance of roads, highways, and bridges should revisit cooperative agreements they have with each other in order to improve the terms for accepting storm water connections.

m. The Regional Transportation Planning Agencies (RTPAs) should be encouraged to incorporate nonpoint source structural BMPs into their Transportation Improvement Programs (TIPs).

n. Congestion Management Agencies (CMAs) should incorporate structural BMPs and the analysis of particulate matter (PM2.5, PM10,and >PM10) into their Congestion Management Plans (CMPs).

o. CMAs should support the use of alternative transportation for people, goods, and services (mass transit, zero emission vehicles, low emission vehicles) beyond its current level-of-effort.

p. CEQA and NEPA lead agencies should include reasonable dollar figures on water quality management/maintenance in the life cycle costs of roadway systems when comparing alternatives.

q. Caltrans should require training for nonpoint source prevention and control for road construction contractors through Cooperative Training Assistance Program (CTAP) or Caltrans courses.

r. Regional, local, and state transportation agencies should provide unit cost data on sediment and erosion control bid items.

s. The Resources Agency and CalEPA should urge the California Transportation Commission (CTC) to raise the dollar value per acre of state highway landscaping jobs, and to redefine highway landscaping to include water pollution control (e.g., landscape right-of-ways with plants that serve as valuable habitat adjacent to watercourses.)

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APPENDICES

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ATTACHMENT A

RECOMMENDATIONS FOR
NEW AND REDEVELOPMENT CONTROLS FOR STORM WATER PROGRAMS
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Attachment A: Recommendations for New and Redevelopent Controls for Urban Runoff Pollution Control Programs

FOREWORD

This Guidance is the recommendations of the Technical Advisory Committee for Urban Runoff Pollution (TAC) regarding the policies, goals and practices that should be included in new and redevelopment programs to protect and improve storm water quality from urban activities. Specifically, these include watershed protection policies, project site planning measures, best management practices (BMPs) for project construction, best management practices for post-construction, and general management measures for implementation of the various new and redevelopment controls at the local level.

The TAC recommends that the State Water Resources Control Board (SWRCB) adopt a policy requiring the Regional Water Quality Control Boards (RWQCB) to approve new or revised policy for the prevention and control of urban runoff pollution from new development, redevelopment, and construction activities. The TAC recommends that RWQCBs utilize the approach and policies presented in this document as the baseline requirements for local governments for the storm water quality issues, sensitive resources, land uses, and development review and approval processes unique to each local government.

The TAC recommends that RWQCBs encourage area-wide watershed management planning, policy adoption, and regional storm water quality control implementation as a better approach than restrictions and controls on individual development projects. The favored approach has greater potential to achieve watershed protection goals, reduce conflicts with other existing policies, plans and/or requirements, and eliminate apparent arbitrariness and unfairness in dealing with individual development projects. Some of the individual site controls recommended may appear in conflict with or be inappropriate with components of an area-wide watershed management plan. If the watershed management plan is based on the principles embodied in the Recommendations, then the plan should supersede the recommended individual project controls. The following are examples of this situation. If regional structural treatment controls are planned then a municipality can minimize requirements for structural treatment controls at individual projects; or if adequate setbacks are established for development near streams and wetlands, fewer BMPs need to be required at each individual development to protect nearby sensitive water quality resources. Another example would be cases where a municipality has a policy of allowing higher density development (greater impervious surface) for certain projects, such as those in infill areas, while requiring lower density development (limited impervious surface) in other areas. In these cases, efforts to limit impervious surface for all individual projects can be reduced.

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Attachment A: Recommendations for New and Redevelopent Controls for Urban Runoff Pollution Control Programs

USE OF THIS DOCUMENT

In implementing the RWQCB policy, local governments would not be expected to implement every item exactly as described in this Recommendation. They are expected to select a variety of the management practices, or aspects of the management practices, for their individual local programs by considering the trade-offs associated with not implementing other practices. For example, it may seem infeasible to include certain treatment controls at every newly proposed development, but not infeasible to include them in all developments of a specific type or size.

These Recommendations are intended to be used in conjunction with the *California Storm Water Best Management Practices Handbooks*, local program guidance materials from municipalities, and any other appropriate documents on storm water quality controls for new and redevelopment.

I. POLICIES

A. WATERSHED PROTECTION

Apply the following (or equivalent) watershed protection policies to all new development and redevelopment proposals during the planning, project review and permitting processes:

1. To the extent feasible, preserve, and where possible, create or restore areas that provide water quality benefits, such as riparian corridors and wetlands, and promote the design of new development so that it protects the natural integrity of drainage systems and water bodies.

2. Avoid conversions of areas particularly susceptible to erosion and sediment loss and/or establish development guidance that identifies these areas and protects them from erosion and sediment loss. These areas are characterized by steep slopes, highly erodible soils, periods of intense rainfall, and inability to re-vegetate once disturbed.

3. Require the integration of storm water quality protection into construction and post-construction activities at all development sites. This should include minimizing the use of toxic materials and their careful containment on site.

4. Wherever practicable, maintain peak runoff rates at pre-development levels.

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B. MINIMUM REQUIREMENTS

For all new development and redevelopment, the following (or equivalent) minimum requirements should be applied during the planning, project review and permitting processes. If the proposed project may result in adverse impacts (refer to the TAC recommended *Revised CEQA Checklist*), additional controls should be implemented to reduce or mitigate the potential impact to a level of insignificance. Where impacts cannot be reduced to a level of insignificance, development should not occur.

1. Site Planning Practices

The following (or equivalent) site planning practices should be applied to all proposed projects whenever possible:

a. Protect areas with water quality benefits.
b. Protect areas susceptible to erosion and sediment loss.
c. Limit the amount of impervious surface proposed (particularly directly connected impervious areas) through clustering and site and lot design.
d. Limit land disturbance activities and the area to be impacted by these activities; any land disturbance should result in a naturally appearing slope or landform.
e. Limit the disturbance of the natural topography, drainage system and vegetation.

2. Construction BMPs

An appropriate selection of the construction BMPs presented in the *California Storm Water BMP Handbook for Construction Activity*, or similar BMPs, should be implemented for all proposed projects. The Handbook presents more detailed descriptions, design standards, performance criteria, etc., for each BMP. An example of baseline BMPs that represent an acceptable minimum level of effort for any site are listed in Table 1. BMPs selected for the site must promote the following conditions:

a. Prevention and control of erosion and sedimentation (e.g., stabilization of denuded areas);
b. Preservation of natural drainage systems, wetlands and other water quality resources;
c. Source control of construction site materials, chemicals, and wastes;
d. Control and treatment of runoff from graded or disturbed areas;
e. Streambank erosion control;
f. Limited construction access route(s);

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g. Protection of adjacent properties; and
h. Proper operation and maintenance of all BMPs.

3. Post-construction BMPs

All proposed projects should implement an appropriate selection of post-construction BMPs that promote the following conditions:

a. Prevention and control of erosion and sedimentation;
b. Source control of potential pollutants;
c. Control and treatment of runoff; and
d. Protection of wetlands and water quality resources.

Tables 2 and 3 are examples of acceptable baseline BMPs depending on project-specific characteristics. Additional BMP selection guidance can be found in the *California Storm Water BMP Handbooks*.

4. Reporting Erosion and Storm Water Control Strategies

a. Proposed projects should provide information on the proposed strategy for erosion and storm water control that includes at least the following:
   i. A map (using standard symbols) which shows:
      - existing and proposed removal of vegetation,
      - existing and final contours of the site,
      - other proposed land disturbance (e.g. clearing),
      - areas of potential water quality impact (e.g. land disturbance near a creek),
      - proposed and required setbacks and easements,
      - proposed erosion and storm water control practices (BMPs) during construction (as indicated in B.2. Construction BMPs above) and post-construction (as indicated in B.3. Post-construction BMPs above and Tables 2, and 3);
   ii. The schedule for construction, operation and maintenance of BMPs (including inspection frequency and details, and any record keeping or report preparation required);
   iii. Calculations used in designing erosion and storm water quality BMPs.

   This information may be added to a map (and/or described with text, as needed) being submitted for other development application requirements. For

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example, proposed source control BMPs could be listed on the preliminary drainage plan, or proposed construction BMPs could be described in the erosion control plan.

b. Proposed projects where clearing, grading, and excavation results in a land disturbance greater than five acres (in addition to the information listed in 4.a. above) must also provide the following information on the proposed strategy for erosion and storm water control:

i. A description of responsibility and funding for permanent BMPs;

ii. Descriptions, specifications and design assumptions and calculations for temporary and permanent erosion, sediment and storm water BMPs for construction (as indicated in B.2. above) and post-construction (as indicated in B.3. above and Tables 2 and 3); and

iii. A contingency plan in case of heavy rain or possible failure of measures.

These projects are required to comply with the State Construction Storm Water General Permit including preparing a Storm Water Pollution Prevention Plan (SWPPP). The information listed in 4.a. and b. should be included in SWPPPs. Municipalities can require submittal of a SWPPP to fulfill Minimum Requirement 4. *Reporting Erosion and Storm Water Control Strategies.*

5. Redevelopment and Infill

If a project is in a redevelopment area and a storm water management plan has been prepared for that area, the project must meet all the requirements of the plan. Additionally, the project should use applicable source control BMPs such as those identified as baseline BMPs identified below in Section III and summarized in Tables 2 and 3, Tier 1 and Tier 2. All other infill projects should be treated on a case-by-case basis since constraints on infill development, such as limited land and existing structures abutting property, may require different combinations of BMPs than can be imposed for new development. The same criteria and requirements for new development should be considered and applied for redevelopment and infill whenever possible.

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II. MANAGEMENT PRACTICES

Public agency management practices to accomplish application of the above policies and minimum requirements include:

A. CONDUCT WATERSHED RESOURCE INVENTORY AND ANALYSIS

Conduct a resource inventory and information analysis to develop a watershed management plan. This should include the identification of "sensitive areas" within the watershed. Local governments can reduce the need to impose BMPs on individual projects proposed in "sensitive areas" by restricting development in these areas.

B. IMPLEMENT WATERSHED MANAGEMENT PLANS AND/OR POLICIES

Implement watershed management plans and/or policies through ordinances, infrastructure planning, site development standards (e.g., limits on amount of impervious surfaces, setback requirements, buffer zones, slope restrictions, clustering requirements).

C. REQUIRE STATE CONSTRUCTION STORM WATER GENERAL PERMIT

Require all proposed projects where clearing, grading and excavation results in a land disturbance greater than five acres to prove coverage under the State Construction Storm Water General Permit as a condition of approval of the proposed project. This can be accomplished by requiring submittal of a copy of the Notice of Intent sent to the State Water Resources Control Board for coverage under the State Construction Storm Water General Permit.

D. REQUIRE STORM WATER IMPACTS IN ENVIRONMENTAL DOCUMENTS

Require all proposed projects to address storm water impacts, permits and mitigation measures in environmental documents required by CEQA and NEPA (Negative Declarations, EIRs, etc.).

E. REQUIRE INFORMATION ON PROPOSED STRUCTURAL CONTROLS

Require all development plans for proposed projects to include schematic information presenting proposed structural storm water quality controls (including those for the post-construction phase) in addition to notes discussing source control BMPs, and making these conditions of development approval.

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F. ANALYZE PROPOSALS FOR PLAN AND POLICY CONSISTENCY

Analyze proposals for consistency with plans and policies during proposal review and permit approval processes.

G. ESTABLISH AN INSPECTION PROGRAM

Establish an inspection program to insure approved projects are constructed and operated in accordance with plans and policies that includes training for inspectors, financial guarantees to ensure compliance, checklists for field activities, a reporting system that can be used to track effectiveness of BMPs, and enforcement procedures (or referral for enforcement) for non-compliance.

H. DEVELOP AN OPERATION AND MAINTENANCE PROGRAM

Develop an operation and maintenance program to guarantee post-construction responsibility for on-site storm water quality controls; this program should include conditions and procedures that will apply when the public agency is responsible and that will apply when a private entity is responsible.

I. IMPLEMENT STORM WATER QUALITY MASTER PLANNING

Implement storm water quality master planning to develop conditions when regional treatment facilities would be preferable to on-site facilities and develop an operation, maintenance, and inspection program and public agency financing options.

J. ESTABLISH AN EDUCATION/INFORMATION DISSEMINATION PROGRAM

Establish an education/information dissemination program that includes such things as: brochures to distribute to developers and contractors at permit counters and by mail; reference and training manuals for planners, engineers, inspectors, developers, contractors; training and information exchange workshops.

K. ESTABLISH AGREEMENTS OR POLICIES WITH FLOOD CONTROL AGENCIES

Establish agreements or policies with flood control agencies regarding the relationship between runoff control and storm water quality control (specifically, maintaining post-development peak runoff rate and average volume of runoff at levels that are similar to pre-development level, to the extent practicable); and establish agreements or policies regarding the need to attain storm water quality benefits with all new and on-going flood control

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projects and flood control operation and maintenance activities.

L. IDENTIFY AND DEVELOP OTHER POLICIES NEEDED

Identify and develop other policies needed to resolve conflicts between implementation of storm water controls and current standard practices and policies (such as fire safety issues, building codes, etc.).

III. RECOMMENDATIONS FOR BASELINE BMPs

The following recommendations and corresponding tables (Tables 1-3) are suggestions for what should constitute a minimum level of effort for implementing best management practices for the prevention and control of urban runoff pollution from residential, industrial, and construction activities. The expected level of effort is tiered based on project size. Tier 1, targeted at projects of all sizes, includes general categories of controls that are generally good housekeeping practices. Tier 2, targeted at project areas one acre or greater, provides for a greater level of control by recommending the implementation of more specific programs and practices. For projects greater than 5 acres, Tier 3 recommends the requirement of treatment controls to meet performance goals.

In addition to the three basic tiers based on project size, an additional level of effort is recommended for projects which may pose a threat to a sensitive area. If the environmental review (CEQA/NEPA) or any other review of the project site identifies that the project is in the proximity of or may directly or indirectly impact a sensitive area, implementation of additional control measures should be implemented to reduce the potential impact to a level of insignificance.

A. TIER 1- Baseline BMPs for Projects of All Sizes

1. Residential:

a. Education and Training- For developments with no property owner association or community association (association), practical information materials on good housekeeping of hazardous products, proper use and disposal for hazardous products, and prohibited discharge practices and materials should be provided, initially by the developer (as furnished by the local government), to the first residents/occupants/tenants, and thereafter by the public education program.

For developments with an association, the association should provide the educational materials (as furnished by the local government) to all members periodically.

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b. Common Area Landscape Control- Efficient irrigation, appropriate landscape design and proper maintenance should be implemented to reduce excess irrigation runoff, promote surface filtration, and minimize use of fertilizers, herbicides and pesticides (by the association or a contractor hired by the association).

c. Common Area Litter Control- For developments with an association, trash management and litter control should be implemented by the association or their contractor that includes litter patrol, emptying trash receptacles in common areas, and noting trash disposal violations by homeowners or businesses and reporting the violations to the association for investigation.

d. Labelling Storm Drain Facilities- The phrase "No Dumping-Drains to Bay", or an equally effective phrase, should be labeled on new storm drain inlets (by stencilling, branding or plaques) to alert the public to the destination of storm water and to prevent direct discharge of pollutants into the storm drain. Water courses should be similarly labeled by posting signs. This should be done by the developer unless the local government accepts responsibility for it as a condition of development approval.

e. Runoff Control- To the extent practicable, maintain post-development peak runoff rate and average volume of runoff at levels that are similar to pre-development levels. The developer should design the proposed project accordingly. This will probably require additional coordination and consultation with flood control department or district personnel. The local agency responsible for project review and approval should have established an agreement or policy with flood control personnel regarding the relationship between runoff control and storm water quality control.

2. Industrial:

The BMPs listed below should be implemented for activities that apply to the industrial project under consideration. Any other appropriate source control BMPs described in the *California Storm Water BMP Handbook for Industrial Activities* and applicable to the industrial project under consideration should be implemented. All applicable industrial projects must apply for and comply with the terms of an industrial NPDES storm water discharge permit.

a. Restaurant Grease Control- Restaurants should be designed with contained areas for cleaning mats, containers and sinks connected to sanitary sewers. Grease may be disposed of to the sanitary sewer (with approval from the local sanitary agency if necessary) or collected in a contained area and removed regularly by a disposal and

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recycling service.

b. Trash Control- Trash enclosures and dumpster areas should be covered and protected from roof and surface drainage. If water cannot be diverted from the areas, a self-contained drainage system that discharges to the sanitary sewer (with approval from the local sanitary agency if necessary) or to the storm drain through a sand filter (see further discussion in Tier 2, 3. Swales or Sand Filters) should be considered. Sand filters must be inspected and cleaned at appropriate intervals.

c. Cleaning, Maintenance and Processing Control- Areas used for washing, steam cleaning, maintenance, repair or processing should have impermeable surfaces and containment berms, roof covers, recycled water wash facility, and discharge to the sanitary sewer (with approval from the local sanitary agency if necessary).

d. Fuel Dispensing Controls- Fuel dispensing areas should be on impermeable surfaces extending 10 to 12 feet beyond the actual dispensing area and covered. They should be constructed to prevent drainage across or from the dispensing area, and must drain to a sump/tank or clarifier to allow for testing and interruption of storm water flow before discharge to the storm drain system. Sand filters, oil/water separators must be installed in storm drains and must be inspected and cleaned at appropriate intervals. Materials removed may need to be disposed of as hazardous waste. The dispensing area must have a spill cleanup plan, routine cleaning near dispensers, and routine inspections of equipment for proper functioning and leak prevention.

e Outdoor Storage Controls- Oils, fuels, solvents, coolants, and other chemicals stored outdoors should be in containers and protected from drainage by secondary containment structures such as berms and roof covers. Bulk materials stored outdoors, should also be protected from drainage with berms and covers. Process equipment stored outdoors should be inspected for proper function and leaks, stored on impermeable surfaces and covered. Storage areas should implement a regular program of sweeping and litter control and a spill cleanup plan.

f. Loading Dock Controls- Loading docks should be covered, surrounded by berms or curbs, or constructed to prevent drainage onto or from the area. A regular program of inspecting vehicles for leaks and spills, sweeping, litter control, and spill cleanup shall be implemented. Water used for washing and accumulated waste should be diverted from the storm drain system, collected and disposed off-site, or discharged to the sanitary sewer (with approval from the local sanitary agency if necessary).

g. Landscape Controls- Efficient irrigation, appropriate landscape design and proper

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maintenance should be implemented to reduce excess irrigation runoff, promote surface filtration, and minimize use of fertilizers, herbicides and pesticides (by the association or a contractor hired by the association). Drought tolerant and xeriscape landscaping should be promoted.

h. Public Agency Project Controls- Public Agency Projects should also be subject to the above seven source control BMPs as appropriate for the activities involved in the project. Larger public agency projects should also subject to BMPs in Tiers 2 and 3 as applicable. Examples of public agency projects and applicable Tier 1 BMPs include:

i. Golf Courses and Parks- landscape controls (see g. above) and waste management (proper application and disposal of chemicals and of clippings);
ii. Roads and Highways- landscape controls (see g. above), minimum use of chemical stabilizers and growth inhibitors, street sweeping, debris removal, maintenance of retaining walls and pavement, and proper operation and maintenance of runoff facilities;
iii. Utilities- landscape controls (see g. above), erosion and runoff control;
iv. Airports, Marinas, Recreational Boating Facilities and Ports- pavement sweeping, vehicle and equipment cleaning and maintenance (see 3. above), fuel dispensing controls (see d. above), outdoor storage controls (see e. above), loading dock controls (see f. above), operation of proper pumpout, dumping and restroom facilities, and operation of boat maintenance/cleaning facilities above the waterline.

3. Commercial:

BMPs described above as Tier 1 BMPs for Industrial Activity (a. through h.) should be implemented for activities that will occur at the commercial project under consideration. Any other appropriate source control BMPs described in the *California Storm Water BMP Handbook for Industrial Activities* and applicable to the commercial project under consideration should also be implemented. The BMPs are described in more detail in the *California Storm Water BMP Handbook for Industrial Activity*.

4. Additional Controls to Minimize Potential Impacts

Where it has been identified that a project may result in adverse impacts to sensitive areas, additional controls should be included to insure that runoff from the proposed project will not

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negatively impact water quality .

a. Roof Downspout System- These systems are infiltration trench systems intended only for use in infiltrating runoff from roof downspout drains in areas where there is no significant depositional air pollution (generated on- or off-site). Infiltration devices are only acceptable in areas with suitable conditions. Municipalities should be consulted regarding soil suitability.

b. Vegetated Swales- Swales are vegetated channels that treat concentrated flow. A swale requires a minimal slope, certain types of vegetation, certain dimensions and appropriate maintenance.

c. Vegetated Filter Strip- Vegetated filter strips treat sheet flow. If sheet flow is not maintained, filter strips do not function properly. They are placed parallel to the contributing surface. They require certain dimensions and appropriate maintenance. Studies indicate a minimum length of 50 feet or a length at least as long as the runoff-contributing area (EPA, 1993).

d. Stream Erosion Control- The discharge must pass through an erosion control structure such as an energy dissipator or other form of outlet protection prior to entering the stream or other water body. Biotechnical controls should be used for stream bank protection whenever possible.

B. TIER 2- Baseline BMPs for Projects Greater than 1 Acre

1. The following BMP recommendations are applicable to residential, industrial and commercial activities.

a. All Tier 1 BMPs should be implemented.

b. Site Planning Practices- Practices such as limiting land disturbance area and activities, limiting use of impervious surfaces, avoiding areas with water quality benefits and susceptibility to erosion, protecting existing vegetation and natural topography, and clustering the structures must be considered.

c. Vegetated Swales or Sand Filters- Drainage from all paved surfaces, including streets, parking lots, driveways, commercial drive-through areas, and roofs should be routed through vegetated swales, buffer strips or sand filters prior to discharge to the storm drain system. Roof downspout systems can alternatively be used to treat roof drainage. For large parking lots (determined by local governments) , sand filters or equivalent BMPs should be installed and these must be inspected and cleaned at appropriate intervals. The property owner,

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association or facility operator is responsible for hiring the contractor depending on agreements established during the development process.

d. Street Sweeping- Streets and parking lots should be swept immediately prior to and once during the storm season. If the local government does not agree to accept responsibility for street sweeping, the developer must arrange for street sweeping and report the arrangement and on-going street sweeping events to the local government as a condition of development approval.

e. Labelling and Maintenance of Storm Drain Facilities- The phrase "No Dumping-Drains to Bay", or an equally effective phrase, should be labeled on new storm drain inlets (by stencilling, branding or plaques) to alert the public to the destination of storm water and to prevent direct discharge of pollutants into the storm drain. Water courses should be similarly labeled by posting signs. This should be done by the developer unless the local government accepts responsibility for it as a condition of development approval. Storm drain facilities should be inspected at least twice each year and cleaned immediately prior to and once during the storm season. If the local government does not agree to conduct maintenance activities, the developer must arrange to perform maintenance and report the arrangement and on-going maintenance activities to the local government as a condition of development approval.

f. Common Car Wash Area- For multi-family residential or managed residential (e.g. mobile home parks) developments with greater than 50 units, a car wash area should be designated for common usage that drains to the sanitary sewer (with approval from the local sanitary agency).

C. TIER 3 Baseline BMPs for Projects Greater than 5 Acres

1. The following BMP recommendations are applicable to residential, industrial and commercial activities.

a. All Tier 2 BMPs should be implemented.

b. Treatment Controls Based on Performance Goal- An appropriate selection of the following BMPs, referenced by identification numbers in the *California Storm Water Municipal BMP Handbook* should be implemented:

Wet Ponds TC2
Constructed Wetlands TC3
Swales and Vegetated Filter Strips (Biofilters) TC4
Extended Detention Basins TC5

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Sand Filters TC6

These BMPs must be designed with consideration of a performance goal of reducing the average annual total suspended solid loadings (expected from the site in its developed condition) by 80 percent. Following a design approach similar to (or more sophisticated than) the one presented in the *State Best Management Practices Municipal Handbook* is recommended to achieve this goal. This recommendation is based on the assumption that following this (or another acceptable) approach will result in attainment of the performance goal.

An operation and maintenance schedule should be developed and the responsibility for it established based on agreements made during the development review process. If the local government does not agree to accept responsibility for operation and maintenance, the developer must arrange the operation and maintenance responsibility and report the arrangement and on-going operation and maintenance activity to the municipality as a condition of development approval. Operation and maintenance activities must include frequent inspections to visually evaluate influent and effluent conditions to determine performance in removal of visual pollutants (e.g. turbidity, oil/grease, floatables); water levels to determine storage capacity and retention time; and to determine operation of key design features such as inlet and outlet structures.

2. Examples of Additional Controls to Minimize Potential Impacts

a. Water Quality Monitoring- Treatment control BMPs for sites that consist of greater than five acres of directly connected impervious area and are located in sensitive areas must be monitored. The purpose of water quality monitoring is to determine if the controls selected are functioning as designed and resulting in improved storm water quality, and not to measure compliance with effluent limitations or existing water quality standards. In some cases, developers will be responsible for water quality monitoring to evaluate the effectiveness of the treatment controls they installed in a new development. In other cases, a local storm water program will be responsible for and require assistance from developers in cooperative area-wide monitoring of treatment controls. RWQCBs should work with municipalities to provide water quality monitoring guidance to developers so monitoring efforts will be reasonable, consistent and meaningful. RWQCBs may also participate in water quality monitoring to evaluate treatment control effectiveness through pilot programs. Water quality monitoring will be required for these larger developments in sensitive areas on a case-by-case basis until such time as some form of a region-wide storm water treatment control monitoring program is established.

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TABLE 1

MINIMUM CONSTRUCTION BMPS RECOMMENDED FOR ALL DEVELOPMENT PROJECTS

(See Section B.2. Construction BMPs and refer to the *California Storm Water BMP Handbook for Construction Activities* for more detail)

A. Limit construction access routes and stabilize access points;

B. Stabilize areas denuded due to construction (prior to the wet season, October 1 through May 1) by using suitable practices including, but not limited to temporary or permanent seeding, mulching, sod stabilization, vegetative buffer strips, protection of trees, plastic covering, application of ground base on areas to be paved;

C. Protect adjacent properties by appropriate use of vegetative buffer strips, sediment barriers or filters, dikes or mulching, or by a combination of these measures and other appropriate measures;

D. Delineate clearing limits, easements, setbacks, sensitive or critical areas and their buffers, and trees and drainage courses by marking them in the field;

E. Stabilize and prevent erosion from temporary conveyance channels and outlets;

F. Use sediment controls and filtration to remove sediment from water generated by dewatering;

G. Use proper construction material and construction waste storage, handling and disposal practices;

H. Use proper vehicle and equipment cleaning, fueling and maintenance practices;

I. Control and prevent discharge of all potential pollutants, including, but not limited to, pesticides, petroleum products, nutrients, solid wastes, and construction chemicals, that occur on-site during construction.

J. Prepare a contingency plan in the event of unexpected rain or BMP failure including, but not limited to, an immediate response plan, storing extra or alternative control materials on-site (stakes, fences, hay bales), notifying the local agency, etc.

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TABLE 2

SUMMARY OF RESIDENTIAL POST-CONSTRUCTION BMP SELECTION[1]

SITE SIZE (ACREAGE)[2]	BASELINE BMPs	ADDITIONAL BMPs[3]
< 1 acre	Tier 1: 1. Education/Training 2. Landscape Control 3. Litter Control 4. Storm Drain Labeling 5. Runoff Controls	Tier A1: 1. Roof Downspout Systems 2. Vegetated Swales 3. Vegetated Filter Strips 4. Stream Erosion Control
1-5 acres	Tier 2: 1. Tier 1 BMPs 2. Site Planning 3. Vegetated Swales/Sand Filters 4. Street Sweeping 5. Maintenance of Storm Drain Facilities 6. Common Car Wash Area	Tier A2: 1. Refer to Tier A1 above
> 5 acres	Tier 3: 1. Tier 2 BMPs 2. Treatment Control Designed to Meet Performance Goal	Tier A3: 1. Tier A1 2. Water Quality Monitoring

[1] Accompanying text describes Tiers and BMPs in more detail. The California Storm Water BMP Handbooks explain BMP selection and design details.

[2] Positive consideration should be given to sites that minimize the amount of directly connected impervious area (DCIA). DCIA is defined as the area covered by pavement, building roofs, and other impervious surfaces which drain directly into the storm drain, excluding impervious areas which drain directly onto effective infiltration devices designed to infiltrate most (80%) of the runoff.

[3] An additional level of effort is recommended for projects which may pose a threat to a sensitive area. If the environmental review (CEQA/NEPA) or any other review of the project site identifies that the project is in the proximity of or may directly or indirectly impact a sensitive area, implementation of additional control measures should be implemented to reduce the potential impact to a level of insignificance.

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TABLE 3

SUMMARY OF INDUSTRIAL AND COMMERCIAL POST-CONSTRUCTION BMP SELECTION[4]

SITE SIZE (ACREAGE)[5]	BASELINE BMPs	ADDITIONAL BMPs[6]
< 1 acre	Tier 1: 1. Grease Controls 2. Trash Controls 3. Cleaning, Maintenance, and Processing Controls 4. Fuel Dispensing Controls 5. Outdoor Storage Controls 6. Loading Dock Controls 7. Landscape Controls 8. Public Agency Project Controls 9. Coverage by and Compliance with an Industrial NPDES Storm Water Discharge Permit 10. Runoff Controls	Tier A1: 1. Roof Downspout Systems 2. Vegetated Swales 3. Vegetated Filter Strips 4. Stream Erosion Control
1-5 acres	Tier 2: 1. Tier 1 BMPs 2. Site Planning 3. Vegetated Swales/Sand Filters 4. Street Sweeping 5. Maintenance of Storm Drain Facilities	Tier A2: 1. Refer to Tier A1 above
> 5 acres	Tier 3: 1. Tier 2 BMPs 2. Treatment Control Designed to Meet Performance Goal	Tier A3: 1. Tier A1 2. Water Quality Monitoring

[4] Accompanying text describes Tiers and BMPs in more detail. The California Storm Water BMP Handbooks explain BMP selection and design details.

[5] Positive consideration should be given to sites that minimize the amount of directly connected impervious area (DCIA). DCIA is defined as the area covered by pavement, building roofs, and other impervious surfaces which drain directly into the storm drain, excluding impervious areas which drain directly onto effective infiltration devices designed to infiltrate most (80%) of the runoff.

[6] An additional level of effort is recommended for projects which may pose a threat to a sensitive area. If the environmental review (CEQA/NEPA) or any other review of the project site identifies that the project is in the proximity of or may directly or indirectly impact a sensitive area, implementation of additional control measures should be implemented to reduce the potential impact to a level of insignificance.

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ATTACHMENT A.1

RECOMMENDED PROCEDURES FOR IMPLEMENTATION OF STORM WATER QUALITY CONTROLS

INTRODUCTION

The purpose of these procedures is to recommend general guidelines for coordinating the implementation of storm water quality plans, policies, and best management practices (BMPs) with existing planning and permitting procedures. These procedures provide a model. Each local government should take and modify these procedures, if necessary, to reflect their respective planning and permitting procedures. For example, an entity's "personalized" procedures manual could identify the departments and staff positions involved (e.g., planning, community development, building, and public works) and appropriate responsibilities and duties. Other changes may include modification of the procedures chart to more clearly represent specific local government requirements.

STORM WATER QUALITY CONTROLS AND THE PLANNING PROCESS

This section recommends the procedure to integrate storm water quality plans, policies and best management practices (BMPs) into the planning and permitting process. The goal is to minimize impacts from projects during the site planning and design phase by the developers and local government staff responsible for reviewing and approving projects. Pro-active and preventive action results in reduced costs for the developer and more reliable pollution control. For example, by using appropriate site planning techniques (e.g., minimizing the use of impervious surfaces) a developer can reduce the need for treatment control BMPs.

A developer should be provided information on storm water management plans, policies and BMPs during the pre-design, planning phase of a project. For small projects that may not go through the planning phase, local government staff should provide information on storm water management plans, policies, and BMPs when permit application materials are requested. Efforts in the early pre-design, planning phase are likely to result in more permit applications that address plans and policies and include appropriate BMPs. Proper guidance during the planning phase ensures that project development and design is an interactive, rather than a reactive, process. Developers benefit by learning about requirements that may have been costly to comply with if design were at a later stage, and agencies benefit by ensuring that permitting proceeds in a smooth fashion. If necessary, local government staff should take advantage of additional opportunities to insure consideration of adequate storm water quality

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plans, policies and BMPs prior to the permit application phase; during preparation and after submittal of preliminary plans and/or tentative plans, developers can be reminded or advised further of general requirements, recommendations and necessary changes in project design.

Early Information Distribution

Local governments should develop brochures, fact sheets, etc. to distribute at department offices, permit counters and by mail. These documents should summarize the process and requirements/recommendations for incorporating storm water quality plans, policies and BMPs into projects.

Informal Meeting

Local government staff can use informal meetings, typically used to identify required permits and approvals, to convey information to the developer regarding storm water quality plans, policies, and BMPs.

Preliminary Plan

BMPs appropriate to the project should be included in a preliminary plan. BMPs to be considered at this phase include site planning, construction phase BMPs, and post-construction source control BMPs and treatment control BMPs. The BMPs proposed should be based on the type of development under consideration (indicating how and what pollutants might be generated), and site characteristics, such as slope and soil types.

Local government staff need to ensure that the BMPs chosen are appropriate for the type of project proposed. The preliminary plan may need to be reviewed by several entities (e.g., public works, building departments). Following review of the submittal, staff should respond to the preliminary plan regarding the following issues:

1. Are the BMPs selected appropriate? If the BMPs need to be reconsidered, an explanation should be provided. It may be necessary for the staff and developer to work through the BMP selection process together.

2. Is responsibility for short and long term maintenance addressed? No BMP should be approved until either the agency or the developer or a third party accepts these responsibilities.

Tentative Plan

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Discussions with the developer during the preliminary plan stage should be the basis of the selection and layout of storm water quality BMPs. The revised plan, or tentative plan, should clearly indicate the type and location of BMPs to be used on the topographic map submitted as the tentative plan. Accompanying text explaining the BMPs proposed should be attached if further explanation is necessary. This may be the appropriate time for a public works engineer to review the plans and specify design criteria appropriate for use in designing the proposed BMPs. Following review of the tentative plan, further changes may need to be requested. The local government staff should emphasize the importance of including all changes required or agreed to by the developer during permit application review in the final plans.

Application for Permits

Projects with conditional approval should submit storm water quality control information along with applications for required permits and submittal of an erosion control plan. Refer to section B.4. *Reporting Erosion and Storm Water Control Strategies* in the TAC Recommendations for items that should be included. In addition, all projects should be required to submit a brief plan describing construction BMPs to be used to prevent storm water pollution by sediment from denuded or stockpile areas, fluids leaking from heavy equipment, runoff from stored materials such as bags of plaster, etc.

Inspection and Enforcement

Site inspections and enforcement actions, usually performed by field inspectors as part of administration of grading and building permits, should also be performed to ensure storm water quality BMPs are being used during the construction phase and are installed for the post-construction phase, as indicated on plans and in permits. Local government staff responsible for inspections should be trained to verify proper use of BMPs.

IMPLEMENTATION OF PROCEDURES BY LOCAL GOVERNMENTS

The general, procedural recommendations described will be most effective if they are fit to an agency's specific situation by assigning responsible departments and/or staff members to each step. The following steps are suggested to tailor the preceding recommendations to your agency's specific needs:

- Construct a Flow Chart to Match Your Planning/Permitting Process

Clearly identify each of these steps and phases in one flowchart. If you have never done this before, this exercise should result in an informative outline of your planning process that will

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highlight any existing problem areas as well as provide an excellent educational tool for the public.

- Distribute the Storm Water Quality Control Tasks to Fit Your Flow Chart

Identify the specific storm water quality control tasks to be performed at different points in the planning/permitting process, then allocate the tasks to the appropriate steps in the planning/permitting process flow chart. Take care to comply with the goal of implementing storm water quality controls as early in the process as possible. Remember--storm water quality controls should be considered during the site planning and design phase, not "tacked on" after the fact.

- Designate Responsible Departments and Individuals

To ensure that each storm water quality control task is accomplished, designate responsible departments and staff. Label each task on your planning/permitting process flow chart with the responsible department and staff member(s). Finally, make sure that the people involved in implementing these steps receive adequate training to fulfill their new tasks.

- Identify and Address Necessary Policy Decisions

Some task items may require more than simple training to implement; decision makers may need to make policy level determinations. For example, before requiring developers to build treatment control BMPs, a jurisdiction will need to define a maintenance policy. The maintenance policy, in turn, will have funding-related consequences. Another potential issue may be use of regional facilities. Identifying and addressing all these issues up front will prevent the planning/permitting process from bogging down once implementation of a storm water quality controls for new developments begins.

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ATTACHMENT B

REVISED ENVIRONMENTAL CHECKLIST
ENVIRONMENTAL IMPACTS/NON-IMPACTS

CEQA, in Section 15063.(f), Initial Study Format, states that these forms are only suggested, and public agencies are free to devise their own format for an Initial Study.

This Environmental Checklist Form has been revised to include recommended changes to facilitate consideration of storm water (and other water quality issues) in environmental determinations on proposed projects. Recommended changes from the standard form are typed in **underline and bold**. You may use this example directly, or revise your existing standard forms similarly.

NOTE:

- *Summarize conclusions for each (EARTH, AIR, etc.) with supporting evidence: why there is the potential for (POT.), why there is (YES), or why there is not (NO) – a significant environmental impact. Use the space provided at the end of each section, or add an attachment with a clear reference.*
- *Use information such as other reports, plans or studies as supporting evidence. Add persons/agencies contacted.*
- *Include mitigation measures. Include a mitigation monitoring program as an appendix.*

5. EARTH: ***Will the proposal result in:***	***Significant Impact?***		
	NO	***POT.***	***YES***
5.1 Unstable earth conditions or in geologic substructures?	___	___	___
5.2 Disruptions, displacements, compaction or overcovering of the soil?	___	___	___
5.3 Change in topography or ground surface relief features?	___	___	___
5.4 The destruction, covering, or modification of any unique geologic or physical features?	___	___	___
5.5 Any increase in wind or water erosion of soils, either on- or off-site?	___	___	___
5.6 Changes in the deposition or erosion of beach sands, or changes in siltation which may modify the channel of a river or stream, or the bed of the ocean or any bay, inlet or lake?	___	___	___
5.7 Exposure of people and property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazard?	___	___	___

EARTH: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

_____

_____

_____

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6. AIR: Will the proposal result in:	Significant Impact? NO	POT.	YES
6.1 Substantial air emissions or deterioration of ambient air quality?	___	___	___
6.2 The creation of objectionable odors?	___	___	___
6.3 Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	___	___	___

AIR: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

7. WATER: Will the proposal result in:	Significant Impact? NO	POT.	YES
7.1 Changes in currents, or the course or direction of water movements, in either marine or fresh waters, or wetlands?	___	___	___
7.2 Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	___	___	___
7.3 Alterations to the course or flow of flood patterns?	___	___	___
7.4 Change in the amount of surface water in any water body, or wetlands?	___	___	___
7.5 Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen, or turbidity or other typical storm water pollutants (e.g. sediment from construction, hydrocarbons and metals from vehicle use, nutrients and pesticides from landscape maintenance, metals and acidity from mining operations).	___	___	___
7.6 Alteration of the direction or rate of flow of ground waters?	___	___	___
7.7 Change in the quantity of groundwaters, either through direct additions or through interception of an aquifer by cuts or excavations?	___	___	___
7.8 Change in the quality of groundwaters through infiltration of reclaimed water or storm water runoff that has contacted pollutants from urban, industrial or agricultural activities?	___	___	___
7.9 Alteration of wetlands in any way?	___	___	___
7.10 Substantial reduction in the amount of water otherwise available for public water supplies?	___	___	___
7.11 Exposure of people or property to water related hazards such as flooding or tidal waves?	___	___	___

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WATER: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

8. PLANT LIFE *Will the proposal result in:*	Significant Impact? NO	POT.	YES
8.1 Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops and aquatic plants)?	___	___	___
8.2 Reduction of the numbers of any unique, rare or endangered species of plants?	___	___	___
8.3 Introduction of a new species of plants into an area, or result in a barrier to the normal replenishment of existing species?	___	___	___
8.4 Reduction in acreage of wetlands?	___	___	___

PLANT LIFE: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

9. ANIMAL LIFE: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
9.1 Change in the diversity of species, or number of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?	___	___	___
9.2 Reduction of the numbers of any unique, rare or endangered species of animals?	___	___	___
9.3 Introduction of a new species of animals into an area, or result in a barrier to the migration or movement of animals?	___	___	___
9.4 Deterioration to existing fish or wildlife habitat?	___	___	___

ANIMAL LIFE: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

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10. NATURAL RESOURCES: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
10.1 Increased in rate of use of natural resources?	___	___	___

NATURAL RESOURCES: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

11. ENERGY: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
11.1 Use of substantial amounts of fuel or energy?	___	___	___
11.2 Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?	___	___	___

ENERGY: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

12. LAND USE: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
12.1 A substantial alteration of the present or planned land use of an area?	___	___	___
12.2 Reduction in acreage of any agricultural crops?	___	___	___

LAND USE: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

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13. POPULATION: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
13.1 Will the proposal alter the location, distribution, density, or growth rate of human population of an area?	___	___	___

POPULATION: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

14. HOUSING: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
14.1 Will the proposal affect existing housing, or create a demand for additional housing?	___	___	___

HOUSING: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

15. TRANSPORTATION/CIRCULATION: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
15.1 Generation of substantial additional vehicular movement?	___	___	___
15.2 Effects on existing parking facilities, or demand for new parking?	___	___	___
15.3 Substantial impact upon existing transportation systems?	___	___	___
15.4 Alteration to present patterns of circulation or movement of people/goods?	___	___	___
15.5 Alterations to waterborne, rail, or air traffic?	___	___	___
15.6 Increases in traffic hazards to motor vehicles, bicyclists or pedestrians?	___	___	___

TRANSPORTATION/CIRCULATION: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

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16. PUBLIC SERVICES:	Significant Impact?		
Will the proposal heve an effect upon, or result in a need for new or altered governmental services in any of the following areas:	NO	POT.	YES
16.1 Fire protection?	___	___	___
16.2 Police protection?	___	___	___
16.3 Schools?	___	___	___
16.4 Parks or other recreational facilities?	___	___	___
16.5 Maintenance of public facilities, including roads or storm drain facilities?	___	___	___
16.6 Other governmental services?	___	___	___

'UBLIC SERVICES: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

17. UTILITIES:	Significant Impact?		
Will the proposal result in:	NO	POT.	YES
17.1 A need for new systems, or substantial alterations to the area utilities?	___	___	___
17.2 Power or natural gas?	___	___	___
17.3 Communication systems?	___	___	___
17.4 Water?	___	___	___
17.5 Sewer or septic tanks?	___	___	___
17.6 Storm water drainage or storm water quality control?	___	___	___
17.7 Solid waste and disposal?	___	___	___

JTILITIES: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

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18. NOISE: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
18.1 Increases in existing noise levels?	___	___	___
18.2 Exposure of people to severe noises?	___	___	___

NOISE: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

19. HAZARDS/HUMAN HEALTH: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
19.1 A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	___	___	___
19.2 Possible interference with an emergency evacuation plan?	___	___	___
19.3 Creation of any health hazard or potential health hazard?	___	___	___
19.4 Exposure of people to potential health hazards?	___	___	___

HAZARDS/HUMAN HEALTH: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

20. AESTHETICS: *Will the proposal result in:*	Significant Impact? NO	POT.	YES
20.1 The obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	___	___	___

AESTHETICS: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

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21. CULTURAL RESOURCES: Will the proposal result in:	Significant Impact? NO	POT.	YES
21.1 The alteration of, or the destruction of, a prehistoric or historic site?	___	___	___
21.2 Adverse physical or aesthetic effects to a prehistoric or historic building, structure or object?	___	___	___
21.3 Does the proposal have the potential to cause a physical change which would affect unique ethnic or cultural values?	___	___	___
21.4 Restrict existing religious or sacred uses within the potential impact area?	___	___	___

CULTURAL RESOURCES: Conclusions w/evidence - Persons contacted. Monitoring/Mitigation Measures?

22. CUMULATIVE/GROWTH INDUCING IMPACTS:

NOTE: Describe any cumulative/growth inducing impacts that may occur due to implementation of the project. Identify checklist topic related to the impact and provide adequate evidence.

23. FEASIBLE PROJECT ALTERNATIVES:

NOTE: If there are significant environmental impacts caused by the project that are unmitigable below significance, describe below any possible project alternatives that would have less environmental impacts.

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24. STATEMENT OF MANDATORY FINDINGS OF SIGNIFICANCE:

NOTE: If there are significant environmental impacts which cannot be mitigated and no feasible project alternatives are available, then complete the mandatory findings of significance and attach to this Initial Study as an appendix. This is the first step for starting the environmental impact report (EIR) process.

25. FISH AND GAME ENVIRONMENTAL DOCUMENT FEES

Assessment of Fee:

For purposes of implementing Section 735.5 of Title 14, California Code of Regulations: if based on the record as a whole, the Planner determines that implementation of the project described herein, will result in changes to resources A - G listed below, then a Fish and Game Document Filing Fee must be assessed. Based upon analysis using the criteria A - G, and information contained in the record, state conclusions with evidence below.

A) Riparian land, rivers, streams, water courses, and wetlands under state and federal jurisdiction;
B) Native and non-native plant life and the soil required to sustain habitat for fish and wildlife;
C) Rare and unique plant life and ecological communities dependent on plant life, and;
D) Listed threatened and endangered plant and animals and the habitat in which they are believed to reside;
E) All species of plant or animals as listed as protected or identified for special management in the Fish and Game Code, the Public Resources Code, and the Water Code, or regulations adopted thereunder;
F) All marine terrestrial species subject to the jurisdiction of the Department of Fish and Game and the ecological communities in which they reside;
G) All air and water resources the degradation of which will individually or cumulatively result in the loss of biological diversity among plants and animals residing in air or water.

De minimis Fee Exemption: For purposes of implementing Section 735.5 of the California Code of Regulations: A *De minimis Exemption* may be granted to the Environmental Document Fee if there is substantial evidence, based on the record as a whole, that there will not be changes to the above named resources 24.A - G caused by implementation of the project. Using the above criteria, state conclusions with evidence below, and follow Planning and Building Inspection Department procedures for filing a De minimis Exemption.

Conclusions: _____

_____

_____

_____

Evidence: _____

_____

_____

_____

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24. STATEMENT OF MANDATORY FINDINGS OF SIGNIFICANCE:

NOTE: If there are significant environmental impacts which cannot be mitigated and no feasible project alternatives are available, then complete the mandatory findings of significance and attach to this Initial Study as an appendix. This is the first step for starting the environmental impact report (EIR) process.

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B) Native and non-native plant life and the soil required to sustain habitat for fish and wildlife;
C) Rare and unique plant life and ecological communities dependent on plant life, and;
D) Listed threatened and endangered plant and animals and the habitat in which they are believed to reside;
E) All species of plant or animals as listed as protected or identified for special management in the Fish and Game Code, the Public Resources Code, and the Water Code, or regulations adopted thereunder;
F) All marine terrestrial species subject to the jurisdiction of the Department of Fish and Game and the ecological communities in which they reside;
G) All air and water resources the degradation of which will individually or cumulatively result in the loss of biological diversity among plants and animals residing in air or water.

De minimis Fee Exemption: For purposes of implementing Section 735.5 of the California Code of Regulations: A *De minimis Exemption* may be granted to the Environmental Document Fee if there is substantial evidence, based on the record as a whole, that there will not be changes to the above named resources 24.A - G caused by implementation of the project. Using the above criteria, state conclusions with evidence below, and follow Planning and Building Inspection Department procedures for filing a De minimis Exemption.

Conclusions: _____

_____

_____

_____

Evidence: _____

_____

_____

_____

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25. ADDITIONAL COMMENTS

NOTE: Include topic hearing and number.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

26. ATTACHED APPENDICES

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6) _____

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ATTACHMENT C

PROGRAM SUMMARY FOR CONTROL OF RUNOFF FROM URBAN DEVELOPMENT

PURPOSE OF SUMMARY

Staff prepared this summary of programs that may implement the EPA management measures (MMs) for urban development, construction, and roads, highways, and bridges for the use of the Technical Advisory Committee (TAC). The summary is not an exhaustive survey of programs down to the detail of regulations and policies, nor does it provide recommendations on how the MMs should be implemented. Rather it is meant to provide the TAC with a quick survey of the programs that already exist to implement the subject MMs, and to point the TAC towards some possible gaps in implementation. These programs are generally embodied in the enabling statutes, regulations, ordinances, and plans of local, state, and federal agencies. This summary was given to the TAC in the beginning of the process.

State Water Resources Control Board/Regional Water Quality Control Boards

California Porter-Cologne Water Quality Control Act (Porter-Cologne)

The Porter-Cologne Water Quality Act is the principal law governing water quality regulation in California. This statute established the State Water Resources Control Board and nine regional water quality control boards which are charged with implementing its provisions. The Porter-Cologne Act, applicable to both surface and ground waters, is designed to protect the beneficial uses of the State's waters through the establishment of water quality control standards and the implementation of water quality control plans.

Water Quality Control Plans

Each of the Regional Water Boards has adopted a Water Quality Control Plan (Basin Plan) which describes and directs the regulation of water quality in its region. Basin Plans describe the beneficial uses of waters within the region, set water quality standards to protect those uses and lay out an implementation program to ensure that the standards are met.

Waste Discharge Requirements

The State and Regional Water Boards may issue waste discharge requirements under the authority of the Porter-Cologne Water Quality Control Act for any discharge or proposed discharge of waste to waters of the state. The requirements must take into consideration the beneficial uses to be protected, the water quality objectives, and other waste discharges.

Compliance with Management Practices. Porter-Cologne limits how Regional Water Boards can require use of management practices. Ordinarily, WDRs and other Porter-Cologne orders may not "specify the design, location, type of construction, or particular manner in which compliance may be had," but must allow compliance "in any lawful manner." (Cal. Water Code §13360.) Thus, WDRs ordinarily specify the allowable discharge or resulting condition

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of receiving water, rather than the manner by which those results are to be achieved. However, the Regional Water Boards may set discharge limitations such that the only practical way to comply is to use management practices. Discharge prohibitions and other limitations on the volume, characteristics, area, or timing of discharge are not affected by this statutory constraint. Regional Water Boards may also waive WDRs for a specific discharge or a category of discharges, upon condition that identified management practices are followed.

Water Quality Investigations. The State and Regional Water Boards can conduct investigations into water quality, directly or in cooperation with other agencies. They may also require that dischargers carry out water quality investigations, and may require any state or local agency to investigate and report on water quality issues, even if that agency is not a discharger.

Clean Water Act

The Federal Water Pollution Control Act of 1972, commonly referred to as the Clean Water Act (CWA) required states to establish water quality standards for both municipal and industrial dischargers. Technology-based standards prescribe minimum standards of performance for municipal and industrial point source dischargers without regard to the quality of the receiving waters. Effluent limits require the application of "best practicable control technology currently available...", known as BPT limits and industrial dischargers are required to install the "...best available technology economically achievable..."(BAT limits). The CWA established the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES permits are designed to be the key to enforcing the effluent limitations and water quality standards. All point source dischargers are required to obtain permits. The State and Regional boards have been delegated the responsibility for issuing NPDES permits to control discharges to surface waters of the United States.

NPDES Storm Water Permit Program

The 1987 Amendments to the CWA set forth new provisions to require permits for the discharge of storm water from separate storm sewers for both municipal and industrial dischargers. Pursuant to the CWA Reauthorization in 1987, the USEPA promulgated regulations (Phase I) for storm water discharges in November 1990. The regulations list the types of storm water discharges for which NPDES permits are required. These include discharges from municipal separate storm drain systems serving populations of 100,000 or more, discharges associated with certain specific industrial activities, discharges from construction activities that result in the disturbance of five acres total land, and discharges that contribute to violations of water quality standards or are significant contributors of pollutants to receiving waters.

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General Industrial Activities Storm Water Permit: In November of 1991, the State Water Board adopted the General Industrial Activities Storm Water Permit covering all categories of industrial activities required to be permitted under federal regulations, except construction activities. Federal regulations require industrial dischargers to control and eliminate the sources of pollutants in storm water through the development and implementation of storm water pollution prevention plans (SWPPP). The objectives of the SWPPP are to help identify the sources of pollution that affect the quality of industrial storm water discharges and describe the implementation of practices to reduce pollutants in industrial storm water discharges. The SWPPP must include source control BMPs and as necessary, treatment control BMPs which will constitute BAT and BCT, and will achieve compliance with water quality standards.

General Construction Activities Storm Water Permit: On August 20, 1992, the State Water Board adopted the General Construction Activity Storm Water Permit. Permits are required for all storm water discharges associated with construction activities resulting in disturbances of five or more acres including clearing, grading, and excavation. The requirements in the construction general permit are very similar to the industrial general permit. The focus, however is to control the discharge of sediment and building materials in storm waters. Required elements of the SWPPP include site description, erosion and sediment controls, waste disposal, implementation of approved local plans, proposed post construction controls, and non-storm water management.

Municipal Stormwater Permit: Federal regulations authorize the issuance of system-wide or jurisdiction-wide municipal permits. Participants in the program are responsible for development and implementation of storm water management plans (SWMP) to prevent the pollution of storm water within the permitted areas. The SWMP must detail how the permittee will eliminate non-storm water discharges; and apply best management practices, to the maximum extent practicable, to prevent storm water pollution.

Significant sources of polluted runoff which are not presently covered by the NPDES federal stormwater regulations include municipalities with populations under 100,000, construction sites less than five acres in size, and commercial and small industrial sites not specifically listed in statute such as automobile service stations.

Section 404 Permits for Dredged and Fill Materials
Under CWA Section 404, the U.S. Army Corps of Engineers (ACOE) issues permits to regulate discharges of dredged or fill material to "waters of the United States". "Waters of the United States includes most surface waters, including territorial seas, rivers, streams, tributaries, lakes, ponds, and wetlands adjacent to such water bodies. The ACOE issues general Nationwide Permits (NWPs) for classes of activities which it believes pose only minor threats to the environment and individual permits for activities not covered under the NWPs.

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As a condition of permit approval, the applicant is required to obtain Section 401 Water Quality Certification from the State Water Resources Control Board.

Section 401 State Water Quality Certification

Clean Water Act Section 401 allows the State to deny or grant water quality certification for any activity which may result in a discharge to navigable waters and which requires a federal permit or license. Certification means that the permitted activity will comply with State and federal water quality standards, including designated beneficial uses, water quality objectives, and the State's antidegradation policy. The State may deny certification, certify the activity as proposed, certify with conditions,or waive certification.

California Coastal Commission

The Coastal Commission was created by the voters of the State in 1972 and was made a permanent State agency by the Legislature in 1976, through the passage of the Coastal Act. The Commission's area of jurisdiction is the coastal zone, which generally extends seaward to the Sate's three mile limit, in urban areas 1000 yards or less inland from the mean high tide, and in rural areas may extend inland for several miles. The coastal zone does not include any of San Francisco Bay and the Delta.

New development in the coastal zone requires a permit from the Commission, or from a city or county once the Commission has certified the Local Coastal Program. The Commission has no jurisdiction over existing urban development. Within State tidelands, however, the Commission retains permanent permitting authority. Conditions can be attached to coastal permits to require projects to mitigate the potential impacts of urban runoff or hydrologic modification.

To receive a coastal permit, a project must be found to be consistent with the Coastal Act, which includes several policies that address water quality. The Coastal Act policies do not specifically mention nonpoint source pollution, but instead generally require the protection of coastal marine waters, coastal streams, wetlands, and groundwater, as well as the protection of biological populations that inhabit those waters. Therefore, when an application for development is reviewed, impacts from urban runoff are considered, but there are no specific standards. It is important to note that Section 30412 of the Coastal Act states that the State and Regional Water Boards have the sole authority to set water quality standards. Finally, when the Commission reviews a Local Coastal Program, it can require that there are local ordinances in place that require management measures such as erosion control plans and protection of sensitive water bodies.

San Francisco Bay Conservation and Development Commission (BCDC)

BCDC's jurisdiction is San Francisco Bay, Suisun Bay, and 100 feet inland from the mean high tide line of these bays. Within this area, a permit must be obtained for any filling or

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dredging. Their enabling statute, the MacAteer-Petris Act (1967), allows the fill or destruction of wetlands only under very limited circumstances. BCDC's authority over new development proposals within the 100 foot upland area is very limited, and since they have no jurisdiction over activities beyond this area, their ability to control the impacts of NPS pollution on the bay is limited.

Department of Fish and Game

In their role as protectors of the fish and wildlife resources of the state, the Department of Fish and Game (DFG) has two aspects of their enforcement program that directly concerns wetlands and riparian areas. The first stems from Section 1600 of the Fish and Game Code which requires a Section 1601 or 1603 agreement from DFG for any stream alteration. The other relevant aspect of DFG's program is enforcement of Section 5650 of the Fish and Game Code which concerns disposing or discharging of a pollutant into a water course. A typical enforcement action in this area would be against a person who has dumped crankcase oil into a stream.

Air Resources Control Board/Air Quality Management Districts

The California Air Resources Control Board (CARB) is responsible for setting emissions standards for air pollutants. In addition to regulating industrial point source controls, the CARB is the lead agency for several programs targeted at reducing vehicle emissions such as the "Smog Check" program, and "Low Emission Vehicle" program.

Congestion Management Agencies

In addition to atmospheric deposition, several heavy metals and other toxic substances, and sediment-borne pollutants associated with automobiles and related activities are significant contributors to the degradation of water quality. Counties with a metropolitan population greater than 100,000 are required to form a Congestion Management Agency (CMA). The CMA is responsible for the development of a Congestion Management Plan (CMP). As part of the CMP, the agency must address the impacts of land use decisions on regional transportation systems, trip reduction ordinances, and public transit services. Coordination with the CMA could assist pollution reduction efforts.

Integrated Waste Management Board/Local Solid Waste Management Agencies

The 1989 amendments to Division 30 of the Public Resources Code (Waste Management) set forth the goal of a 50% reduction by the year 2000 of solid waste reaching the landfill. Local governments are required to implement source reduction, and composting programs to achieve this goal. Examples of programs implemented at either the State or local level include, household hazardous waste collection, used oil recycling, and public education.

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Local Government

Local government has broad power to control new development through the General Plan, the Subdivision Map Act, the California Environmental Quality Act, and their police powers (to protect the health and safety of the public). State General Plan law (Government Code Sections 65000-66025) requires that each local government prepare a General Plan and adopt ordinances to implement the plan policies. Of the mandated elements of the general plan, there are two that directly address water quality, the conservation element and the open space element. The conservation element requires the conservation of water resources, and may also cover the control of pollution of streams, regulation of the use of land in stream channels and the protection of watersheds. The open space element is supposed to provide for the preservation of habitats and water bodies.

The city or county's zoning ordinances are to be used to assure implementation of the General Plan. These ordinances can regulate grading, erosion control, wetland and riparian setbacks, and control of runoff. In addition to the zoning ordinances, the city or county can use their building code, fire code, and plumbing code to regulate existing and new development.

The California Environmental Quality Act

Known as CEQA, this law requires the lead agency, usually a city or county, to prepare an environmental impact report if a proposed project could have a significant impact on the environment. NPS pollution is not specifically mentioned in the statute, however, it is addressed in three places in CEQA.

Section 15206 states that a project of statewide, regional, or areawide significance shall be denied if the project would interfere with attainment of regional water quality standards as stated in an approved Section 208 plan. This section does not require consistency with Regional Water Board basin plans however. The second place water quality is addressed in CEQA is in the Environmental Information Form filled out by the applicant for a project. As part of this form, the applicant is supposed to answer "yes" or "no" to questions about whether the project would change features of water bodies, drainage patterns, or be sited on filled land or slopes of 10 percent or more. The third place is in the critical Environmental Checklist Form which must be completed by the lead agency. This form has a series of questions about the project's potential impact on water, which include effects on drainage courses, rates of absorption, and alteration of water quality.

Except in special circumstances, all of the adverse environmental effects of a proposed must be mitigated to a level of insignificance in order for a city or county to approve the project. Other agencies that must subsequently approve the project, such as the Coastal Commission and Fish and Game, utilize the environmental documentation generated by the CEQA process, further indicating the importance of the process.

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The Subdivision Map Act
This part of the Government Code has two sections that local government can use to control of NPS pollution. Section 66411 requires that each local government adopt a subdivision ordinance which "shall specifically provide for proper grading and erosion control, including the prevention of sedimentation or damage to offsite property. Section 66474 states that a city or county shall **deny** approval of a tentative subdivision map if it makes the finding, among other things, that "the design of the subdivision or the proposed improvements are likely to cause substantial environmental damage or substantially and avoidably injure fish and or wildlife or their habitat. There is no other specific mention of water quality or natural resources in the Subdivision Map Act, perhaps because subdivisions must also be consistent with the General Plan and they are subject to review under the CEQA.

Federal Highway Administration (FHWA)
The FHWA administers the funding for roads, highways and bridges provided through the Intermodal Surface Transportation Efficiency Act. The FHWA sets guidance for use of these funds, including water quality related issues such as sediment control and stormwater runoff.

American Association of State Highway Transportation Officials (AASHTO)
AASHTO has developed standard guidance for States to follow in constructing and maintaining roads, highways and bridges. Some of this guidance addresses water quality issues.

OTHER AGENCIES
There are a number of other state and federal agencies that are involved in the regulation of activities that concern NPS pollution, such as the California Department of Pesticide Regulation, California Department of Toxic Substance Control, and the U.S. Fish and Wildlife Service. However, staff did not have time to review and summarize their programs for this report.

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ATTACHMENT D

CZARA COASTAL NONPOINT POLLUTION CONTROL PROGRAM and the NPDES STORM WATER PERMIT

Historically, there have always been overlaps and ambiguity between programs designed to control urban runoff nonpoint sources and those designed to control urban runoff point sources (storm water). For example, runoff may often originate as a nonpoint source but ultimately be channelized and become a point source. NPDES permits are required for and issued to point source discharges. Nonpoint sources are sources of pollutant discharges that do not meet the regulatory definition of point source, and as such are not required to be covered by a NPDES permit.

> *Point source is defined (40 CFR Part 122.2) as any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, ... from which pollutants are or may be discharged.*

Storm drain system discharges are considered point source discharges in accordance with the regulatory definition. Section 402(p) of the Clean Water Act establishes permit requirements for certain municipal and industrial storm water discharges. Section 6217 of CZARA requires USEPA to promulgate and states to implement management measures to control nonpoint pollution in coastal waters. The discussion below is intended to clarify the relationship between these two programs and describe the scope and applicability of the coastal nonpoint program to urban runoff.

The storm water permit program is a two-phased program enacted by Congress in 1987 under Section 402(p) of the Clean Water Act. Under Phase I, National Pollutant Discharge Elimination System (NPDES) permits are required to be issued for municipal separate storm sewers serving large or medium-sized populations (greater than 250,000 or 100,000 people, respectively), and for storm water discharges associated with industrial activity. Permits are also to be issued on a case-by-case basis, if USEPA or a state determines that a storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. All other storm water discharges are excluded from coverage under NPDES permits at this time. Under Phase II, USEPA is expected to issue regulations which apply to all other storm water discharges.

Section 6217 of CZARA requires states to develop coastal nonpoint pollution control programs that are in conformity with the Section 6217 (g) guidance management measures [(g) Guidance] published by USEPA. Although the (g) Guidance includes measures to address certain urban runoff, all storm water discharges that are covered by Phase I of the NPDES storm water permit program are excluded from coverage under the (g) Guidance. These include any discharge from a municipal separate storm sewer systems serving a

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population of 100,000 or more, any point source discharge associated with a permitted industrial activity, any discharge which has already been permitted, and any discharge for which USEPA or the state makes a determination that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

At present, USEPA has not yet promulgated its regulations that would designate additional storm water discharges, beyond those regulated in Phase I, that will be required to be regulated under Phase II. It is thus not possible to determine at this point which additional storm water discharges may be regulated by the NPDES program and which will not. Furthermore, due to the great number of such discharges, it is likely that it would take many years to permit all of these discharges, even if USEPA allows for relatively expeditious state permitting approaches such as the use of general permits. Therefore, discharges that potentially may be ultimately covered by Phase II of the storm water permits program are covered by the management measures guidance and must be addressed by the coastal nonpoint pollution control program. Any storm water discharge that ultimately is issued an NPDES permit will become exempt from this guidance and from the coastal nonpoint pollution control program at the time that the permit is issued.

In addition, other activities are exempt from the NPDES permit requirements and thus are covered by the coastal nonpoint pollution control program. Most important, construction activities on sites less than five acres, which are not currently covered by the NPDES Phase I storm water requirements, are covered by the coastal nonpoint pollution control program. Similarly, discharges from wholesale, retail, service or commercial activities, including gas stations, which are not covered by Phase I of the NPDES storm water program, are covered instead by the coastal nonpoint pollution control program.

Table 1 provides a comparison of pollution sources covered by CZARA management measures versus NPDES storm water permits. Note that certain sources, such as service stations, are marked with a conditional *no* (denoted by footnote 3) in the *Covered by NPDES Permit* column. As noted in footnote 3, sources such as service stations *may* be regulated through the storm water management programs of permitted municipalities. Location of a source within an area covered by a municipal storm water permit in and of itself does not exempt the source from coverage under the CZARA management measures. Rather, such sources must be explicitly identified and addressed by storm water management programs of permitted municipalities in order to be considered covered by a NPDES permit. Otherwise, they are subject to the CZARA management measures. In principle, all of the footnote 3 sources should be covered by storm water management programs of permitted municipalities, but if they are not explicitly covered, which is often the case, they are subject to the CZARA management measures.

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It is important to emphasize that while different legal authorities may apply to different situations, the goals of the NPDES and CZARA programs are complementary. Table 2 provides a side-by-side comparison of the NPDES and CZARA requirements. Many of the techniques and practices used to control urban runoff are equally applicable to both programs. In the interest of consistency and comprehensiveness, states have the option to implement the (g) Guidance management measures throughout the state's coastal zone, including Phase I storm water areas, as long as the NPDES requirements are met for areas subject to NPDES requirements. In general, states are being encouraged to develop consistent approaches to addressing urban runoff throughout their coastal zones.

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Table 1. Comparison of pollution sources covered by CZARA Management Measures and NPDES Storm Water Permits

POLLUTION SOURCE	COVERED BY CZARA MANAGEMENT MEASURES	COVERED BY NPDES PERMITTING
New Development - (for population of 100,000 or more)	No	Yes
New Development - (for population less than 100,000)	Yes	No[1]
Construction sites less than 5 acres[2]	Yes	No[3]
Construction sites of 5 acres or more	No	Yes
Retail, commercial, or wholesale activities	Yes	No[3]
Service stations	Yes	No[3]
Industrial activities[4]	No	Yes
Hazardous waste treatment, storage, and disposal facilities	No	Yes
Household hazardous waste	Yes	No[3]
Landfills that receive industrial waste	No	Yes
Recycling facilities including junkyards, scrapyards, salvage yards, and battery reclaimers	No	Yes
Transportation facilities[5] with vehicle maintenance operations	No	Yes
Roads, highways, and bridge operations, and maintenance	Yes	No[3]
Large parking lots (shopping malls, stadiums)	Yes	No[3]
On-site disposal systems	Yes	No[3]
Residential property including lawns and landscaped areas	Yes	No[3]
Recreational areas (ski areas, golf courses, amusement parks)	Yes	No[3]
Greenhouses and nurseries	Yes	No[3]
Illicit connections and discharges	Partial[6]	Yes

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1. The Regional Water Quality Control Board may permit a municipal storm drain system serving a population less than 100,000 on a case-by-case review upon considering the physical interconnections between the storm drain systems, the locations of the discharge relative to larger municipal storm drain system, the quantity and nature of the pollutants, the nature of the receiving waters, or the boundaries of a region defined by a storm water management regional authority.

The pollution prevention plan required as part of a NPDES permit for a construction site must include a description of "storm water management" measures that will be operated after construction is complete. According to the Final NPDES General Permit for Storm Water Discharges from Construction Sites: Fact Sheet, "EPA anticipates that storm water management measures at many sites will be able to provide for the removal of at least 80 percent of total suspended solids," consistent with the CZARA New Development Management Measure. The NPDES permit conditions address only installation of storm water management measures and not future alterations operation, or maintenance.

2. Includes clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale.

3. May be regulated through the storm water management programs of Phase I medium-large municipalities (>100,000).

4. The regulatory definition of storm water discharge associated with industrial activity identifies 11 categories of industrial facilities.

5. Includes vehicle rehabilitation, mechanical repairs, painting fueling, lubrication, equipment cleaning operations, airport de-icing operations, for the following: railroad transportation, local and suburban transit, motor freight and warehousing, U.S. Postal Service, water transportation, transportation by air, and petroleum bulk stations and terminals.

6. Discussed in Pollution Prevention Management Measure - to be included in CZARA coastal NPS programs when not a part of NPDES storm water management program or combined sewer overflow. NPDES storm water program applies primarily to illicit industrial discharges to storm water systems.

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Table 2
MUNICIPAL STORM WATER MANAGEMENT PROGRAMS

ILLICIT DISCHARGE PROHIBITION

NPDES Regulations [40 CFR 122.26(d)(2)(iv)(B)]

- Detect and remove illicit discharges and improper disposal into storm drains

Coastal Nonpoint Pollution Control Program

- Pollution Prevention Management Measure
  - Household hazardous chemicals
  - Other pollutants (floatables, oil, etc.)

INDUSTRIAL/COMMERCIAL SOURCES

NPDES Regulations [40 CFR 122.26(d)(2)(iv)(C)]

- Monitor and control pollutants in storm water discharges from industrial facilities

Coastal Nonpoint Pollution Control Program

- Pollution Prevention Management Measure
  - Pollution prevention and education to reduce pollutants generated from commercial activities including parking lots, gas stations, and other entities not under NPDES purview

NEW DEVELOPMENT / REDEVELOPMENT

NPDES Regulations [40 CFR 122.26(d)(2)(iv)(A)(2)]

- Planning procedures including a comprehensive master plan to reduce discharge of pollutants from areas of development and significant redevelopment. (Post-construction)

NPDES Regulations [40 CFR 122.26(d)(2)(iv)(D)]

- Implement and maintain structural and non-structural BMPs to reduce pollutants in storm water runoff from construction sites.
  - Site planning procedures
  - BMP requirements
  - Inspection and enforcement
  - Education and training

Coastal Nonpoint Pollution Control Program

- New Development Management Measure
  - Post-construction runoff
- Watershed Protection Management Measure
  - Watershed-based development planning
- Site Development Management Measure
  - Site design limitations
- Construction Site Erosion and Sediment Control Management Measure
- Construction Site Chemical Control Management Measure

PUBLIC WORKS ACTIVITIES

NPDES Regulations [40 CFR 122.26(d)(2)(iv)(D)]

- Storm drain system and structural control maintenance
- Practices for operation and maintenance of public streets, roads, and highways
- Procedures to assess water quality impacts of flood control projects and retrofitting of existing structures
- Control application of pesticides, herbicides, and fertilizers in public right-of-ways, at municipal facilities, and by commercial applicators

Coastal Nonpoint Pollution Control Program

- Existing Development Management Measure
  - Operation and maintenance activities
  - Opportunities for retro-fitting
  - Coordination with flood control
- Pollution Prevention Management Measure
  - Lawn and garden activities
  - Turf management
- Roads, Highways, and Bridges Management Measures

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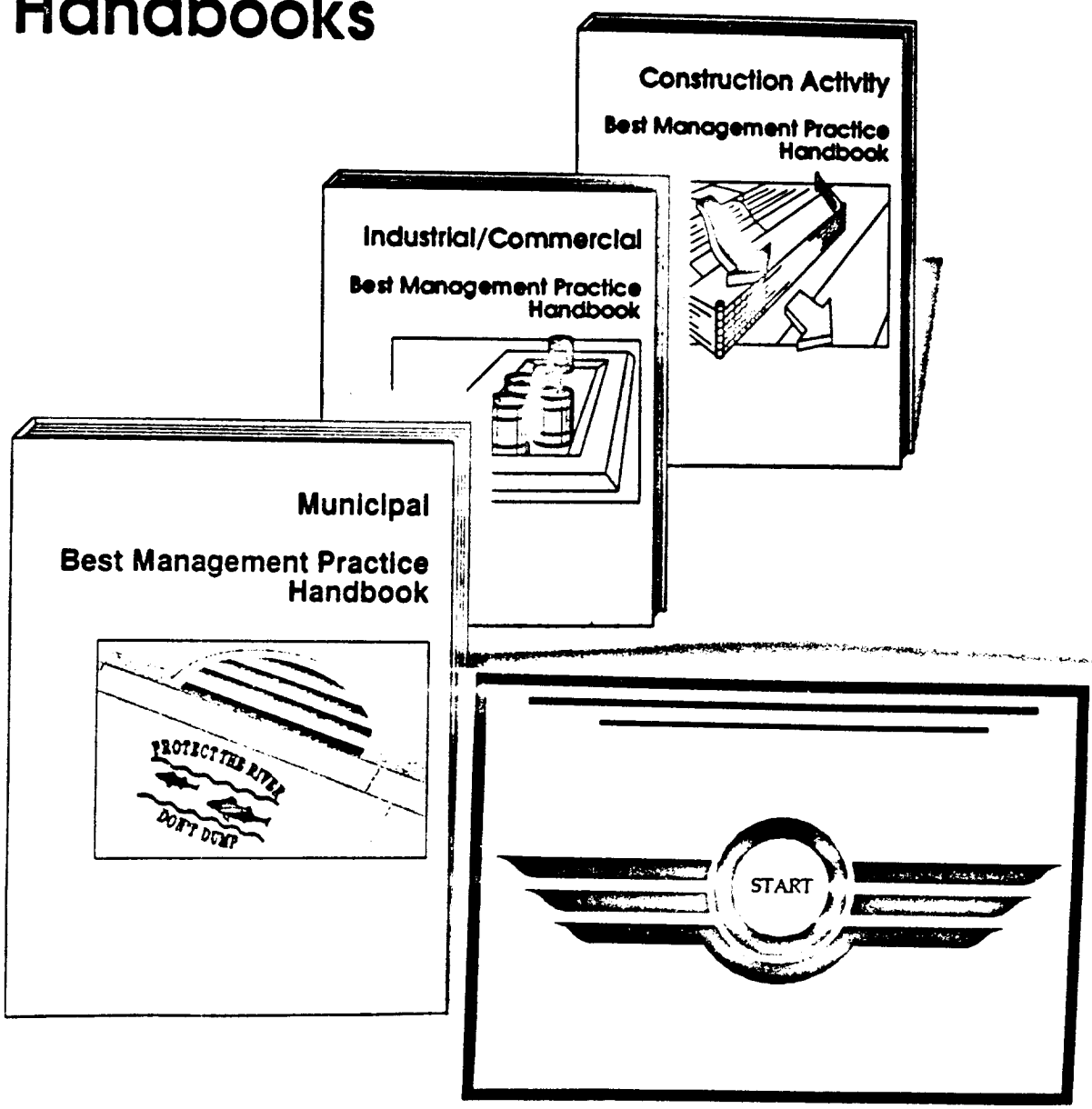
California Storm Water Best Management Practice Handbooks



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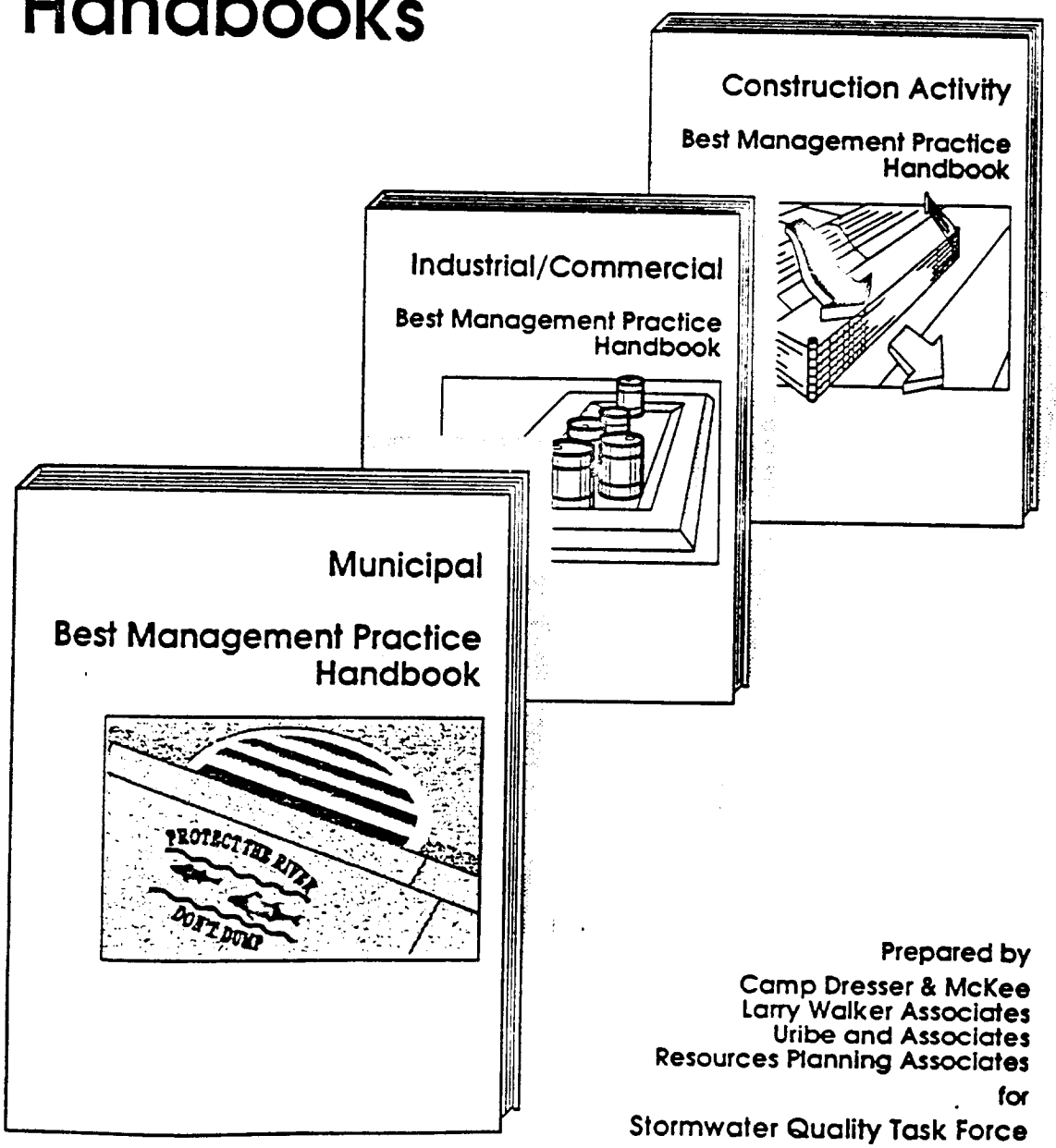

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DISCLAIMER

The statements and conclusions of this Handbook are those of the Grantee and not necessarily those of the State of California. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

This Handbook was produced and published by the Storm Water Quality Task Force, an advisory body of municipal agencies regulated by the storm water program. This Handbook is not a publication of the State Water Resources Control Board or any Regional Water Quality Control Board, and none of these Boards has specifically endorsed the contents thereof. The purpose of this Handbook is to assist the members of the Task Force and other dischargers subject to storm water permits, in attaining compliance with such permits.

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ABSTRACT

The Municipal Best Management Practices (BMPs) Handbook presents specific guidance on selecting best management practices for reducing pollutants in storm water discharges from urbanized areas. The primary audience of the handbook is the municipality responsible for developing a storm water management program under its NPDES storm water permit. The handbook outlines a six step decision making process for developing a municipal storm water management program. More importantly the handbook identifies a process for selecting source and treatment control BMPs that become a part of the municipality's storm water management program.

Detailed fact sheets are provided for the BMPs includes information regarding where they should be applied, what are the targeted pollutants of the BMP, design criteria (when applicable), and examples of their application. The handbook also gives guidelines for measuring the BMP performance.

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FOREWORD

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from storm water is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination (NPDES) permit. The 1987 amendments to the CWA added Section 402(p) which established a framework for regulating municipal, industrial, and construction storm water discharges under the NPDES program. In California, these permits are issued through the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCB). In general, municipalities with a population of over 100,000, industries which have been identified by the Environmental Protection Agency to be a probable source of storm water pollutants, and construction projects that disturb more than five acres must obtain an NPDES permit.

The SWRCB and California members of the American Public Works Association (APWA), recognizing the complex issues involved with developing and implementing an NPDES permit system from storm water discharges, formed the APWA Storm Water Quality Task Force to work as a team to develop a state regulatory program that complies with federal requirements, addresses California's unique demography, topography and climatology, and is affordable for the permittee. The Task Force, in turn, identified the need to have a State handbook to guide permittees in selecting Best Management Practices (BMPs) to reduce pollutants in storm water discharges. This series of Storm Water Best Management Practices Handbooks was funded by members of the Task Force and is directed specifically at developing and implementing storm water quality management programs in California.

The Handbook consists of three volumes:

- Volume 1: Municipal BMP Handbook - Addresses storm water quality management for most municipal activities, particularly those required under the NPDES municipal permit program.

- Volume 2: Commercial/Industrial BMP Handbook - Addresses storm water quality management for facilities that are (or will eventually be) covered by a NPDES general permit for industrial activities.

- Volume 3: Construction BMP Handbook - Addresses erosion control and other storm water quality management concerns required under a NPDES general permit for construction activities.

Each handbook is comprised of six chapters. Chapter 1 describes the pertinent regulations regarding the NPDES permit and defines who must obtain a permit. Chapter 2 describes how to develop a Storm Water Management Program or Storm Water Pollution Prevention Plan, while Chapter 3 provides guidance on the selection of BMPs for the plan. Chapters 4 and 5 describe the details of individual BMPs. Chapter 6 gives guidelines for measuring BMP performance. While the handbooks are meant to provide guidance to regulators and permittees, it should be understood that any final interpretation of the regulations will be done by the appropriate Regional Water Quality Control Board.

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MUNICIPAL HANDBOOK

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Chapter 1

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1. INTRODUCTION

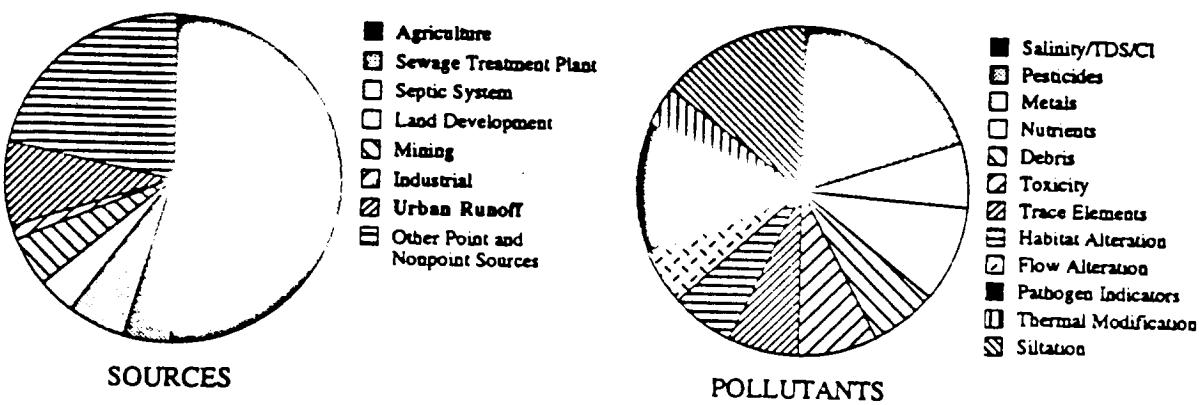
Storm water runoff is part of a natural hydrologic process. However, human activities, particularly urbanization and agriculture, can alter natural drainage patterns and add pollutants to rivers, lakes, and streams (see Figure 1.1). Recent studies have shown that storm water runoff is a significant source of water pollution, causing declines in fisheries and restrictions on swimming, and limiting our ability to enjoy many of the other benefits that water provides (USEPA, 1992).

For many years the effort to control the discharge of storm water has focused on quantity (e.g. drainage, flood control) and, to a limited extent, on quality of the storm water (e.g. sediment and erosion control). However, in recent years awareness of the need to improve water quality has increased. With this awareness Federal, State and local programs have been established to pursue the ultimate goal of reducing pollutants contained in storm water discharges to our water ways. The emphasis of these programs is to promote the concept and the practice of preventing pollution at the source, before it can cause environmental problems (USEPA, 1992). However, where further controls are needed, treatment of polluted runoff could be required.

PURPOSE AND SCOPE OF THE HANDBOOK

This handbook provides general guidance in developing and implementing *best management practices (BMPs)* for inclusion in municipal storm water management programs. As will be discussed in this handbook, federal regulations require municipalities to develop storm water management programs to reduce the discharge of pollutants to the maximum extent practicable (MEP). It is not the intent of this handbook to dictate the actual selection of BMPs (this will be done by the municipality), but rather to provide the framework for an informed selection of BMPs for the program.

Although MEP has not been defined by the federal regulations, the use of this handbook and the selection process presented herein should assist municipalities in achieving MEP. In selecting BMPs which will achieve MEP, it is important to remember that municipalities will be responsible to reduce the discharge of pollutants in storm water to the maximum extent practicable. This means choosing effective



Adapted from SWRCB, 1991

FIGURE 1.1 RELATIVE PERCENTAGE OF POLLUTANTS AND SOURCES FOR RIVERS AND STREAMS IN CALIFORNIA

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BMPs, and rejecting applicable BMPs only where effective BMPs will serve the same purpose, the BMPs would not be technically feasible, or the cost would be prohibitive. The following factors are considered in deciding if a BMP is practicable (see Chapters 2 and 3 for a detail discussion):

1. Pollutant Removal - Will the BMP address the pollutant of concern?

2. Regulatory Compliance - Is the BMP compatible with storm water regulations as well as other regulations for air, hazardous wastes, solid waste disposal, etc.?

3. Public Acceptance - Does the BMP have public support?

4. Implementation - Is the BMP compatible with land uses, facilities, or activity in question?

5. Cost - Will the cost for implementing the BMP exceed the pollution control benefits expected to be achieved?

6. Technical Feasibility - Is the BMP technically feasible considering soils, geography, water resources, etc.?

For the BMPs selected, the municipality must demonstrate a "good faith" effort to implement and maintain them. Finally, the municipality should prepare and adhere to a schedule for implementation.

The handbook primarily addresses the requirements of the storm water program as developed from section 402(p) of the Clean Water Act. There are, however, other federal and state programs that regulate the discharge of storm water either directly or indirectly within a municipal jurisdiction. The handbook does not try to provide a comprehensive review of these programs but rather references are provided for the reader's use.

USERS OF THE HANDBOOK

The primary users of the handbook are the municipalities responsible for selecting BMPs as part of their overall storm water management program. Such users include engineers, planners and environmental specialists. In addition, consulting engineers and developers will find the handbook useful in their work.

ORGANIZATION OF THE HANDBOOK

The overall goal of the storm water management program is to reduce the discharge of pollutants. This handbook is organized to assist the user in developing and implementing such a program. The handbook explains:

- Why is storm water management needed? (Chapter 1)
- What is a storm water management program and how does one prepare it? (Chapter 2)
- What are Best Management Practices and how do you select them? (Chapter 3)
- What BMPs are available and how are they used? (Chapter 4 and 5)
- How do you monitor BMPs performance? (Chapter 6)

DEFINITIONS

Many of the common terms used in the storm water program are defined in the Glossary (Appendix E). However, the user will continually encounter the following terms:

- *NPDES Permit for Storm Water Discharges*. NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the national program for administering and regulating discharges to waterways according to the Clean Water Act (CWA). In California, the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCB) are responsible for administrating the NPDES storm water program.

- *A Best Management Practice (BMP)* is defined as any program, technology, process, siting criteria, operating method, measure, or

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device which controls, prevents, removes, or reduces pollution.

- *Source Control BMPs* are operational practices, that prevent pollution by reducing potential pollutants at the source. They typically do not require construction.

- *Treatment Control BMPs* are methods of treatment to remove pollutants from storm water. Construction and maintenance are required for implementation.

Typical Effects of Urbanization

Hydrology Changes
- Increased flows, volumes, and velocities of runoff
- Decreased groundwater recharge
- Habitat destruction from flow changes, channel erosion, and channel improvements

Pollutant Generation
- Human activities create pollutants which are transported to receiving waters

EFFECTS OF URBANIZATION

There are two main impacts that typically result from urbanization. First the hydrology of the area is changed. The change typically consists of increased runoff volumes, flows, and velocities, while at the same time reduced groundwater recharge. On the other hand, the change may result in increased base flow and lower sediment loads. In either case, the natural habitat of the stream is impacted. Second, the increase in human activities within a watershed creates pollutants. The pollutants are transported in runoff and subsequently discharged to our waters. These activities may range from automobile use to complex chemical processing.

HYDROLOGIC CHANGES

When an undeveloped area changes to support urban land uses, dramatic impacts in the local hydrology result (Figure 1.2). Urbanization changes the natural hydrology of a watershed by increasing runoff and decreasing evapotranspiration, deep infiltration, and shallow infiltration. When an area is developed, natural drainage patterns are modified as runoff is channeled into road gutters, storm drains, and paved channels. The results of these modifications are typically an increase in runoff volume and velocity, and a shorter time for the runoff to leave the watershed, causing higher peak flows.

In addition higher flows cause flooding and adverse effects on natural streams. Before development, at bankfull capacity, natural streams can handle a flow approximately equal to the 2-year frequency peak discharge. After development this bankfull capacity can be exceeded several times per year. The new flow regime also can lead to channel erosion and unwanted widening (Minnesota PCA, 1989).

Urbanization of an arid area may pose a different change in the watershed hydrology. In arid regions the installation of lawns, parks, and golf courses increases vegetative coverage and can lead to a reduction of runoff volume and velocity, thereby, reducing the sediment load in the stream.

Storm Water Pollutants of Concern

- Sediment
- Nutrients
- Bacteria and Viruses
- Oxygen Demanding Substances
- Oil and Grease
- Metals
- Toxic Pollutants
- Floatables

URBAN STORM WATER POLLUTANTS

Pollutants most frequently associated with storm water include sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, heavy metals, other toxic chemicals, and

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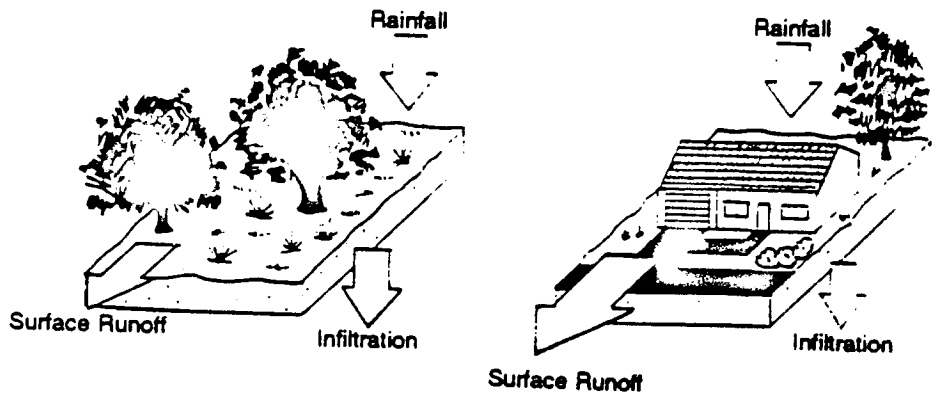
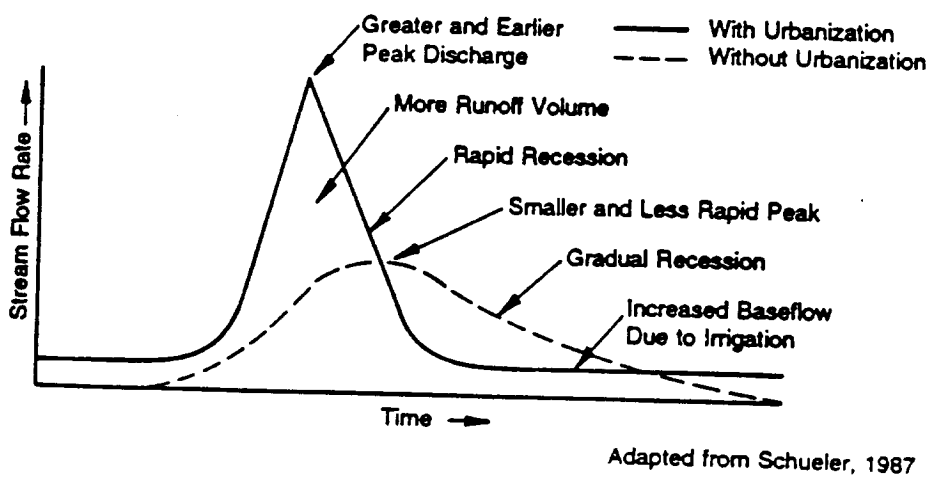


A. WATER BALANCE



B. STREAMFLOW

FIGURE 1.2 CHANGES IN CALIFORNIA WATERSHED HYDROLOGY RESULTING FROM URBANIZATION

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floatables. These pollutants and their impacts on water quality and aquatic habitat are described as follows:

- *Sediment* is a common component of storm water, and is a pollutant in its own right. Excessive sediment can be detrimental to aquatic life (primary producers, benthnic invertebrates and fish) by interfering with photosynthesis, respiration, growth, and reproduction. In addition, the sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons (APWA, 1981).

- *Nutrients* including nitrogen and phosphorous are found in storm water. These nutrients can result in excessive or accelerated growth of vegetation or algae resulting in impaired use of water in lakes and other sources of water supply. For example, nutrients have led to a loss of water clarity in Lake Tahoe. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish.

- *Bacteria and viruses* are common contaminants of storm water. For separate storm drain systems, main sources of these contaminants are animal excrement and sanitary sewer overflows. High levels of coliform bacteria in storm water have led to the closure of waterways such as the beaches in Santa Monica Bay (Gold, et al., 1992).

- *Oxygen demanding substances* including plant debris (such as leaves and lawn-clippings), animal excrement, street litter, and organic matter are commonly found in storm water (USEPA, 1992; Woodward-Clyde, 1990). Such substances depress the dissolved oxygen levels in streams, lakes, and estuaries.

- *Oil and grease* contain a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations (Woodward-Clyde, 1990). The main sources of oil and grease are leakage from engines, spills at fueling stations, overfilled tanks, restaurant grease traps, and waste oil disposal (Berman, L., et al, 1991).

- *Lead, zinc, cadmium, and copper* are the heavy metals found most commonly in storm water. Chromium and nickel are also frequently present (USEPA, 1983). Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies (see Table 1.1). Storm water runoff is considered a major source of metals that have accumulated in the sediment of South San Francisco Bay. This accumulation has resulted in restricted water uses and impaired aquatic habitat.

Table 1.1 Runoff Concentrations and Freshwater Water Quality Objectives (ug/l) of Various Metals from Three Land Use Categories

Metals	Water Quality Obj. (a)	Land Use Category(b)		
		Resid./ Comm.	Indust. Sites	Open Space
Cadmium	0.66 (c)	1.3	5.5	0.5
Chromium (d)	11	14	33	8
Copper	6.5 (c)	31	49	6
Lead	1.3 (c)	37	121	2
Nickel	88 (c)	25	48	8
Zinc	59 (c)	200	1324	7

(a) Freshwater aquatic life 4-day average objective from California Inland Surface Waters Plan. Objectives are written in terms of total recoverable concentrations. Runoff concentrations are total concentrations.
(b) Concentrations reported as median values (Woodward-Clyde, 1989).
(c) Objective is calculated based on an assumed hardness in the receiving water of 50 mg/L as $CaCo_3$.
(d) Objective is for hexavalent chromium.

- *Other toxic materials* (priority pollutants) may be found in storm water in low concentrations. Pesticides, phenols, and polynuclear or polycyclic aromatic hydrocarbons (PAHs) are the organics most frequently found in storm water (City of Seattle, 1989).
- *Floatables* in storm water are pollutants that may contain significant amounts of heavy

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metals, pesticides, and bacteria. Typically resulting from street refuse or industrial yard waste, floatables also create an aesthetic "eye sore" in water ways or detention basins.

SOURCES OF POLLUTANTS

The primary sources of storm water pollution in urban areas include automobiles and activities associated with automobile use (pavement, bridges), housekeeping and landscaping practices, industrial activities, construction, non-storm water connections to the drainage system, accidental spills, and illegal dumping. Table 1.2 relates pollutant sources with the pollutants they generate.

AUTOMOBILES AND RELATED ACTIVITIES

Sediment

Significant sediment-borne pollutants associated with highway runoff come from pavement wear, vehicles, atmospheric deposition, and road maintenance (USEPA, 1991). Atmospheric deposition contains appreciable quantities of sulfur, toxic and heavy metals, pesticides, organic compounds, fungi, pollen, and soil (Novotny and Chesters, 1981). Asbestos in runoff can occur from wear of clutch and brake linings (Berman, et al., 1991).

Accelerated erosion of highway slopes occurs primarily as sheet, gully, or rill erosion. Bridge construction may cause significant erosion and sedimentation (USEPA, 1991). Sand applied to icy roads can also create a significant sediment load.

Nutrients

Nitrogen and phosphorous associated with highway runoff come from atmospheric deposition and roadside fertilizer application (USEPA, 1991). Phosphorous has also been associated with application of sand and salt on roads (Oberts, 1986).

Heavy Metals and Toxic Chemicals

Several heavy metals and other toxic substances found in storm water are associated with automobile use. Chromium, copper, lead, zinc, iron, cadmium, nickel, and manganese associated with automobiles and highways come from many different sources including auto body rust, bearing and bushing wear, brake lining wear, diesel fuel and gasoline exhaust, metal plating, motor oil (stabilizing additives), steel highway structures (guard rails, etc.), and tire wear (filler material). Other toxic pollutants occur primarily through the use of products for de-icing, and weed, rodent, and insect control (Beaton, et al., 1972). Hydrocarbons typically come from spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, and asphalt surface leachate. Hydrocarbon levels are highest from parking lots, roads, and service stations (Schueler, 1987).

Maintenance of transportation structures can result in runoff and direct discharge of lead, rust, paint, particulates, solvents, and cleaners. Runoff from bridges may deliver considerable loadings of heavy metals, hydrocarbons, and toxic substances from cars and de-icing of roads as a result of direct delivery through scupper drains into receiving waters with no overland buffering or treatment (USEPA, 1991).

URBAN HOUSEKEEPING/LANDSCAPING PRACTICES

Sediment

Landscape activities are a source of erosion and subsequent sedimentation.

Nutrients

In urban areas, major sources of nutrients are organic matter such as lawn clippings, leaves, street dirt, automobile exhaust, and excessive use of fertilizers. Areas such as golf courses and cemeteries which receive unusually high fertilizer applications are major sources of nutrients (Schueler, 1987).

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TABLE 1.2 COMMON SOURCES OF POLLUTANTS IN URBAN RUNOFF

Pollutant	Automobile/ Atmospheric Deposit	Urban Housekeeping/ Landscaping Practices	Industrial Activities	Construction Activities	Non-Storm Water Connections	Accidental Spills & Illegal Dumping
SEDIMENTS	X	X	X	X		
NUTRIENTS	X	X	X	X	X	X
BACTERIA AND VIRUSES		X		X	X	X
OXYGEN DEMANDING SUBSTANCES		X	X	X	X	X
OIL AND GREASE	X	X	X	X	X	X
Anti-Freeze	X	X		X	X	X
Hydraulic Fluids	X	X	X	X	X	X
Cleaners and Solvents	X	X		X	X	X
HEAVY METALS	X	X	X	X	X	X
Chromium	X	X	X			
Copper	X	X	X			
Lead	X	X	X			
Zinc	X	X	X			
Iron	X		X			
Cadmium	X		X			
Nickel	X		X			
Manganese	X		X			
Paint		X		X	X	X
Wood Preservatives		X		X	X	X
TOXIC MATERIALS						
Fuels	X		X	X	X	X
PCBs	X				X	X
Pesticides	X	X	X	X	X	X
Herbicides	X		X	X	X	X
FLOATABLES		X	X	X		X

References: Minnesota PCA (1989); Berman, L., et al. (1991); Woodward-Clyde (1990); USEPA (1991); Schueler (1987); Beaton, J., et al. (1972); and Oberts, G. (1986).

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Bacteria and Viruses

Improper disposal of fecal material from household pets is a source of bacterial contamination (USEPA, 1991). Other sources include septic tanks and deposits of organic matter that accumulate and decompose in storm inlets, catch basins, storm drains, and drainage channels (Berman, et al., 1991). Sanitary sewer systems may also seep or overflow into the drainage system.

Oxygen Demanding Substances

In urban areas, plant debris (such as leaves and lawn-clippings), animal excrement, street litter, and organic matter are common sources of oxygen demanding substances found in storm water (Minnesota PCA, 1989).

Heavy Metals and Toxic Chemicals

Sources of heavy metals include weathered paint, wood preservations, and pesticides (Woodward-Clyde, 1990). Excessive herbicide or pesticide use contributes toxic chemicals to the storm water. Household toxics such as oil/grease, antifreeze, paint, household cleaners and solvents are widely used and may be improperly used, stored, and disposed of which can lead to storm water pollution (Berman, et al., 1991). A national study of suburban storm water showed few instances of detectable quantities of synthetic organic compounds, with the exception of plasticizing compounds often found in many plastic products. Also found, but less frequently, were wood preservatives and pesticides (USEPA, 1983).

INDUSTRIAL ACTIVITIES

Trace metals (particularly chromium, copper, lead, and zinc) found in storm water may come from industrial use (Woodward-Clyde, 1990). Pesticides, herbicides, solvents, oils and other synthetic organic compounds are widely used in industrial settings and may be improperly stored and disposed of leading to contaminated runoff. The user is referred to the Industrial BMP Handbook for a detailed discussion regarding industrial sources of pollutants.

CONSTRUCTION

Construction sites may generate considerable sediment, trace metals, nutrients, oil and grease, pesticides, herbicides, and other synthetic organic compounds. The user is referred to Construction BMP Handbook for a detailed discussion.

NON-STORM WATER CONNECTIONS

Inadvertent or deliberate discharge of sanitary sewage and industrial waste to storm drains is a widespread and serious occurrence. Illicit connections of sanitary sewers to storm drain sewers (e.g., floor drains) are a source of storm water contamination.

ACCIDENTAL SPILLS AND ILLEGAL DUMPING

Deliberate dumping of chemicals into storm drains and catch basins (especially used crankcase oils) is a common source of pollutants (USEPA, 1991) and can be a local problem. Virtually any chemical, if not properly stored and handled, can be accidentally spilled or illegally dumped.

STORM WATER PROGRAMS

The need to protect our environment has resulted in a number of laws and subsequent regulations and programs. At times, this has resulted in overlap and ambiguity between the programs. This situation is true for the storm water programs. The Federal Clean Water Act, as amended in 1987, and the State Porter-Cologne Act are the principal vehicles for the control of storm water pollutants. There are, however, other programs that directly or indirectly deal with the control of storm water pollutants. Examples include: Federal Coastal Zone Act Reauthorization Amendments of 1990, and the State Hazardous Waste Source Reduction and Management Review Act. In addition, the implementation of storm water programs must take place at a number of levels: federal, state, local, and site-specific (industry, municipal and construction).

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Consequently, it is important that the user have an understanding of the relationship between the programs/regulations.

In the following section, various programs are discussed in relationship to the control of pollutants in storm water. These storm water regulatory programs are new and expected to evolve over the next several years. Thus the user is advised to contact local regulatory officials for further information.

FEDERAL NPDES PROGRAMS

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination (NPDES) permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal, industrial, and construction storm water discharges under the NPDES program. On November 16, 1990, USEPA published final regulations that establish application requirements for storm water permits. Under these regulation, these storm water discharges must be permitted:

- A discharge for which a permit has been issued prior to February 4, 1987.
- A discharge associated with certain industrial activity (see box, this page). These facilities which discharge industrial storm water either directly to surface water or indirectly, through municipal separate storm drains, must be covered by a permit. (See the Industrial and Construction BMP Handbooks for a detail discussion regarding these industrial activities.)
- A discharge from a municipal separate storm sewer serving a population greater than 100,000. In California, county-wide NPDES permits have been issued which include most of the State's urbanized areas (see box, next page).

Facilities Required to Have A NPDES Permit

- "Heavy" manufacturing facilities
- Manufacturing facilities if materials are exposed to storm water
- Active and inactive mining and oil and gas facilities;
- Recycling facilities;
- Transportation facilities;
- Facilities subject to the requirements of 40 CFR Subchapter N;
- Hazardous waste treatment, storage, or disposal facilities;
- Landfills, land application sites, and open dumps;
- Steam electric generating facilities;
- Wastewater treatment plants with design flows greater than 1 million gallon per day.
- Construction activity

- A discharge for which the ruling authority (i.e., the California State Water Resources Control Board via the nine Regional Boards) determines is contributing to violations of water quality standards or is a significant source of pollutants to waters of the United States.

STATE NPDES PROGRAM

The State Porter-Cologne Act (Water Code §13000, *et seq.*) is the principal vehicle for controlling storm water pollutants. The Act requires the development of Basin Plans for drainage basins within California. Each plan serves as a blueprint for protecting water quality within the various watersheds. These basin plans are used in turn to identify more specific controls for discharges (e.g., wastewater treatment plant effluent, agriculture drainage). The basin plans are implemented through the NPDES program.

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California Counties with NPDES Storm Water Permits (1)

Alameda	Sacramento
Los Angeles	San Bernardino
Orange	San Diego
Riverside	Santa Clara

California Municipalities/Counties Pursuing NPDES Storm Water Permits

Cities

Bakersfield	Modesto	Suisun City
Fresno	Oxnard	Vallejo
Fairfield	Stockton	

Counties

Contra Costa	San Mateo	Kern
Ventura		

(1) Consult with local RWQCB to determine which municipality within these counties is covered by a NPDES permit.

In California, the NPDES storm water permitting program is administered by the SWRCB through the nine RWQCBs. For industrial facilities and construction activities, the SWRCB elected to issue a statewide general permit that applies to all storm water discharges requiring a NPDES permit. (The San Francisco RWQCB also has a general permit which applies to industries within Santa Clara Valley.) Municipalities on the other hand must obtain an individual NPDES storm water permit for their entire storm drainage system.

The Clean Water Act requires that municipalities prohibit non-storm water discharges to municipal storm drains and reduce the discharge of pollutants to the MEP using "management practices, control techniques and system, design and engineering methods, and such other provisions...appropriate for the control of such pollutants."

The State of California has interpreted Federal regulations regarding storm water discharge to include narrative effluent limitations. These limitations prohibit the discharge of non-storm water and include the use of BMPs to control and eliminate sources of pollutants. According to the State of California, BMPs are "schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste removal, or drainage from raw material storage" (SWRCB, 1991).

Municipal NPDES Permit Requirements

- Provide adequate legal authority to carry out storm water management program.
- Characterize current discharges with screening and monitoring.
- Prepare and implement storm water management program.
- Estimate pollutant load reduction due to storm water management program.
- Ensure adequate funding.

MUNICIPAL NPDES PROGRAM

As noted previously, municipalities with a population of over 100,000 or that have been determined to be a significant contributor of pollutants are also required to obtain a NPDES storm water permit. The November 16, 1990 regulations detailed the information required by the municipality to prepare a NPDES permit application. The application is divided into two parts. Part 1, basically, requires the discharger to collect existing information regarding storm water dischargers, receiving waters, management programs, fiscal resources, and associated elements. In Part 2, the municipality is then expected to take this information and formulate a storm water management program designed to reduce the discharge of pollutants to the maximum extent practicable. The municipality is expected to select and implement the best management practices to ensure this reduction. This handbook provides the basis for selecting BMPs that become a part of the municipal storm water management program.

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OTHER FEDERAL AND STATE PROGRAMS

California Coastal Nonpoint Pollution Control Program

The Coastal Zone Act Reauthorization Amendments of 1990 require states with approved coastal zone management programs to develop and submit a Coastal Nonpoint Pollution Control Program to USEPA and National Oceanographic and Atmospheric Administration (NOAA) for approval. The purpose of the program is to work closely with other state and local authorities to develop and implement management measures for nonpoint source pollution including urban runoff to restore and protect coastal waters. Coastal storm water control programs are not intended to supplant existing coastal zone management programs or nonpoint source management programs. Rather, they are to serve as an update and expansion of existing nonpoint source management programs and are to be coordinated closely with the existing nonpoint source management programs (USEPA, 1991). In California, the Coastal Commission and Water Quality Control Boards are responsible for the development and implementation of this program.

National Estuary Program

EPA administers the National Estuary Program under Section 320 of the Clean Water Act. This program focuses upon all pollutant sources in geographically targeted, high priority estuarine waters. Through this program, USEPA assists state, regional, and local governments in the development of comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters (USEPA, 1991). The USEPA (Region 9), SWRCB, and RWQCBs are responsible for administering the California program which includes the San Monica Bay Restoration Project and the San Francisco Estuary Project.

Pesticide Program

USEPA administers the pesticide program under the Federal Pesticide, Fungicide, and Rodenticide Act. Among other things, this program authorizes the USEPA to control pesticides (sometimes found in storm water) that may threaten ground and surface water (USEPA, 1991). Potential actions carried out under this program include national requirements on labels, training, development of State Management Plans, and national prohibition of certain domestic uses of designated chemicals.

Hazardous Material/Waste Control Programs

There are numerous laws and regulations regarding the control of hazardous material and waste. Some of these programs, in turn, have a direct or indirect impact on a municipality's effort to control pollutants in storm water discharges from industrial facilities. The following programs provide examples of how the hazardous control programs can be used to reduce storm water pollutants.

- Hazardous Materials, Storage, and Emergency Response. The program regulates hazardous materials storage and emergency response planning. A company's annual Business Plan must include hazardous material (hazmat) inventory, estimates of hazardous waste amounts and emergency response planning. Much of the information provided in the Business Plan is useful to municipalities in developing controls for industrial activities.

- Workers Right-to Know. Under this program, the company's employee is advised through the use of material safety data sheets (MSDS), material labeling, and employee training of the potential for contact with hazardous substances. Such training can be expanded to include issues regarding source control of storm water pollutants.

- Hazardous Waste Source Reduction and Management Review. Under this program, hazardous waste generators must look at source reduction as the preferred method for

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managing waste. The industry must prepare a "source reduction evaluation review and plan" which identifies all hazardous waste streams and potentially viable source reduction approaches. Again, this plan can serve to reduce industrial storm water pollutants.

Wetlands and Groundwater

The SWRCB is the primary state agency in matters of water quality. State policies set forth by the SWRCB are administered by the Regional Water Quality Control Boards. RWQCB may also set water quality policy specific to their regions (e.g., Basin Plans). These policies pertain to a wide variety of water quality and quantity issues. The NPDES program applies to all discharges to surface waters including wetlands. Storm water discharges may also pose a threat to groundwater. In such cases, the RWQCB may impose waste discharge requirements on storm water discharges to protect groundwater or wetlands. During the formation of a municipal storm water management program, it is advisable that the RWQCB be consulted in regard to the BMPs which are being considered that may impact these water resources.

The SWRCB has yet to form a policy covering the use of artificial wetlands for storm water treatment. However, important considerations for those constructing artificial wetlands for the treatment of storm water include:

- Creation of beneficial uses may result in a requirement to preserve and protect those beneficial uses, even if the source of water is artificial.

- Wetlands can act as sinks for pollutants. Constructed wetlands must be designed to facilitate maintenance, and regular maintenance must occur before pollutants build up to levels that become toxic to wildlife.

For these reasons, consultation with the RWQCB or SWRCB is important during the planning phase of a project (see Chapter 2).

Air Quality Programs

Deposits from the atmosphere are a contributing cause of storm water pollution. Source control of automobile and industrial emissions is required to reduce this source of contamination (Woodward-Clyde, 1990).

Such source control should be coordinated with other state/local air quality programs. As an example, Proposition 111 required counties with a metropolitan population greater than 100,000 to form a Congestion Management Agency (CMA). This agency, which typically is a joint power authority, coordinates the development of a Congestion Management Program (CMP). This program in turn addresses, among other things, impacts of land use decisions on regional transportation systems; trip reduction ordinances; and public transit services. Consequently, close cooperation between the CMA and the municipality would benefit each entity's efforts to reduce pollutants in the environment.

Spill Prevention and Clean-up Plans

Federal regulations require on-shore facilities engaged in operations that could reasonably be expected to discharge oil in harmful quantities to prepare Spill Prevention Control and Countermeasure (SPCC) Plans. NPDES regulations for some industrial activities also require SPCC Plans as part of the facility's BMP program (see Industrial BMP Handbook).

OTHER LOCAL PROGRAMS

In many cases, storm water pollution control may already be achieved by existing regulations and programs. Existing regulations which may be applicable are summarized in Table 1.3. Such regulations may become an integral part of the municipality's storm water management program.

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TABLE 1.3 EXISTING REGULATIONS FOR STORM WATER POLLUTION CONTROL

REGULATION	ACTIVITY	POTENTIAL
General Plan Law	Municipal development objectives Adoption of ordinances	Storm water management controls, e.g., pollutants control, watershed protection
California Environmental Quality Act (CEQA)	Environmental review of projects	Mitigation measures for reduction of pollutants
Subdivision Map Act	Adoption of ordinances	Standard/Regulations for grading, erosion protection, detention/retention design, and dust control
Flood Plain Management & Drainage Ordinances	Control of velocity	Control of erosion
	Detention/retention	Control of sediment, pollutants, and quantity
	Bank stabilization and outlet controls	Erosion and Sediment controls
Clean Water Act 401 and 404 Permits	Permits dredging and filling in "waters of the United States"	Erosion control, sediment control, long-term sediment balance & minimize pollutants
		Vegetative controls to preserve riparian areas
Zoning Ordinances	Cluster development	Minimize runoff & impervious areas
	Hillside development	Slope & erosion restriction. May include revegetation or stabilization.
	Landscape/open space	Vegetative BMPs perimeter controls reduction of runoff
Sewer Use Ordinance	Control of illicit connections	Pollutant controls
Uniform Building Code	Chapter 70 - Excavating & Grading	Minimize erosion & sedimentation
		Standards for stable cut & fill slopes
Uniform Plumbing Code	Prevention of illicit connection	Pollutant controls
	Various chapters on materials & application/use	Pollutant controls
Fire Code	Storage of materials	Pollutant controls
Air Quality Management Plans	Emission	Sediment & dust controls
1601 and 1603 Stream Bed Alternation Agreements	Alternations to creek and stream beds	Pollutant controls and prevent loss of habitat
Coastal Zone Act	Regulation of non-point pollution to the ocean	Pollutant controls

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Chapter 2

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2. HOW TO DEVELOP A STORM WATER MANAGEMENT PROGRAM

Chapter 1 documents that the sources of storm water pollution are extensive, ill-defined, and highly variable. Management alternatives for control of these pollutant sources are numerous, and the cost of total control may be quite high. Planning and prioritization therefore are fundamental to developing an effective storm water management program which targets identifiable, controllable pollutants. This section briefly describes the elements of a Storm Water Management Program (SWMP), typical planning activities to achieve a cost-effective program, and strategies for its cost-effective implementation.

WHAT IS A SWMP?

The Storm Water Management Program (SWMP) must be a comprehensive program designed to reduce the discharge of pollutants to the maximum extent practicable. The SWMP, at a minimum, must address the activities listed in the box on this page in order to comply with the 1990 USEPA NPDES permitting regulations. Other activities (e.g., non-industrial businesses, the transportation system) should also be addressed if found to be a significant source of pollution entering the municipal storm drain system.

This handbook discusses how to select the best management practices (BMPs) for each activity. These BMPs are what will be done to prevent pollution from entering storm water (source control) and/or treat polluted runoff (treatment control). Implementing a SWMP requires much more than selecting BMPs. USEPA's 1990 NPDES permitting regulations and the corresponding Part 2 guidance manual have identified various institutional areas that need to be addressed:

- Comprehensive Planning: What system-wide or watershed-wide planning process, involving active public participation, will be used to define program goals and BMP priorities.

Activities to be Addressed in SWMP

For Residential/Commercial Activities:

- Roadway and drainage facility operations and maintenance programs
- BMP planning for new development and redevelopment projects
- Retrofitting existing or proposed flood control projects with BMPs
- Municipal waste handling and disposal operations
- Pesticide, herbicide, and fertilizer use controls

For Improper Discharge Activities:

- Prevention, detection and removal program for illegal connections to storm drains
- Spill prevention, containment, and response program
- Program to promote proper use and disposal of toxic materials
- Reduce storm water contamination by leaking/overflowing separate sanitary sewers

For Industrial Activities:

- Inspection and control prioritization and procedures
- Monitoring of significant industrial discharges

NOTE: See Industrial BMP Handbook for guidance.

For Construction and Land Development Activities:

- Water quality and BMP assessments during site planning
- Site inspection and enforcement procedures
- Training for developers and contractors

NOTE: See Construction BMP Handbook for guidance.

- Responsible Parties: Who will be involved in the SWMP, and what intergovernmental coordination will be required, e.g., how will the various municipal departments integrate the SWMP into their existing responsibilities, and how should the SWMP be coordinated between adjoining municipalities within a watershed.

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- Legal Authority: Are enabling legislation and local regulations needed to implement the SWMP?

- Effectiveness: What are the inspection, monitoring, reporting, and review procedures used to determine SWMP effectiveness?

- Maintenance: What steps will be taken to ensure the effectiveness of the SWMP does not diminish.

- Outreach: How will municipal staff, businesses, and citizens be informed, educated, and trained about the BMPs.

- Funding: Who will pay, and what are the costs and funding sources.

Figure 2.1 shows that each of the areas listed above is an indispensable "link" of an effective SWMP (Shaver, 1988), and that to be effective, the SWMP possess the following four characteristics:

- *It is Comprehensive*: All "links" are needed - - one weak link causes the entire program to fail.

- *It is Integrated*: Maximum effectiveness will be achieved not by regulation alone, education alone, or municipal action alone, but by an integrated program encompassing all three.

- *It is Balanced*: Each responsible party must be defined, and specific direction must be given to each party. Directions should be commensurate with their share of the problem and equitable to their share of the solution.

- *It is Continuous and Dynamic*: Meaningful storm water pollution reductions, particularly in developed areas, will take a long time, certainly longer than the 5-year permit term. The SWMP thus should be implemented in a manner which addresses the dynamics of an evolving, long-term program.

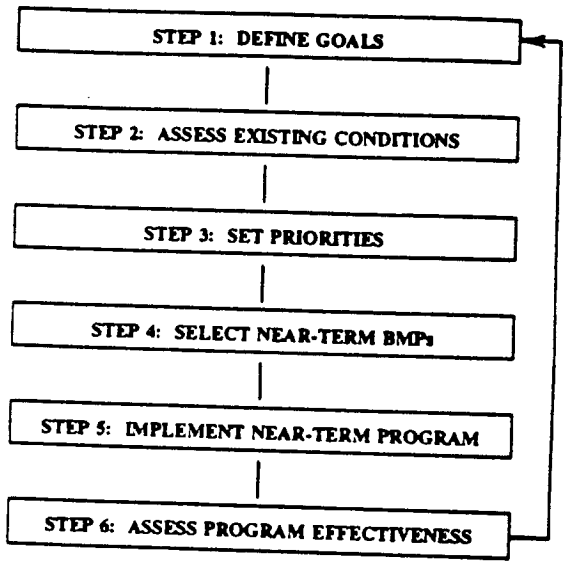

FIGURE 2.2 PLANNING PROCESS FOR DEVELOPING SWMP

The remainder of this chapter addresses the planning process that is required to successfully develop, implement and assess a storm water management program.

HOW TO DEVELOP A STORM WATER MANAGEMENT PROGRAM

A six-step decision-making process for developing a municipal storm water management program is shown in Figure 2.2. This is a results-oriented approach aimed at first developing a long-range strategy for municipal storm water management, and then implementing a few strategic programs in the near-term within the context of the long-range strategy:

- The first three steps involve a long-range planning approach to defining a municipality's storm water management program:

  - Defining goals: A statement of what the program aims to achieve, and the critical factors which will determine its success.

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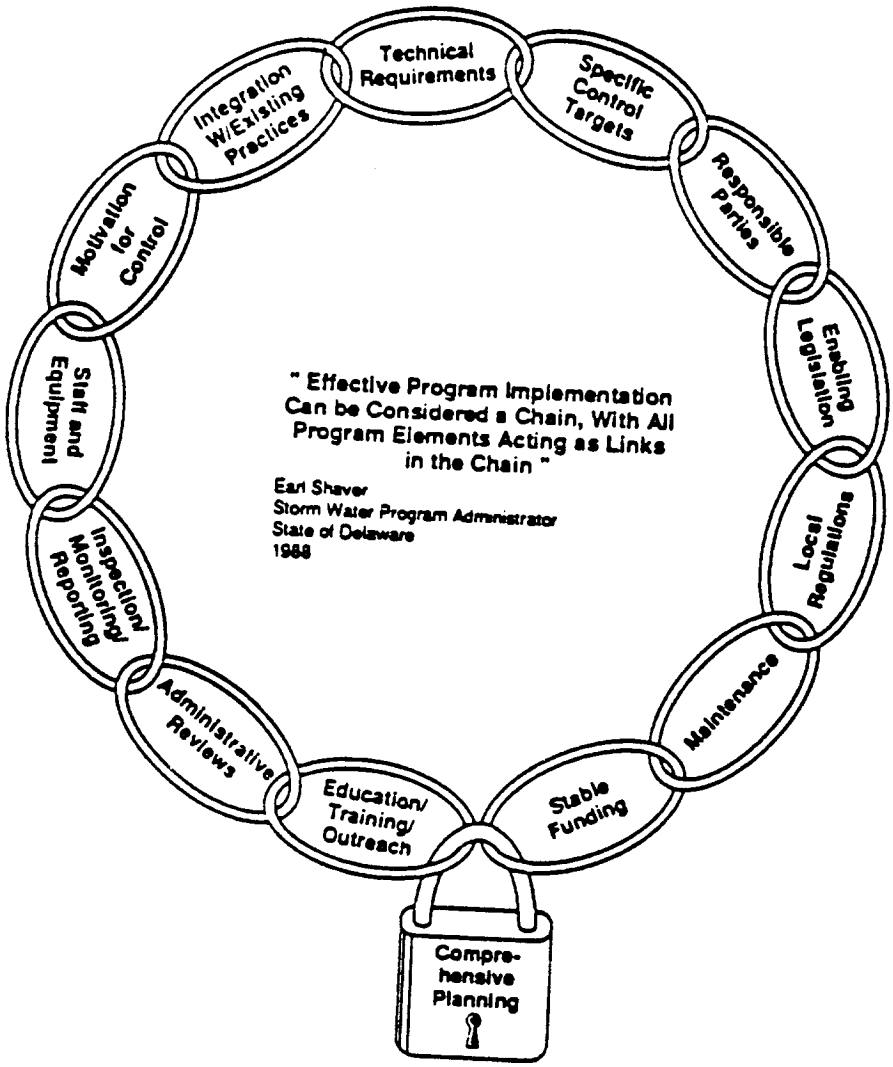

FIGURE 2.1 THE IMPLEMENTATION "CHAIN"

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- Assessing existing conditions: Before any action is taken, a quick assessment of existing conditions should be performed. The NPDES Part 1 permit application is a good example of such an assessment -- a first cut look at factors affecting storm water quality management, based on readily available information.

- Setting priorities: With storm water management, there is much more that needs to be done than can practically be done, and there is more that is unknown than known. Prioritizing is therefore essential.

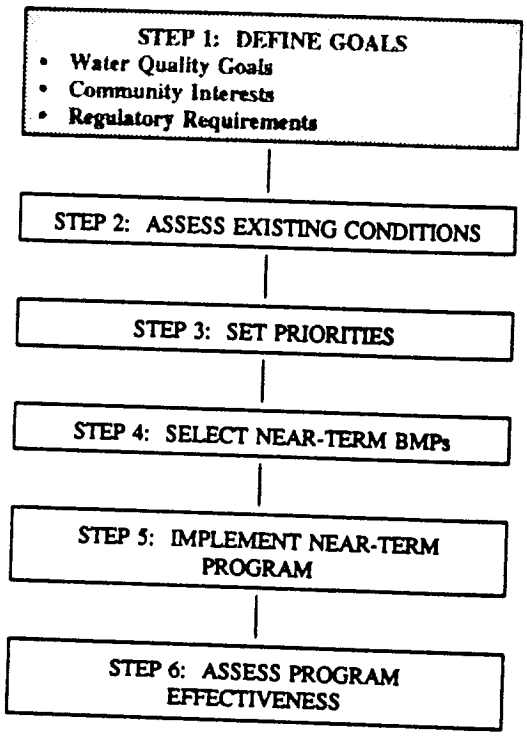
- The next two steps of Figure 2.2 (Select Near-Term BMPs and Implement Near-Term Programs) involve selection and implementation of a complementary and integrated set of BMPs. Step 4 is the essence of this handbook.

- The last step in this decision process is focussed on Assessing the Effectiveness of BMPs implemented. The monitoring, reporting, and inspection requirements of the NPDES permit should be oriented toward gaining insight into the performance of the BMPs implemented in the near-term to guide in meeting long-range goals. The "feedback" arrow in Figure 2.2 serves the municipality in assuming that the program goals and priorities are regularly reassessed.

STEP 1: DEFINE GOALS

WATER QUALITY GOALS

Since water quality protection is the ultimate goal of the Clean Water Act and hence the NPDES permit, one of the primary goals of the municipality's storm water management program is to protect water quality. As a complement to the Federal regulations and purpose, the RWQCBs have developed Basin Plans which further define the water quality objectives of the various water bodies within the regions' watersheds. The municipality must recognize these objectives, and establish water



quality goals which aim toward ultimately addressing these objectives in technically feasible, cost-effective ways. Near-term and/or interim goals are useful to point the program in the proper direction and lay the groundwork for targeting and phasing the program.

The municipality must also recognize that compliance with seemingly simple water quality goals may carry significant cost burdens. This is evident in reviewing Table 2.1, next page. If water quality goal 4 is selected as the goal of the SWMP, the evidence is that enormous costs would be incurred and that current technology is insufficient to meet existing standards for several constituents under the State Inland Surface Water Plans (LWA, 1990). Therefore it is imperative that the municipality understand the implications of water quality goals and the cost associated with obtaining these goals.

COMMUNITY INTERESTS

Each community has definite views on what it desires of its receiving waters, what are the

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Table 2.1
Water Quality Protection Goals

Water Quality Goals	Performance Standards	
	Future Loadings	Future Water Quality
1. No significant degradation	Minimize increase	Minimize deterioration
2. Nondegradation	No increase	No deterioration
3. Improved water quality	Lower than existing	Better than existing
4. Meet water quality standards during storm events	Significantly lower than existing	Better than existing

local areas of concern, and what actions it is willing to take to address these interests. These interests can only be determined, however, through public workshops where citizens are informed about storm water pollution and invited to present their views. The goals will nearly always be expressed in terms of desired use (e.g., swimming, surfing, fishing, boating, aquatic life habitats, aesthetics). These goals must be related back to the watersheds draining into these receiving waters. Two simple extremes are: (1) swimming and surfing require control of public health risks from coliform bacteria in the urban runoff, while (2) aesthetics may only require litter control.

But one single level of control need not be applied uniformly across the metropolitan area. Certain waters will be more valuable to the community and some will be less important. Various watershed-specific goals can be compiled to help set the community goals for a metropolitan area, or determining the priority for achieving prescribed water quality goals in various parts of the region.

REGULATORY REQUIREMENTS

The Clean Water Act amendments of 1987 established two principal goals for the municipal storm water program:

- Eliminate non-storm water discharges from storm drains.
- Reduce storm water pollution to the maximum extent practicable.

USEPA, in turn, issued the 1990 NPDES regulations which defined the activities to be addressed by the municipality in order to meet these goals (see box, page 2-1).

The first goal is relatively straight-forward, but potentially time-consuming and expensive to achieve. Non-storm water discharges are typically intermittent, unpredictable, widely dispersed, and thus difficult to detect. They may be physical connections to storm drains, or may result from dry weather water use which becomes contaminated. An effective storm water management program must address non-storm water discharges; however, the aggressiveness of this program should be judged by the early field screening activities and other assessments of the relative number of potential discharges and their relative impact on receiving water quality. Some California cities (including Los Angeles, San Diego and Santa Monica) have begun implementing treatment controls (e.g., disinfection, collection/treatment at the wastewater treatment plant) for dry weather flows into particularly sensitive water bodies.

The definition of MEP has essentially been left up to the local municipality and regulatory agency. It may be developed through a comprehensive planning process like the one laid out in Chapters 2 and 3 of this handbook. MEP should consider the magnitude of the problem, constraints on its resolution, the effectiveness and track record of available BMPs, and costs. MEP is not a fixed target, but should be re-examined and, if necessary, revised to incorporate current knowledge about the sources of pollution and the demonstrated effectiveness of BMPs. Also, other sections of the Clean Water Act (e.g., §304(l)) may impose additional requirements for certain receiving waters.

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STEP 2:
ASSESS EXISTING
CONDITIONS

A common question asked in the NPDES storm water permitting process is "What is the storm water quality problem?" While this is a logical question, a firm scientific answer is quite difficult and costly to give. In order to move the program forward, a quick "ballpark" assessment of existing conditions based on readily available data is recommended. Much of this data was collected for the Part 1 Permit Application. Individuals on municipal staff with intimate, pragmatic knowledge on the "lay of the land" are a major asset when assessing existing conditions. The four major areas that should be explored when assessing existing conditions (see box) are discussed in the following paragraphs.

Existing Condition Assessment

- What is currently known about storm water pollution in the municipality.
- Watershed characteristics which influence storm water pollution and its management.
- Characteristics of the community which influence storm water programs.
- Existing programs which currently achieve, are compatible with, or need to be involved in a good storm water management program.

POLLUTANT SOURCES

Specific, heavily concentrated sources of pollutants make good early targets for the SWMP because their cleanup is both observable and measurable. These might include old commercial and industrial areas, as well as core urban areas where large impervious areas directly connected to the storm drain are most likely to be found. Core areas also offer the best opportunity for finding non-storm water connections. Often, elements of the community employing "bad housekeeping practices" are considered to be eyesores (if not in violation of

STEP 1: DEFINE GOALS

STEP 2: ASSESS EXISTING CONDITIONS
- Pollutant Sources
- Watershed Characteristics
- Community Character
- Existing Programs

STEP 3: SET PRIORITIES

STEP 4: SELECT NEAR-TERM BMPs

STEP 5: IMPLEMENT NEAR-TERM PROGRAM

STEP 6: ASSESS PROGRAM EFFECTIVENESS

code). Municipal-owned facilities (e.g., the municipal corporation yard) should be early targets to ensure that the municipality has its "own house in order." Early initiatives which reduce loadings from significant pollutant sources demonstrate that the municipality has an equitable program (i.e., a "level playing field for everyone"). Visual observation is the best way to begin targeting pollutant sources in the near-term -- once the most concentrated sources are addressed, long-term monitoring programs may begin providing insight to more widely dispersed pollutant sources.

WATERSHED CHARACTERISTICS

Each watershed should be examined. Appropriate program targets and control measures will be determined according to watershed characteristics. Characteristics should include the following:

- Receiving water characteristics (e.g., water quality, fish habitat, recreational benefits) are

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evaluated to help identify pollutants of concern.

- Drainage System Characteristics (e.g., drainage design, base flow, right-of-ways, open space adjacent to the drainage system) define how pollutants are conveyed to the receiving water and opportunities for incorporating treatment control BMPs into the drainage system.

- Land use characteristics (e.g., existing development patterns, areas for new development, open space policies) are used for selecting and setting priorities for the most appropriate BMPs for each land use.

- Physical characteristics (e.g., soil, slope, subsurface conditions, climate/precipitation) govern the suitability and effectiveness of treatment control BMPs.

- Ecological Characteristics (e.g., open space, habitat, wetlands) define areas where natural systems can be incorporated into BMPs.

COMMUNITY CHARACTER

Knowing the makeup and activities of the community is particularly important for source control BMPs, which require significant community involvement to be effective. Active and concerned community groups can (and should) become involved. It is important to identify their concerns and link the concerns to storm water pollution control objectives. Factors to be considered include demographics, community organizations, environmental and aesthetic issues, and business climate.

EXISTING PROGRAMS

The most cost-effective way to implement the SWMP is to integrate it with existing programs. Thus a vital planning step is to determine:

- Programs that currently use BMPs to manage storm water pollutant sources,

- Programs that manage pollutant sources, but require BMPs to enhance their storm water pollution control effectiveness, and

- Programs that currently cause pollution and require BMPs to abate this pollution.

When assessing existing programs, it may be beneficial to compare the activities of the existing programs with the BMPs described in this Handbook (see Chapters 4 and 5). Consideration should be given to areas where the SWMP can be "piggybacked" with existing programs in a cost effective manner.

Once the existing programs are assessed, a good place to begin to incorporate storm water management goals into the municipality's General Plan (see BMP SC1 - Land Use Planning/Management in Chapter 4). The General Plan is a concise statement of the goals directing the municipality's existing programs. Several examples of integrated municipal programs follow:

- Many environmental regulations, including the NPDES storm water permitting program, favor pollution prevention. The Conservation Element of the General Plan probably discusses other pollution prevention programs (e.g., household hazardous waste collection, waste minimization, landfill management, pesticide use) which should be integrated into the SWMP. A single pollution prevention program which satisfies several environmental regulations should be developed.

- A community's water resources management activities (i.e., flood control, water supply, water conservation, groundwater management) should be integrated with the SWMP (Roesner and Matthews, 1990). Most storm water treatment control BMPs involve detaining/retaining runoff, slowing runoff velocity, and promoting percolation into the ground. A community's flood control policies, criteria, and facilities should be examined, and alternatives considered which address both the frequent storms (which convey most of the storm water pollution

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over the course of the year) and the infrequent storms (which cause floods). BMPs to consider include reducing direct connections of impervious area (DCIA) to the storm drain system, and using more vegetated and/or pervious drainage channels, detention basins, and infiltrating devices. Watershed master planning is recommended because some BMPs may be inappropriate in certain terrain (e.g., steep hillsides, low permeable soils, high groundwater zones). Percolation and storage of runoff may benefit a community's water conservation policies expressed in the General Plan's Conservation Element (e.g., "storm watering" of native vegetation, groundwater recharge, non-potable water supply, instream flow management).

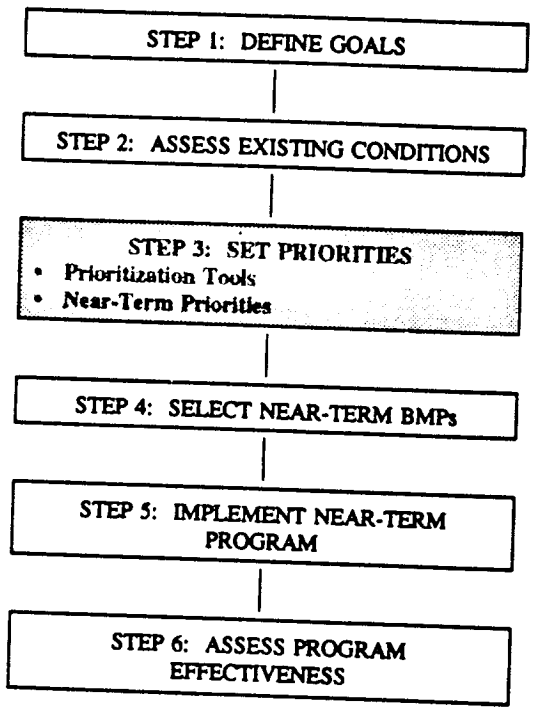
- A principal source of urban storm water pollution is the automotive/transportation system (see Chapter 1). The Circulation Element of the General Plan may relate how efficient use of the transportation system (e.g., public transport, ride sharing, staggered work hours, relieving traffic congestion) can reduce vehicular emissions and, consequently, storm water pollution discharges.

- How and where land is developed may significantly change the impact of storm water pollution on receiving waters. Directing intensive land uses away from more sensitive receiving waters has been proven to be a very effective source control BMP for new development projects.

- Many communities have found that treatment control BMPs are easily incorporated into parks and recreation areas with proper planning, design, and landscaping. The Open Space Element of the General Plan could promote these types of "multi-use" facilities as a cost-effective way of meeting SWMP goals.

STEP 3: SET PRIORITIES

The next step in developing and implementing the municipality's SWMP is to prioritize the goals. From Step 1 the municipality will know:



- What are the critical, known water quality issues that need to be addressed? (Water Quality Goals)

- What does the community want to protect? (Community Interests)

- What does the municipality have to do to meet its NPDES regulatory requirements? (Regulatory Requirements)

It is unlikely that all goals can be met in the near-term. Consequently, the municipality needs to prioritize its effort for both the near- and long-term goals.

Step 2 yields information about the municipality's ability to address these goals:

- Where are the pollutant sources?

- What are the watershed characteristics influencing BMP effectiveness?

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- What existing program scan be used as the foundation for the SWMP?

This information must be used to establish a priority for addressing the activities listed on page 2-1.

The following section provides a discussion regarding prioritization tools and likely categories of near-term programs.

> ***Prioritization Questions***
>
> How much can we afford?
> Do I think it will work?
> What are we already doing?
> Can I show that it works?
> Where are the worst problems?
> Can I learn something new?
> What are the easiest solutions?
> Is this the right direction?
> What has been successful for someone else?

PRIORITIZATION TOOLS

The first step in setting priorities is to review the information gathered in the existing condition assessment, broadly lay out alternatives, and screen alternatives. One way to summarize existing information and the issues to be considered in establishing a program is shown in Figure 2.3. Such a summary may be developed through a "brainstorming" session with the various responsible parties and using this handbook to identify available BMPs. The summary, once completed, may serve as a tool to solicit feedback from policy makers and regulatory agencies.

The next step is to develop a "short-list" of the most appropriate BMPs. Chapter 3 lays out a methodology and presents worksheets for selecting and ranking BMPs, for both source control BMPs and treatment control BMPs. Using these worksheets, the SWMP for each activity may be prioritized and phased.

To prioritize BMPs, three key factors must be determined:

1. A suitable, acceptable selection of BMPs.
2. An evaluation of the pollutant control/ removal which can be achieved by the BMP.
3. The portion of the drainage area to which the BMP can be applied.

The prioritization serves as a plan for determining BMPs based on actual drainage area characteristics, projected BMP performance, and cost-effectiveness considerations.

NEAR-TERM PRIORITIES

The SWMP must consider the phasing of program goals. A long-term program for all SWMP activities is required by the 1990 regulations. A near-term program (for the 5-year permit term) is also needed to focus attention on significant pollution source reduction. The near-term priorities should be programs that meet the following three criteria:

1. All activities defined by the storm water regulations are addressed.
2. BMPs are implemented in areas where mitigation of storm water pollution is most important to the community and/or regulatory agencies.
3. There are funds and staff to implement criteria 1 and 2.

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Program Activities: Improper Discharges
Program Element: Promote Proper Use and Disposal of Toxic Materials

Type of Development Addressed: Existing Development

Appropriate Federal Regulation: 40 CFR 122.26(d)(2)(iv)(B)(6) - a description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.

Compliance Objective: Develop target educational campaigns commensurate with ability of community to provide means of proper management and disposal (e.g., collection sites, times).

BMP Selection Issues

Responsible Parties:
- City Public Works Department
- County Department of Environmental Health Services
- Municipal Fire Agencies

Activities of Interest:
- Household disposal/dumping
- Commercial disposal/dumping
- Industrial disposal
- Public Agency disposal/dumping

Available BMPs:
- Household hazardous waste collection
- Used oil recycling
- Waste minimization

Alternate Levels of Service:
- Existing, no increase
- Optimized, no increase
- Increased
  - Education programs
  - Collection sites and extended hours
  - Monitoring

BMP Implementation Requirements

Legal, Regulatory and Enforcement Provisions:
- Ordinances (discharge/pretreatment)
- New ordinances
- Prosecution of violators

Administrative Requirements:
- Inspection and monitoring
- Pilot program
  - Record keeping
  - Educators
  - Media specialists

Inspection, Monitoring, Reporting Requirements:
- Frequency
  - Per site
  - Per year
- Measurement of effectiveness
- Sampling
  - Pilot area

Community Involvement/Outreach:
- Flyers
- Hot line
- Public service announcements

Funding:
- General fund
- Fines
- Users fee
- State Revolving Loan Fund

FIGURE 2.3 EXAMPLE STORM WATER PROGRAM SUMMARY

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STEP 4: SELECT NEAR-TERM BMPS

Initially, BMP selection should be limited to high priority activities. These early efforts need to be targeted -- either to an existing, successful program -- a particular localized pollutant source -- or a small area where all aspects of the program can be fully managed. It is important that the near-term program demonstrate immediate results, even on a small scale, to both the community and to the regulatory agency to gain and keep their support.

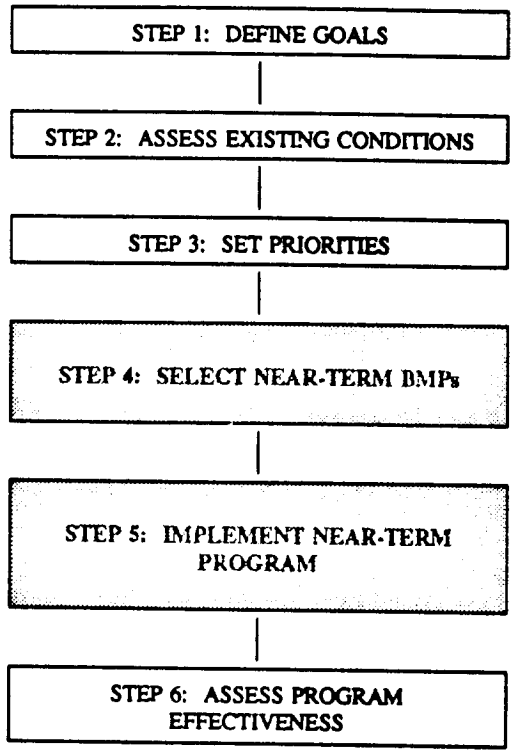
A single BMP is usually insufficient to control storm water pollution from a single activity; rather, an integrated, complementary set of BMPs tailored to local conditions should be selected for each activity (see box, below). For example, the City of Palo Alto targeted vehicle maintenance facilities for control of metals in both urban runoff and sanitary wastewater. The City developed an intensive program of education, spill management, material use/disposal, ordinances, economic incentives, manuals, etc., which has the full support of facility owners, community/ environmental groups, elected officials, and regulatory agencies (Uribe & Associates, 1992).

Tailor to the Local Condition

- Community/business composition.
- Hydrologic conditions (slope, soil, drainage patterns, climate).
- Land use patterns.
- Local practices.
- Community concerns.
- Institutional characteristics.

STEP 5: IMPLEMENT NEAR-TERM PROGRAM

The BMPs selected for implementation in Step 4 will be incorporated into the municipal SWMP. Such



incorporation will generally fall into one of the following five classes:

- Adequate Existing Program
- Redirect Existing Program
- Start New Program
- Develop Watershed Master Plan
- Conduct Targeted Pilot Study

Depending upon the classification, the implementation programs will be somewhat different. Some guidance for implementation is presented below.

ADEQUATE EXISTING PROGRAM

Programs which achieve some degree of storm water pollution control are already in place for most municipalities. These may be municipal programs, programs sponsored by overlapping jurisdictions, or private initiatives. Typical existing programs include household hazardous waste collection, hazardous spill response units, hazardous material storage rules, compliance

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with Resource Conservation and Recovery Act (RCRA) and California landfill management and closure regulations, litter control programs, and erosion and sedimentation control requirements. For these programs, all that may be required is better documentation and effective communication about their conduct and effectiveness at storm water pollution control.

REDIRECT EXISTING PROGRAMS

Other programs may be compatible with storm water pollution control, but require some redirection. In this category, the objective should be to incorporate good storm water management into an existing program, and to get documentation related to storm water pollution control back to the municipal storm water coordinator. Existing programs which may be redirected include detention/retention requirements for new development, construction site and building permit inspection programs, drainage system maintenance activities, and transportation and land use planning programs.

START NEW PROGRAM

An entirely new program may be appropriate in the near-term if it is clearly cost effective. There are two instances where new programs are favored in the near-term:

- An existing program provides the institutional structure to facilitate effective implementation (see previous section).
- A new program involving the community at large required to increase effectiveness.

Widespread, active community involvement is essential for a successful program. Community involvement includes clearly defining the problem and promoting measures which solve it (see box). Achieving community involvement requires a well balanced effort. A program which merely informs, without facilitating action or achieving results, may result in a negative backlash which hinders the program.

Criteria for Active Community Involvement

- Reflects the characteristics of the community.
- Acknowledges community priorities.
- Heightens awareness about the problem/program.
- Provides clear, concise information.
- Explains what each individual must do.
- Gives the individual an easy way to do what is asked.
- Monitors the program and gains feedback.

DEVELOP WATERSHED MASTER PLAN

In California, the Community and Area Plans developed under the General Plan often use watershed master plans to define localized conditions for land development, and infrastructure requirements for drainage and flood control. NPDES permitting requirements call for storm water pollution control planning to be incorporated into such land use and infrastructure planning. Treatment control BMPs (see Chapter 5) are selected most cost-effectively through watershed master planning.

A watershed master plan conducted by the municipality establishes an overall "framework" for storm water pollution control within the watershed. This framework consists of a system of on-site and regional storm water quantity/quality control measures (Figure 2.4). The watershed master plan should produce the following distinct products:

- Existing and projected future pollutant loads, impacts of these pollutant loads, and pollutant reduction goals.
- Watershed-specific BMPs (e.g., storm water management policies, facility design criteria) to be implemented on-site during land development/flood control projects.

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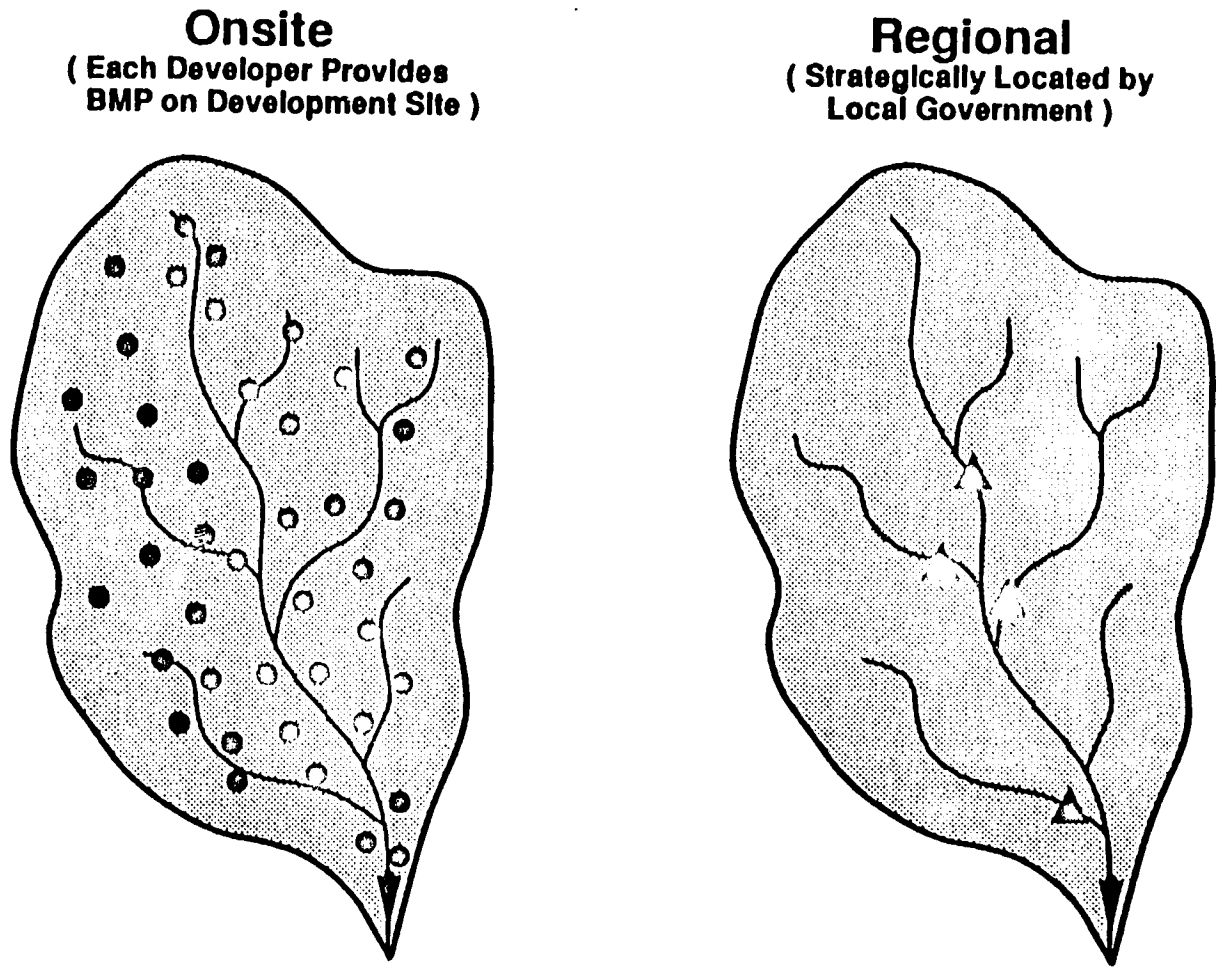

FIGURE 2.4 ALTERNATIVES FOR BMP DEPLOYMENT

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- Conceptual design of regional BMPs (e.g., multi-objective flood/storm water pollution control facilities).
- O&M needs and responsibilities.
- Methods for assessing effectiveness of master planned BMPs.
- A financing and administrative plan.

Once developed, the watershed master plan provides a capital improvement plan for regional quantity/quality control facilities, and guidance on BMP selection for municipal staff and individual developers. This guidance might take the form of storm water pollution control goals to be incorporated into the General Plan, zoning/subdivision ordinances, and administrative procedures and policies. BMP SC1, Land Use Planning/Management in Chapter 4 gives more details about appropriate BMPs.

CONDUCT TARGETED PILOT STUDY

Pilot studies are an interim step aimed at achieving significant control of a specific pollutant source while gaining practical knowledge to base long-term implementation decisions. They should be directed at a representative microcosm of the municipality and should be considered where municipal-wide implementation is expected to be cost-prohibitive in the near-term. Possible pilot studies may include street sweeping programs, school curriculum on storm water pollution control, storm water pollution control initiatives directed at small businesses, innovative treatment technologies, and illicit connection detection programs. Pilot studies are most appropriate for source control BMPs, where a high level of community involvement may be required, implementation may be labor-intensive, effectiveness is largely unmeasured, and effective implementation may be municipality (perhaps site) specific. While a large body of research and practical field experience already exists for treatment control BMPs, pilot studies of these BMPs may still be necessary to adopt them to local conditions.

Implementing On-Site and Regional BMPs
(Adapted from Hartigan, 1986)

On-Site

- Implementation Procedures
  - Municipal Master Plan recommends conceptual sizing criteria
  - Each developer defines specific BMPs meeting sizing criteria
  - Developer designs and constructs BMPs
  - Property owner responsible for providing maintenance
- Appropriate Applications
  - Single developer within large watershed
  - Infill/Retrofit for small parcels
  - No suitable regional site exists
  - Smaller, non-residential sites with maintenance agreements
  - Site grading which reduces DCIA, directs runoff to vegetate areas, or captures runoff for on-site reuse or percolation

Regional

- Implementation Procedure
  - Municipal Master Plan strategically locates facility, and prepares conceptual design
  - Municipality or developer designs and constructs BMP for multiple development projects
  - Developers pay equitable fee-in-lieu-of constructing on-site facility
  - Maintenance performed by municipality
- Appropriate Applications
  - Where Master Plan demonstrates community-wide economies of scale
  - Where suitable site exists downstream of areas already partially or fully developed
  - Where critical receiving water issues warrant greater municipal role
  - To maximize multi-use benefits (e.g., flood control, parks/recreation, groundwater recharge)
  - Where property owners cannot provide appropriate maintenance and require municipal assistance

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STEP 6: ASSESS PROGRAM EFFECTIVENESS

Assessing the program effectiveness can be difficult, as well as expensive. Chapter 6 describes the methods used for assessing the performance of BMPs. The assessment basically consist of two methods:

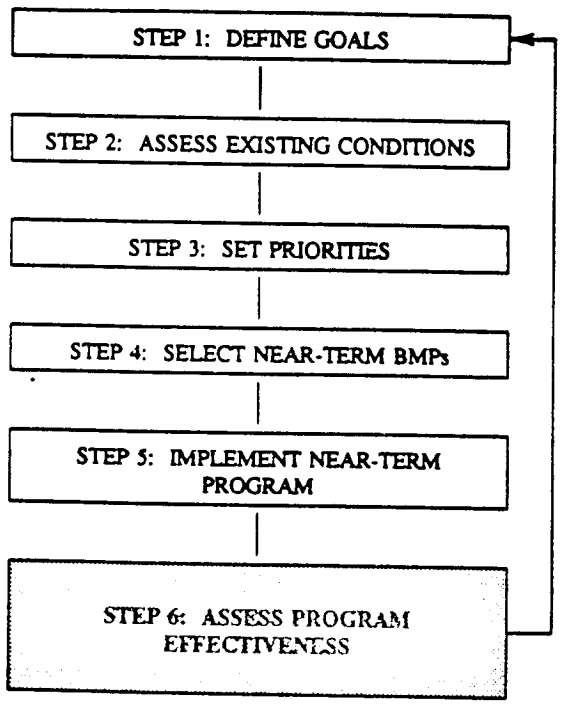
- *Water Quality Monitoring* is, of course, the first method that comes to mind. Here the monitoring can take place in either the receiving water where the storm water discharges to or in the storm water discharges prior to the receiving water.

  In either case it is important that the municipality decide the objective of the monitoring program. There are three distinctly different objectives to consider:

  (1) Characterize the storm water discharges. Here the monitoring program is basically set up to provide water quality data for comparison with other data bases (e.g., NURP, RWQCB) and to determine if there is a pollutant that warrants special attention in the SWMP.

  (2) Characterize the receiving water during storm water dischargers. This type of monitoring provides information on the short-term effects of storm water discharges to receiving waters. A monitoring program carried out under this objective could include "biological surveys" as well as water quality sampling.

  (3) Assess the effectiveness of the SWMP in reducing pollutants. To accomplish this objective, a carefully laid out program is required. Because of the wide variability in storm water quality, this monitoring program should focus on small watersheds where one or more BMPs have been targeted. Pilot studies provide an excellent opportunity for evaluating targeted BMPs in a well defined area or watershed.



- *Non-conventional monitoring* is the enumeration of some quantity other than water quality data to infer pollution reduction or water quality improvement. There are many different kinds of indirect measures that can be devised to estimate the success of a particular BMP program. For example, public surveys may show increases in environmental awareness. Another example would be monitoring the amount of used oil collected.

Keep in mind that the assessment must be dynamic. The assessment should provide insight into what is working and what is not. Based on this, the six steps in the SWMP decision making process are reconsidered. Each "loop" through this decision making process should move the SWMP closer to understanding and meeting the long-term goal of cost-effective water quality protection.

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Chapter 3

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3. BMP SELECTION

GENERAL GUIDANCE FOR SELECTION OF BMPs

Chapter 2 described the steps involved in the development of a Storm Water Management Program. A major step in this program development is the selection of BMPs. This Chapter contains guidance on the selection of both source control and treatment control BMPs.

Selecting the proper BMPs for any given situation is a function of the following:

- The Federal storm water regulations.
- The receiving water beneficial uses to be protected.
- The cost of BMP program implementation.

A SWMP must (according to EPA regulations) implement BMPs for each of the activities to be addressed by the SWMP, as listed in the left column of Table 3.1. At a minimum, this handbook recommends that one or more BMPs be selected from each category of BMPs with an "X" shown on Table 3.1. This handbook does not recommend specific BMPs. This is a task for the local community based on the specific circumstances of that community (see Chapter 2).

The reduction of pollutants in storm water discharges to the maximum extent practicable is the statutory requirement of the storm water regulations. Ultimately the goal is to protect the receiving water. For each different receiving water within the municipality, the beneficial uses of that water body should be identified and the specific pollutants important for protecting those uses be defined. For example, waters used for fishing and/or swimming should be protected from fecal coliform contamination; thus, BMPs selected for the watershed(s) draining to that receiving water body should be those that minimize fecal coliform contributions. (An example BMP is an illicit connection removal program.)

Cost is another major consideration with respect to the BMPs selected for implementation. The NPDES regulations are conscious of this fact in that they call for the reduction of pollutants in urban runoff to the "maximum extent practicable." Guidelines for assisting the planner in the determination of when MEP has been reached are provided in both the **Selection of Source Controls** and **Selection of Treatment Controls** sections that follow.

As a final comment regarding the selection of BMPs, there is no single BMP that is going to solve all of the water quality problems; rather it is a combination of BMPs which contribute to the reduction of pollutants in the runoff. As shown in Figure 3.1 a multi-level strategy is required beginning with source controls, then continuing on with treatment controls for sites, and finally, where required, community-wide treatment controls.

SELECTION OF SOURCE CONTROL BMPs

A comprehensive storm water management program requires certain source control BMPs be implemented on existing development. In addition, some source controls will be applied in developing areas once the new development has been completed. Eight categories of source control BMPS are described in Chapter 4.

Planning Management BMPs are directed toward minimizing the runoff from new developments and siting infrastructure so as to discourage development in environmentally sensitive areas that are critical to maintaining water quality. These controls are very cost-effective if implemented in the site planning

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Required Elements of SWMP	SOURCE CONTROL BMPS CHAPTER 4							
	Planning Management	Material Use Control	Material Exposure Controls	Material Disposal & Recycling	Spill Prevention & Cleanup	Illegal Dumping Controls	Illicit Connection Controls	Street/ Storm Drain Maintenance
FOR RESIDENTIAL/ COMMERCIAL ACTIVITIES:								
Roadway and drainage facility maintenance		X						X
BMP planning for new development and redevelopment projects	X							X
Retroffiting existing or proposed flood control projects with BMPs	(See Page 3-9, Chapter 3)							
Municipal waste handling and disposal operations		X	X	X	X	X		
Pesticide, herbicide, and fertilizer use controls		X	X	X	X	X		
FOR IMPROPER DISCHARGE ACTIVITIES:								
Prevention, detection, and removal of illegal connections to storm drains							X	
Spill prevention, containment, and response		X	X	X	X	X		
Promote proper use and disposal of toxic materials		X	X	X	X	X		
Reduce storm water contamination by leaking/ overflowing separate sanitary sewers					X	X		
FOR INDUSTRIAL ACTIVITIES:								
Inspection and control prioritization and procedures		X	X	X	X	X	X	X
Monitoring of significant industrial discharges						X	X	
FOR CONSTRUCTION AND LAND DEVELOPMENT ACTIVITIES:								
Water quality and BMP assessments during planning	X	X	X	X	X	X		X
Site inspection and enforcement procedures	X	X	X	X	X	X		X
Training for developers and contractors	X							

TABLE 3.1 APPLICATION OF BMPs TO SWMP PROGRAM ELEMENTS

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(TO)

Required Elements of SWMP	TREATMENT CONTROL BMPS CHAPTER 5								Construction BMP Handbook	Industrial BMP Handbook
	Infiltration	Wet Ponds	Constructed Wetlands	Biofilters	Extended Detention Basins	Media Filtration	Oil/Water Separators	Multiple Systems		
FOR RESIDENTIAL/COMMERCIAL ACTIVITIES:										
Roadway and drainage facility maintenance										
BMP planning for new development and redevelopment projects	X	X	X	X	X	X	X	X	X	
Retrofitting existing or proposed flood control projects with BMPs	X	X	X		X			X		
Municipal waste handling and disposal operations										X
Pesticide, herbicide, and fertilizer use controls									X	X
FOR IMPROPER DISCHARGE ACTIVITIES:										
Prevention, detection, and removal of illegal connections to storm drains									X	X
Spill prevention, containment, and response									X	X
Promote proper use and disposal of toxic materials									X	X
Reduce storm water contamination by leaking/ overflowing separate sanitary sewers										
FOR INDUSTRIAL ACTIVITIES:										
Inspection and control prioritization and procedures										X
Monitoring of significant industrial discharges										X
FOR CONSTRUCTION AND LAND DEVELOPMENT ACTIVITIES:										
Water quality and BMP assessments during planning	X	X	X	X	X	X	X	X	X	
Site inspection and enforcement procedures									X	
Training for developers and contractors									X	

TABLE 3.1 APPLICATION OF BMPs TO SWMP PROGRAM ELEMENTS (Continued)

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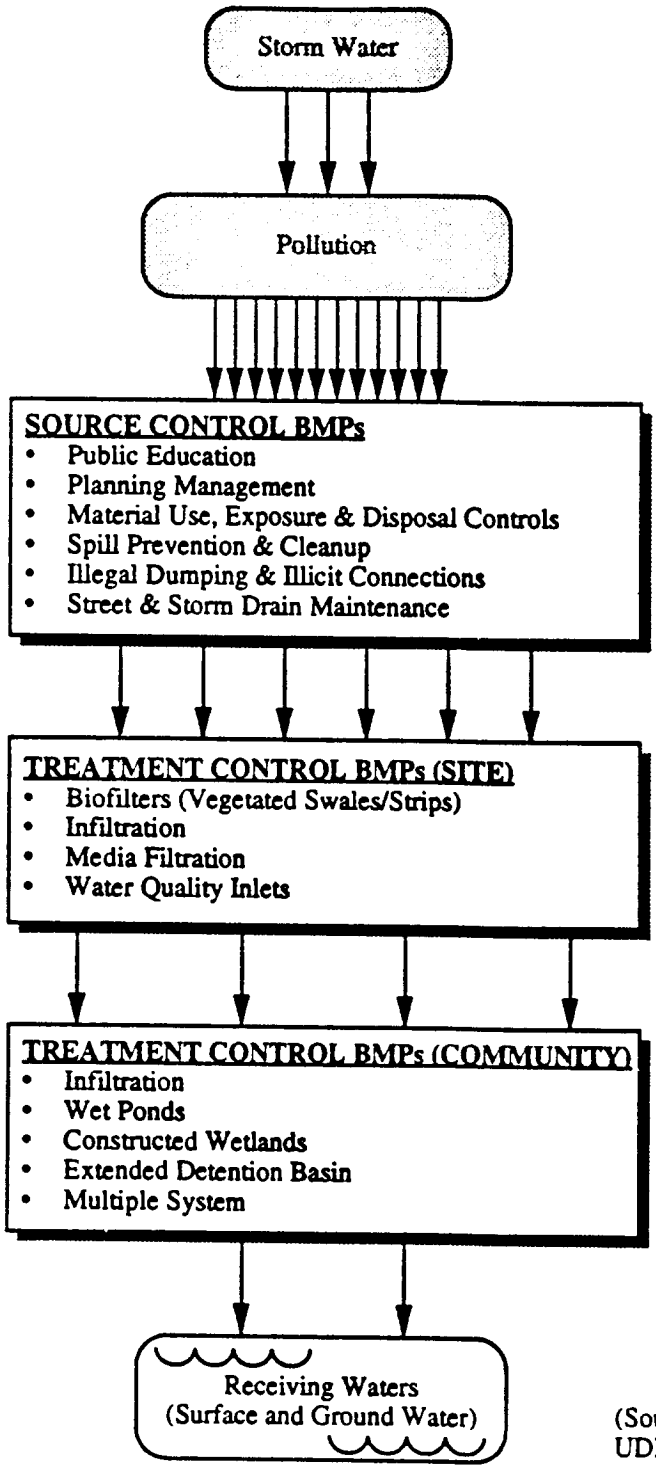

(Source: Modified from UDFCD, 1992)

FIGURE 3.1 MULTI-LEVEL STRATEGY FOR STORM WATER MANAGEMENT PROGRAM

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phase of new development projects and sizeable redevelopment projects. Examples of these controls at the municipal planning level include zoning ordinances, subdivision regulations, and buffers and setback requirements. At the site planning level for new development and redevelopment, these controls include minimizing impervious area that is connected directly to the storm drainage system, and providing setbacks from surface waters and wetlands to protect their environmental integrity.

Materials Management is addressed by the next three BMP categories: Material Use Controls; Material Exposure Controls, and Material Disposal and Recycling. BMPs in these categories are directed at controlling the use, storage and disposal of chemicals that could pollute runoff. The objective is to minimize the opportunity for rainfall or runoff to come into contact with these chemicals.

Spill Prevention and Cleanup is directed primarily toward minimizing the risk of spills during outdoor handling and transport of chemicals, and developing plans and programs to contain and rapidly clean up spills when they do occur before it rains and /or before the spill works its way into the storm drain system.

Illegal Dumping Controls consist of ordinances, public education programs, and penalties aimed at keeping individuals and businesses from dumping waste products into drainage systems. These wastes include solid waste/liquid waste and yard trash.

Illicit Connection Controls are directed toward preventing by ordinance, and eliminating by removal, connections to the storm drainage system that discharge any material except runoff into the drainage system. This includes bans on connection of floor drains, washdown areas, septic tank overflows, and the like.

Street/Storm Drain Maintenance includes BMPs that remove pollutants from paved areas and maintain runoff quality controls that exist within the drainage system. Examples include street sweeping, catch basin cleaning, road and bridge maintenance and maintenance of structural controls in the system for runoff quality management.

As noted in Chapter 2 the selection of source control BMPs is only one step in developing a storm water management program. Prior to the selection the municipality should understand where it wants to head with the program and what it already has in place. Once this information is provided the selection of source control BMPs is made easier.

EVALUATION CRITERIA

Worksheet 1 (page 3-12) and a selection criteria have been developed to assist the municipality in selecting source control BMPs. The selection criteria are important because it includes a number of factors that should be considered when selecting source control BMPs. These factors include:

- Ability to meet regulatory requirements
- Effectiveness of the BMP to remove pollutants of concern
- Public acceptance of the BMP
- Ability to be implemented
- Institutional constraints to BMP
- Cost for implementation

The selection criteria provide for a sliding scale of 1 to 5 to rank the BMP in meeting the above factors.

To use worksheet 1 the municipality should first list the program elements required under the storm water regulations and the categories of BMPs provided in the preceding paragraphs (see Table 3.1). The fact sheets for source control BMPs as presented in Chapter 4 are then reviewed to identify the BMPs available to the municipality. For each BMP identified the municipality ranks the BMPs according to its ability to meet the selection criteria. The criteria for ranking the source control BMPs is as follows:

Meets Regulatory Requirements

Does the BMP comply with the Federal storm water regulations or a RWQCB permit condition? For the most part the selected BMP

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will address the requirements of the storm water regulations. In certain situations the local RWQCB may require a specific BMP in which case the BMP will become a mandated BMP.

Rating Score:
5 - Meets specific RWQCB requirements
3 - Meets storm water regulations
1 - Does not meet regulatory requirements

Effectiveness of Pollutant Removal

Does the BMP have a high likelihood of reducing pollutants of concern? This is probably one of the hardest questions to answer especially for source control BMPs. Presently the knowledge required to make this assessment is lacking. Consequently, most source control BMPs will receive a low rating, not so much because they are not effective in removing pollutants, but because the ability to quantify the removal is not available. It is more likely that the rating of the source control BMPs will be relative to each other. Also some BMPs are more suited for removing a specific pollutant than others. Refer to the fact sheets in Chapter 4 for assistance regarding targeted pollutants.

Rating Score:
5 - Highly effective in removing pollutants with sufficient data to support such a claim.
3 - Expected to provide moderate level of pollutant removal.
1 - Ineffective in removing pollutants or insufficient data are available to make an assessment.

Public Acceptance

Does the BMP have public support? Some source control BMPs will carry more public support than others, e.g. stream clean-up versus tighter land use controls. The successful implementation of source controls depends, to a large extent, on the amount of public support. Such support can be identified by knowing the community interests. Without public support (which should include understanding the issues and problems) the BMP will be ineffective.

Rating Score:
5 - Public understands the problem and supports the BMP implementation.
3 - Likely that the public will support the BMP once they understand the problem but presently does not know the issues.
1 - Public does not support the BMP.

Implementable

Can the BMP be implemented through existing programs or departments? The ability of the municipality to implement a BMP will to a certain extent depend on whether existing programs can be used or expanded. Obviously the likelihood of a BMP to be implemented is greatly enhanced if an existing program (or department) can be used. Other issues to be considered under this criterion is the availability of staff (or does the staff need to be expanded) and equipment. Also the municipality should consider how the BMP will affect inter-departmental coordination and communication (Is there overlap? Will there be "turf battles"?).

Another issue to consider under implementation is whether the BMP should be implemented in a specific area or a larger watershed area. Some BMPs will be more appropriate for a specific target group within a limited area (e.g., industrial illicit connection program) while others need to be implemented area-wide (e.g., elimination of motor oil dumping). Those BMPs that apply to the larger watershed should receive higher consideration.

Rating Score:
5 - Existing program or department can be used and adequate personnel and equipment are available. Applies to larger watershed area.
3 - Existing program will need to be expanded with either more staff or equipment.
1 - Existing program or department does not exist to implement BMPs.

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Institutional Constraints

Are there any institutional constraints that limit the ability to implement the BMP? Typical institutional constraints would include legal and intergovernmental coordination. Many of the source control BMPs can be implemented under existing ordinances or regulations. In some situations a new ordinance will be required. Source control BMP may also require interjurisdictional coordination to be effective. This coordination whether it is through complementary watershed protection ordinances, common public education programs, or shared maintenance duties is critical to selecting BMPs.

Rating Score:

5 - Existing ordinances, intergovernmental agreements, etc. are in place to implement BMP.

3 - New ordinances and intergovernmental agreements will need to be developed; however, there is consensus among the parties that the BMP is important.

1 - New ordinances and intergovernmental agreements will need to be developed. Such ordinances and agreements will require extensive time and cost to develop a consensus.

Cost

How much is the BMP going to cost initially, and, over the long-term, does the municipality have adequate financial means to fund its implementation? Many of the source control BMPs do not require significant capital investments (e.g. storm drain stenciling) while others do (e.g. purchase of vacuum street sweepers). Also it is important to look at the means for generating the funds required for the BMP (or for the storm water program in general). Is the existing funding mechanism (e.g. user fees, general funds, etc.) adequate for funding the BMP or does a new mechanism need to be developed (e.g. utility fund)? Additionally the municipality may want to consider the cost to the community at large, although this may be a difficult task.

Rating Score:

5 - The BMP is low cost and can be funded with the existing municipal funding mechanism.

3 - Moderate cost BMP that will require an adjustment to the City's funding mechanism for support.

1 - High cost BMP or a BMP that will require a major restructuring of the municipal funding mechanism.

Once the worksheets are completed for each program element and the ratings scored the municipality will have a ranking of BMPs. It should be kept in mind that the BMP ranking is only a tool for comparing BMPs. In some situations where the scoring is similar for different BMPs, the municipality may decide to consider the BMPs in question to be equal and suitable for implementation. Nonetheless, the ranking will provide the information for the municipality to decide (1) which BMPs should be implemented immediately, (2) which BMPs should be targeted for pilot scale study, and (3) which BMPs should be phased for later implementation. Such ranking will also serve the purpose of defining MEP as required under the storm water regulations.

The selection criteria and scoring system as presented in the preceeding paragraphs are similar to other selection processes developed around California. Consequently, the user may wish to modify the selection process to accomodate local requirements. Modification of the following selection process attributes maybe considered:

- **Criteria** - The user may want to redefine some of the criteria, or add/subtract criteria.

- **Scores** - Likewise, the user may want to modify the scoring to a simple +, 0, and -, or 1, 2, and 3.

- **Weighting** - In addition, it may be appropriate to group the criteria into tiers reflecting their relative importance to SWMP goals. By multiplying the scores of the highest tier by some factor (e.g., x2) the first tier scores could be weighted more heavily than the others toreflect this importance.

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- **Fatal flaw** - Scoring the BMPs should provide for some fatal flaw (e.g., the BMP is illegal or its implementaiton is completely unacceptable to the public) which would make implementation impossible. Scoring a fatal flaw as a "0" is one way of highlighting the flaw. Any BMP scoring a "0" against a criterion would be eliminated from consideration, regardless of its overall ranking.

SELECTION OF TREATMENT CONTROL BMPs

The treatment control BMPs in this handbook are designed to fit aesthetically into the open space landscaping of new developments. This is the most common method of implementing these controls in other areas of the United States. But these facilities take up considerable land area because the side slopes of detention basins, wet basins, and constructed wetlands are flat to allow for maintenance and to ensure public safety. In certain cases where land availability for treatment controls is very limited, the facilities can be designed according to guidelines in the Industrial Handbook. These facilities will generally take up less space, but will be more costly to construct and they will likely require fencing for safety reasons. It is suggested these only be used when absolutely necessary, because they are not aesthetically pleasing and detract from the general ambience of the community.

Fulfilling the MEP goal may require that performance standards be established for treatment control BMPs. Performance standards are often related to the type or size of storm that should be used for the design of treatment control BMPs. These include swales, buffer strips, infiltration basins and trenches, and extended detention basins and wetponds. General guidelines for the design of many of these types of facilities are found in Chapter 5.

Treatment control BMPs are commonly sized to control small rainfall events (e.g., storms that occur more frequently than once per year on average) and the "first flush" of larger rainfall events. Sizing criteria presented in this handbook were developed for specific hydrologic conditions at a number of locations in California with the computer model STORM (Storage, Treatment, Overflow, Runoff Model), a simplified hydrologic model that translates a long-term time series of hourly rainfall into runoff, then routes the runoff through detention storage (Hydrologic Engineering Center, 1976, and Roesner, et al. 1974). Figure 3.2 shows the capture efficiency of various sizes of extended

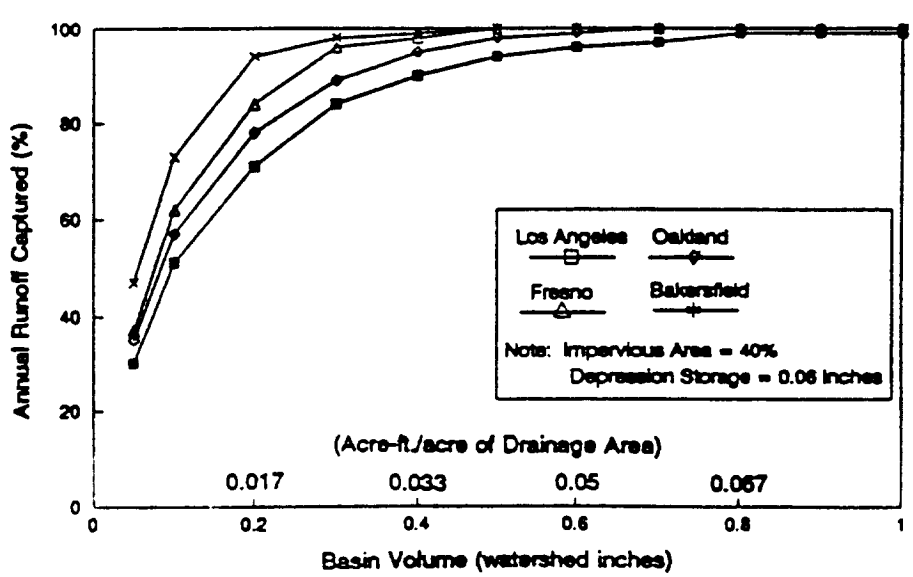

FIGURE 3.2 RUNOFF CAPTURE EFFICIENCY VS. UNIT STORAGE VOLUME FOR TYPICAL RESIDENTIAL AREA

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detention basins for different California cities for a typical single family residential area (impervious area equals 40 percent).

Two horizontal scales are shown on Figure 3.2. The upper scale expresses the required basin volume in acre-feet per acre of drainage area, while the lower scale gives the required basin size in watershed inches. The upper scale is simply the watershed inches divided by 12 which converts acre-inches to acre-feet. The curves show, for example, that in arid climate cities (e.g., Fresno and Bakersfield) capture of the first 1/4 inch of runoff (or 0.02 ac/ft of storage per acre of land tributary to the basin) will result in treatment of 90 to 96 percent of the runoff. Oakland and Los Angeles, on the other hand, require detention basin volumes of 0.3 to 0.4 inches to capture 90 percent of the rainfall. Larger detention basin volumes are needed for areas with a larger amount of impervious area. The complete set of runoff capture curves for California are shown in Appendix D.

One way to use these curves to develop cost-effective BMPs is to relate basin volume to cost, converting the curves to cost-effectiveness curves. The "knee-of-the-curve" is defined at the point where little increase in percent runoff captured occurs with increase in basin volume.

For Fresno, the knee of the curve is about 0.3 inches of basin volume. Some areas have shown that the "knee of the curve" is the 80th percentile runoff event (UD&FCD, 1992). Therefore, management of urban storm water pollution requires management of small storms (typically a 3- to 6-month event). BMPs should address larger, less frequent events only to prevent the BMP from increasing flooding, and to prevent the flood from damaging and/or scouring pollutants from the treatment control BMPs.

In addition, special consideration for sizing larger treatment control BMPs may be required when more strigent water quality objectives are to be met.

To assist with the selection of treatment control BMPs in a given watershed, the decision tree shown in Figure 3.3 has been developed. This decision tree will lead to the treatment control BMPs that are potentially applicable to the site/region. Using the site characteristics and the design guidance for the BMPs contained in Chapter 5, potentially applicable BMPs can be sized and their cost estimated. Worksheet 2 can then be filled in for the watershed(s) and/or pollutant(s) of concern, and ranked in the most cost-effective order.

INTEGRATING BMPs INTO FLOOD CONTROL FACILITIES

Storm water detention has been implemented in developing urban areas for several decades, usually as open earthen or grassed impoundment areas or basins designed to control the peak rate of discharge from one or more design storm events. These basins provide flood control benefits -- typically compensating for the impacts of land development by reducing the peak rates of post-development storm water runoff to pre-development peak rates by providing storage for the excess flows. The storage volume required to accommodate the reduced discharge rate controlled by the basin outflow structures is depicted in a conceptual manner on Figure 3.4 (see page 3-11) as the shaded area at the upper portion of the idealized storm water runoff hydrograph. Storm water detention for the purpose is sometimes referred to as "peak shaving," since the objective is to reduce the peak rate of runoff to control flooding from relatively intense infrequent, e.g., at least two-year and typically ten-year or greater, storms. Generally, the runoff from smaller storms passes through the basin, and the basin outflow structures have very little influence on the character of the discharge hydrograph.

Storm water detention for water quality control has not been as widely implemented and employs a different storage strategy. An important distinction is that while peak runoff rate is the key parameter for flood control, runoff volume is significant for water quality control. Basins constructed for water quality control must capture and detain almost all

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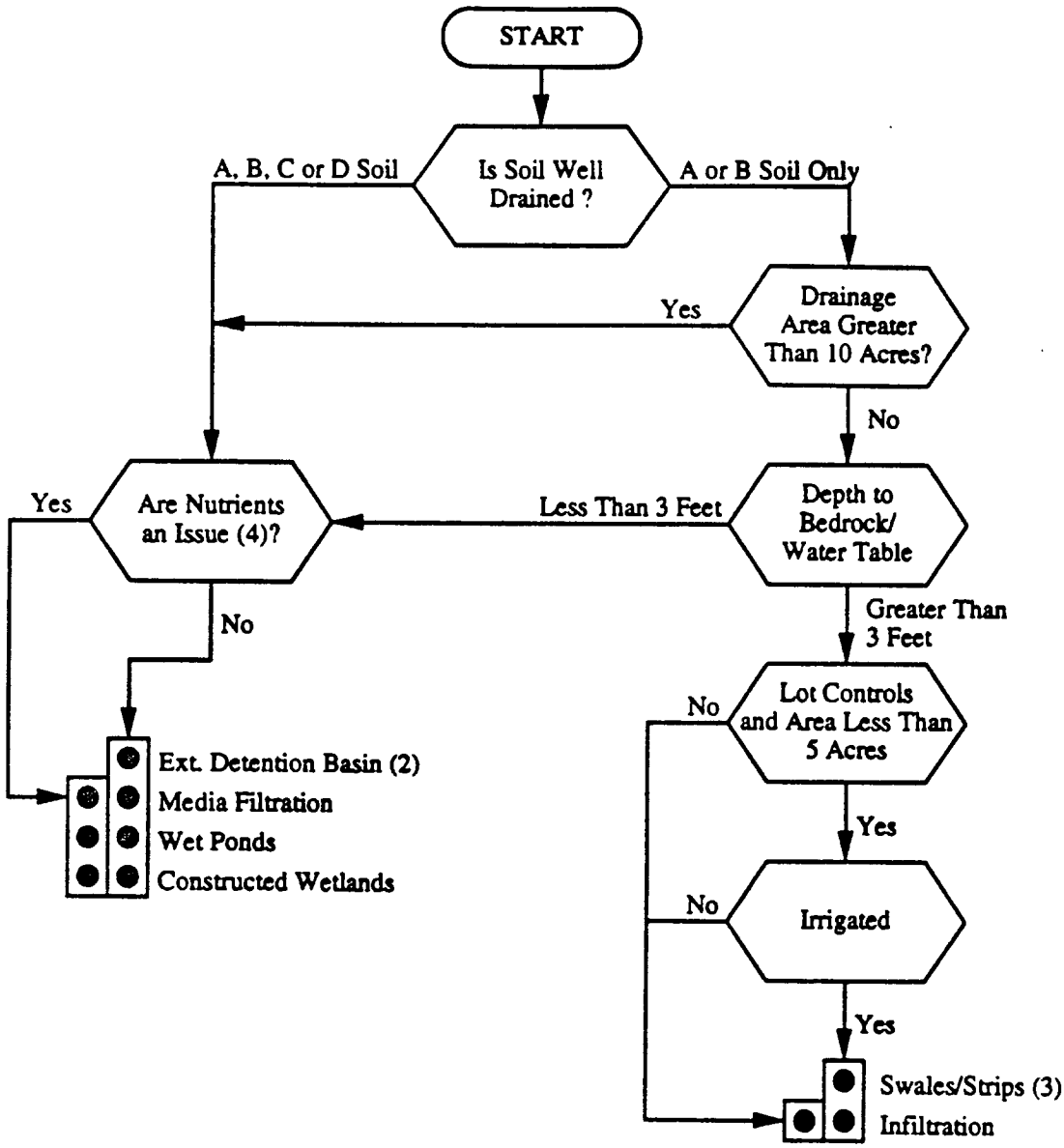

Footnotes:

(1) This is a generalized decision tree, specific site conditions may warrant alternative BMP selection.

(2) Extended detention basin sometimes cannot be used in areas with high water tables if basin excavation is required.

(3) Vegetated swales and strips can only be used when slopes along the flow path are not excessive.

(4) All BMPs shown on the decision tree if properly designed are effective in removing particulate pollutants.

FIGURE 3.3 DECISION TREE FOR DETERMINING POTENTIAL TREATMENT CONTROL BMPs (1)

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runoff for the design storm; however, the design storm is a much smaller event as demonstrated above.

The distinction between these two storage strategies is represented on Figure 3.4, which shows that, while a flood control basin will capture the peak portion of the hydrograph for an intense storm event, the water quality control basin will capture only the initial runoff at the same location from the same event, as depicted by the shaded area at the left on the hydrograph.

However, this represents the entire runoff volume from many of the more frequent smaller storms and, for larger storms, represents the initial washoff of pollutants, that portion of the runoff which is typically observed to contain the highest concentration of pollutants.

The extended (40-hour) drawdown time typically used for water quality detention requires a significantly smaller outlet control structure (typically provided by a small-diameter pipe or a perforated riser) than is required for flood control for the same tributary area. This is illustrated in Figure 3.5, which shows that required orifice (pipe) diameter as a function of tributary area, assuming 0.5 inches of storage is provided in a 5-foot-deep basin. This graph suggests that water quality control basins must serve relatively large areas, as the runoff from a tributary drainage area of over 60 acres is released through a 6-inch outlet pipe and, for an 8-inch outlet pipe, over 100 acres must be tributary to the basin. The outlet pipe diameter becomes excessively small (and therefore susceptible to plugging) for smaller tributary areas.

Caution should be exercised when retrofitting the small outlet control conduit for water quality in an existing flood control detention facility. In particular the flood control performance of the basin must be evaluated for larger storms (e.g., the 10-year, 25-year, and 100-year storms) with the modified outlet. Typically, the flood control outlet must be modified, not only to accommodate the extended detention for smaller storms, but also to compensate for the decreased outflow rate at lower basin stages during larger storms. In addition, the basin may need to be modified to increase the storage volume available for flood control.

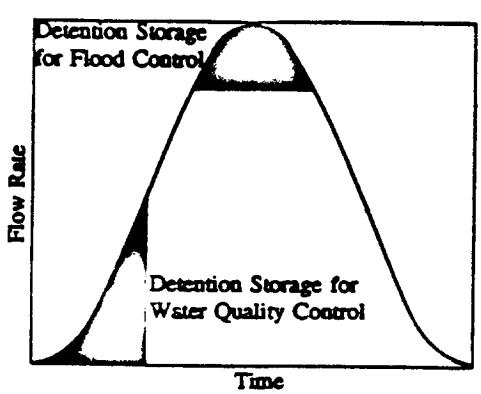

FIGURE 3.4 STORAGE STRATEGIES FOR FLOOD CONTROL &

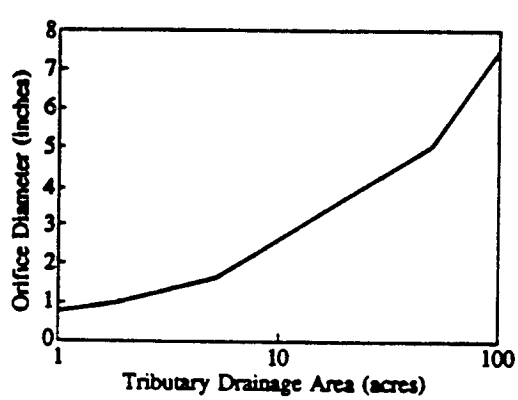

FIGURE 3.5 ORIFICE SIZING TO CONTROL DETENTION

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WORKKSHEET 1
SOURCE CONTROL BMP

PROGRAM ACTIVITIES:

PROGRAM ELEMENT:

BMPs	Meets Regulatory Requirements (1 - 5)	Effectiveness of Pollutant Removal (1 - 5)	Public Acceptance (1 - 5)	Implementable (1 - 5)	Institutional Constraints (1 - 5)	Costs (1 - 5)	Total (30 MAX.)

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WORKSHEET 2
TREATMENT CONTROL BMP

Pollutants of Concern	BMP	Area of Application (Ac)	Annual Pollutant Removed (Lb/Yr)	Annual Capital Costs (1) ($/Yr)	Annual O&M Cost (2) ($/Yr)	Annual Admin. Costs ($/Yr)	Total Annual Costs ($/Yr)	Removal Cost (3) ($/Lb)

NOTE:

(1) Annual capital costs based on a 20-year design period.

(2) Annual administration costs are best determined by a given community once a city-wide program is established.

(3) Removal costs are in units of ($/Yr) / (lb/Yr) = $/Lb.

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Chapter 4

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4. SOURCE CONTROL BMPs

INTRODUCTION

This chapter describes specific source control Best Management Practices for use by municipalities to reduce pollutants in its storm water discharges. Chapter 2 provided a comprehensive review of a municipal Storm Water Management Program while Chapter 3 led you through the steps of identifying BMPs that become a part of the SWMP. Fact sheets are provided for each of the BMP categories shown in the box.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Cost considerations
  - Regulations
  - Administrative and Staffing
  - Equipment
  - Training
- Public Education/Participation
- Limitations

The side bar presents information on where this BMP applies, targeted constituents, and an indication of the level of effort and costs to implement.

For some BMPs, further information, including examples of effective programs and references, is provided in additional sheets.

Source Control BMPs

Public Education
SC0 Public Education/Participation

Planning Management
SC1 Land Use Planning/Management

Material Use Controls
SC10 Housekeeping Practices
SC11 Safer Alternative Products

Material Exposure Controls
SC20 Material Storage Control
SC21 Vehicle Use Reduction

Material Disposal and Recycling
SC30 Storm Drain System Signs
SC31 Household Hazardous Waste Collection
SC32 Used Oil Recycling

Spill Prevention and Cleanup
SC40 Vehicle Leak and Spill Control
SC41 Aboveground Tank Leak and Spill Control

Illegal Dumping Controls
SC50 Illegal Dumping Control

Illicit Connection Controls
SC60 Illicit Connection-Prevention
SC61 Illicit Connection-Detection and Removal
SC62 Leaking Sanitary Sewer Control

Street/Storm Drain Maintenance
SC70 Street Cleaning
SC71 Catch Basin Cleaning
SC72 Vegetation Controls
SC73 Storm Drain Flushing
SC74 Roadway/Bridge Maintenance
SC75 Detention/Infiltration Device Maintenance
SC76 Storm Channel/Creek Maintenance

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ONTARIO WORKSHOP COMMENTS

CIRCLE WORKSHOP MUNICIPAL INDUSTRIAL COMMERCIAL

What did you like about this workshop?

How would you improve this workshop?

Comments

Please leave this sheet on your table where you are sitting.

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Xavier

ONTARIO WORKSHOP COMMENTS

CIRCLE WORKSHOP MUNICIPAL INDUSTRIAL COMMERCIAL

What did you like about this workshop?

How would you improve this workshop?

Comments

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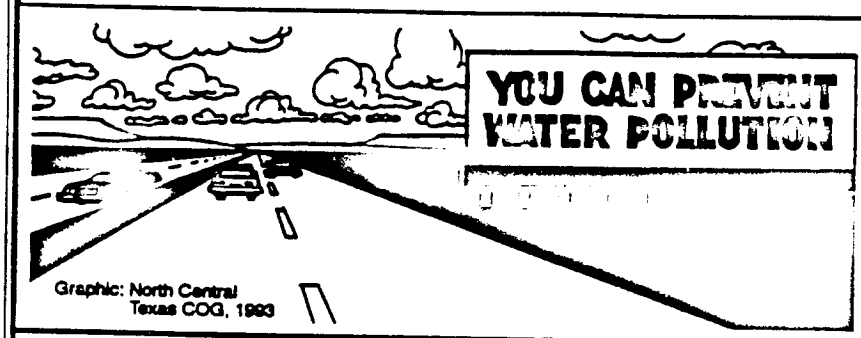
BMP: PUBLIC EDUCATION/PARTICIPATION



Graphic: North Central Texas COG, 1993

Program Elements

New Development

Residential

Commercial Activities

Industrial Activities

Municipal Facilities

Illegal Discharges

DESCRIPTION

Public education/participation, like an ordinance or a piece of equipment, is not so much a best management practice as it is a method by which to implement BMPs. This fact sheet highlights the importance of integrating elements of public education and participation into a municipality's overall plan for storm water quality management. Public education/ participation are vital components of many of the individual source control BMPs that follow in this chapter.

A public education and participation plan provides the municipality with a strategy for educating its employees, the public, and businesses about the importance of protecting storm water from improperly used, stored, and disposed of pollutants. Municipal employees must be trained, especially those that work in departments not directly related to storm water but whose actions affect storm water. Residents must become aware that a variety of hazardous products are used in the home and that their improper use and disposal can pollute storm water. Increased public awareness also facilitates public scrutiny of industrial and municipal activities and will likely increase public reporting of incidents. Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, must be informed of ways to reduce their potential to pollute storm water.

The specific public education/participation aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approaches for assuring public involvement in local storm water management programs. Accordingly, the organization of this fact sheet differs somewhat from the other fact sheets in this chapter.

OBJECTIVES

The public education and participation plan should be based on four objectives:

- Promote a clear identification and understanding of the problem and the solutions,
- Identify responsible parties and efforts to date,
- Promote community ownership of the problems and the solutions, and
- Integrate public feedback into program implementation.

APPROACH

- Pattern a new program after the many established programs from municipalities around the state and country. Whenever possible, integrate storm water public education/participation into existing programs from other departments at your municipality.

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Best Management Practices

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BMP: PUBLIC EDUCATION/PARTICIPATION (CONTINUE)

- Implement public education/participation as a coordinated campaign in which each message is related to the last.
- Present a clear and consistent message and image to the public regarding how they contribute to storm water pollution and what they can do to reduce it.
- Expand definition of "public" to include small businesses and construction site operators who often possess the same limited levels of awareness of the problems, regulations, and solutions as the "general" public. As a result, small businesses need the same level of technical assistance (education) and participation in the process as the "general" public.
- Utilize multi-media to reach the full range of audiences.
- Translate messages into the foreign languages of the community to reach the full spectrum of your populace and to avoid misinterpretation of messages.
- Create an awareness and identification with the local watershed.
- Involve focus or advisory groups in the development of a public education/participation plan. This will create a much more effective plan as well as promote ownership of the plan by those involved.
- Use everyday language in all public pieces. Use outside reviewers to highlight and reduce the use of technical terminology, acronyms, and jargon.
- Make sure all statements have a sound, up-to-date technical basis. Do not contribute to the spread of misinformation.
- Break up complicated subjects into smaller more simple concepts. Present these concepts to the public in a metered and organized way to avoid "overloading" and confusing the audience.

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Additional Information — Public Education/Participation

Approach

Public education and participation are critical elements of many of these source control BMPs. As each municipality chooses source controls, and develops and implements its SWMP, it is very important that the public education and participation aspects of the chosen source controls be integrated into an overall plan. The presentation of a well coordinated and comprehensive campaign will be much more effective and efficient at reaching the target audiences than a series of separate actions whose relation to one another may not be evident.

Target Audiences

To effectively achieve these objectives, the implementation of a public education and participation plan requires that the full range of target audiences be identified and provided with appropriate information and outreach. The following audiences should be included:

- Political - Elected officials and heads of departments, agencies, and commissions;
- Technical (Internal) - Municipal department and agency staffs;
- Technical (External) - State agencies (Cal-EPA, SWRCB, IWMB, ARB), regional agencies (e.g., ABAG, SCAG, AMBAG, water and transportation agencies), and neighboring governments;
- Business - Commercial and industrial, including trade associations;
- Construction - Developers and contractors;
- Community Groups - Fraternal, ethnic, hobby, horticultural, senior citizen, and service;
- Environmental Groups;
- General Public/Residential;
- Schools/Youth Groups;
- Media - Print and electronic, and
- Pollutant-defined - Groups of individuals defined by the specific pollutant(s) they discharge (e.g., used motor oil, pesticides).

Strategic Activities

The public must have a clear understanding of the problem of storm water pollution in order to bring about the behavioral changes needed to reduce the discharge of pollutants. Part of this "clear understanding" involves increasing the public's realization of their "place" in the watershed. The public should be educated about the watershed, where they live in relation to it, and how their behavior affects the health of the whole watershed. Ultimately, municipal employees, citizens, and businesses must realize that they contribute to storm water pollution and that by modifying their behavior they can contribute to the solution. Implementation of the public education and participation plan is the mechanism by which this understanding is attained, and these behavioral changes are brought about.

It has been estimated that some individuals require exposure to the same message up to seven times, from a variety of media, before behavior modification occurs. Therefore, given limited resources, the key question is not what one activity (e.g., fair) or media (e.g., radio) is best, but what mixture of these elements is most effective for the target audience.

In light of this information, the public education and participation plan should include a variety of activities to reach and educate the target audiences. These activities may include:

- Program Planning and Tracking - Public surveys and database;
- Program Identity - Program message, logo, and tag line;
- Collateral Material - Newsletter, fact sheets, brochures, posters;
- Coordinating Committees;
- Media Campaign - Press releases, advertising, public service announcements;

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Additional Information — Public Education/Participation

- Residential Programs - Storm drain stencilling, home toxics checklist/alternatives, and specific neighborhood projects;
- Presentations - Environmental booth, speakers bureau, and special events;
- Business Programs - Workshops, publications, and green business projects;
- Construction Programs - Workshops, educational materials, and certification;
- Consumer Programs - Point of purchase displays and printed grocery bags; and
- School Education - Facility tours, contests, and curriculum.

Elements of a Model Public Education/Participation Plan

The following elements of a model plan are based on plans developed in California and elsewhere. The list of elements is intended as a guideline or menu only. The list of activities is by no means exhaustive, and new activities are being developed by communities on an ongoing basis. The actual level, priority, and schedule of activities in your agency's public education/participation plan must be based on your community's needs and resources. Communities have typically developed 5-year plans to match the length of their NPDES permit. There are some activities that should occur before others. These activities are listed as a group first, followed by a general list of other activities.

Start-Up Activities

- Program Planning and Tracking (Public survey and database) - A public survey is an important tool to assess the use of toxic materials, perceptions of health risk, disposal practices, support and willingness to pay for new programs, and overall environmental awareness. The survey results will educate you as to your community's needs and guide the development and implementation of your public education and participation plan. Surveys are equally important in establishing a baseline for evaluating the effectiveness of your program. As such, surveys should be conducted on a regular basis (e.g, biannual) to gauge your program's success. Strongly consider the use of a professional survey firm. Surveys conducted in an unscientific manner often provide poor information at best, and misinformation at worst.

  A database is another important program assessment tool that should be initiated before the program begins. The database can maintain information on mailing lists, phone inquiries, material distributions, spill incident data, and levels of effort. As much as possible, the program's effort should be quantified to track its progress and to provide feedback to the public and to the regulatory agencies.

- Program Identity (Message, logo, and tag line) - The development of a consistent image which appears on all materials distributed by your program will promote an understanding of the program, its mission, and its interconnectedness with other issues and programs. The development of a program logo with such high public exposure should be performed by a professional graphics firm.

- Coordinating committees - The work of other agencies within your municipality and other groups outside of the municipality often touches on some part of the storm water quality issue as a byproduct of these groups' efforts. Committees should be established that coordinate the storm water public education/participation program with other environmental education efforts within the municipality and at the schools. Likewise, successful implementation of the storm water management program cuts across most municipal departments requiring that representatives from these departments meet regularly to coordinate their efforts.

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Additional Information — Public Education/Participation

Other Activities

- Media Campaign (Press releases, advertising, and public service announcements) - The media (radio, television, and newspapers) offers both widespread coverage and the opportunity to repeat the same message. Cultivate media support and involvement by educating media staff on the purpose of the program. Press releases and public service announcements (PSAs) may be produced on a regular basis to inform the public about upcoming events, household hazardous waste collections, and sources of additional information. Billboards and municipal vehicle (buses, street sweepers) placards are another effective media for transmitting the program logo and tag line.

- Collateral Material (Newsletter, fact sheets, brochure, and posters) - Produce newsletters at regular intervals to inform program participants, the general public, and businesses about the program. Fact sheets may be used to inform the public about specific issues. Brochures provide an overall picture of the program and can be used to highlight the program's comprehensiveness and long term nature. Posters may be displayed at municipal offices for both public education and municipal staff training, and distributed to schools and businesses.

- Residential Programs (Storm drain stencilling, home toxics checklist/alternatives, and specific neighborhood projects) - Because of its short development time and low maintenance costs, storm drain stencilling is often one of the first activities implemented by communities. Likewise, a home toxics checklist/alternatives publication, developed initially to meet household hazardous waste regulations, may be integrated into the public education effort about storm water quality. Some larger communities are targeting specific neighborhoods for more concentrated and immediate education, because of their geographic position in a watershed.

- Presentations (Environmental booth, speakers bureau, and special events) - Direct contact between the municipal staff implementing the storm water management program and the public can be a highly effective way of educating target audiences. Environmental booths can be especially effective because they distribute the message in a three dimensional, sometimes interactive way. A special event can bring extra attention to the program by highlighting a milestone, particularly if reporters from the media cover the event.

- Construction Programs (workshops, educational materials and certification) - Contractors and developers often need education on sources, impacts, and control of pollutants from construction sites. Site operators often need assistance in developing erosion and sediment controls. A certification program may be appropriate for all construction site operators, plan reviewers and inspectors. The certification program would establish a minimum-competency level for those involved in preparing and implementing erosion and sediment control plans, and storm water pollution prevention plans.

- Business Programs (Workshops, publications, and "green" business project) - Some businesses are more likely than others to contribute to storm water pollution. Municipality's can take advantage of this by defining and focusing education efforts on priority businesses. Small businesses, in particular, need assistance with understanding the problems and being made aware of alternatives and solutions. The use of an educational, positive incentive-based program for small businesses is often much more effective than a traditional command-and-control approach.

- Consumer Programs (Point of purchase displays and printed grocery bags) - Point of purchase displays can be very effective because they convey the program's message directly to the consumer at the time and place the purchase decision is being made. Grocery bags printed with the program logo and tag line are a quick and effective way to give brief information to many people.

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Additional Information — Public Education/Participation

- School Education (Facility tours, contests, and curriculum) - The most effective long term method to modify behavior is to educate people at an early age. Facility tours of the wastewater treatment plant, sewer system, household hazardous waste collection center, and other municipal facilities provides children with a first hand look at the processes involved with treating waste and reinforces the awareness that substances deposited to the storm drain are not treated. Contests to develop posters, calendars, etc. are a fun way to raise children's awareness and the accuracy of the resulting products can provide feedback as to effectiveness of other educational efforts. An environmental curriculum covering recycling, energy use, air and water pollution can be a highly effective but long term educational activity. Several groups have recently developed or are developing curricula (see below).

Examples of Effective Programs

There are a number of communities with effective public education/participation programs. The most pro-active include Santa Clara County and the City of Palo Alto, Alameda County, the City and County of San Francisco, the Santa Monica Bay Restoration Project, City of Los Angeles Clean Water Program, City of Santa Monica, the Municipality of Metropolitan Seattle (Metro), and the Unified Sewerage Agency of Washington County, Oregon. In addition, large businesses, such as PG&E, have used inserts in their bill mailings to educate their customers. The California Coastal Commission and the Lindsay Museum are both developing a curriculum targeted at nonpoint source pollution, and the San Francisco Estuary Project has already developed such a curriculum for K-12.

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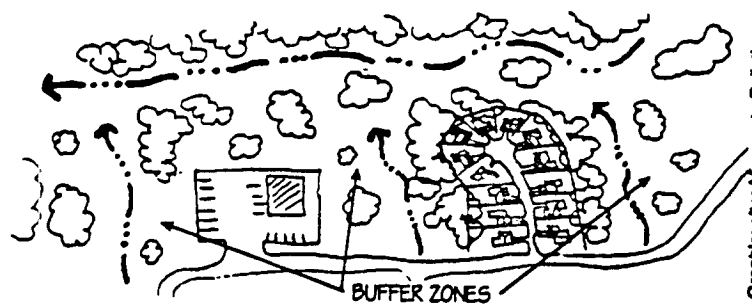
BMP: LAND USE PLANNING/MANAGEMENT



Graphic: after Minnesota Pollution Control Agency, 1989

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

This BMP presents an important opportunity to reduce pollutants in storm water runoff by using a comprehensive planning process to integrate water quality concerns into the development and redevelopment process. It is applicable to all types of land use and represents one of the most effective pollution prevention practices.

APPROACH

The land use planning process need not be complex. A basic schematic model involves:

- Phase 1 - Goals: Determination of clear-cut water quality goals.
- Phase 2 - Study: Identification of planning area then gathering of pertinent data and the writing of a description of the planning area and its associated problems.
- Phase 3 - Analysis and Synthesis: Determine and prioritize the water quality needs as they relate to land use.
- Phase 4 - Recommendations: Future courses of action are developed to address the identified problems and needs determined previously.
- Phase 5 - Adoption: The recommendations are presented to a political body for acceptance and implementation.
- Phase 6 - Implementation: Recommendations adopted by the political body are implemented by the locality.

REQUIREMENTS TO IMPLEMENT

- Cost Considerations
  - Majority of costs are associated with establishing a comprehensive land use plan which addresses the quality of storm water runoff after projects.
- Regulatory
  - Ordinances are usually required to implement and enforce land use plans including those relating storm water runoff quality.
  - Several federal and state initiatives influence land use planning: the National Environmental Policy Act, the California Environmental Quality Act, the Clean Water Act, the Clean Air Act, and the State General Plan process and State Subdivision Map Act.
- Administrative/Staffing
  - Site plans and/or environmental impact documents for projects must be reviewed for compliance.
  - Additional staff may be required to implement site plan review and an inspection program.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ○ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ● Regulatory
- ◒ Staffing
- ○ Training
- ● Administrative

● High ○ Low

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BMP: LAND USE PLANNING/MANAGEMENT (Continue)

PUBLIC EDUCATION/PARTICIPATION

- To gain the necessary support for land use policies, education of the participants in the development process is a necessity.
- Developers, builders and contractors should be educated regarding the positive environmental impacts of land use management including the improvement to storm water runoff quality.
- To increase awareness, education materials should be as specific as possible about the impact of land use policies on watersheds and water quality.
- GIS (Geographic Information Systems) can be a dynamic and effective tool to illustrate water quality impacts.

LIMITATIONS

- Land use planning/management frequently addresses sensitive public issues. Restrictions on certain land uses for the purpose of mitigating storm water pollution may be politically unacceptable.
- The use of land use controls and planning for water quality improvements may be limited by the lack of staff to enforce various aspects of local zoning and building codes.
- The planning process addresses many public needs and legal requirements which often are in conflict with one another. It is difficult but extremely important to integrate and balance these sometimes competing programs.

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Additional Information — Land Use Planning/Management

Purpose

Land use planning/management represents an important long range approach to minimizing the increase of pollutants in storm water runoff. A comprehensive planning process for municipalities should be used to ensure that land use practices do not result in increased pollution of or contamination to receiving water. Management measures may include modifications or restrictions of certain land use activities. Greater restrictions may be required where development can effect impaired, threatened, or significant water bodies.

Subdivision regulations, zoning ordinances, tentative map reviews and improvement plan reviews are tools that may used to mitigate storm water contamination in developing areas. Subdivision regulations, zoning, and tentative map processes are planning tools where municipal agencies can require conditions of approval or establish improvement/construction standards to meet the water quality objectives within specific watersheds.

Subdivision regulations deal with development on a case-by-case basis and may be used to regulate design and improvements through improvement/construction standards. Zoning ordinances influence development by managing the types of land use activities (single family residential, commercial, etc.) allowed within specific watersheds. Establishing open space areas for future sedimentation basins, land conversation, and management of high density areas in sensitive areas can be made. The tentative map process allows for a final environmental analysis for consistency with the water quality objectives established in the general plan and zoning ordinance. Specific discharge facilities, reductions in directly connected impervious areas (DCIAs) and treatment controls are considered during this process. The improvement plan review process is the mechanism where municipal agency would implement and monitor compliance with any required conditions of approval established during the planning process.

Water Quality Impacts

One objective of land use planning/management is to mitigate negative water quality impacts in developing areas by managing the types of land uses. Management of land use provides the greatest certainty of water quality protection with the least maintenance requirements. Effective practices can be used to control pollutants associated with impervious covers. Where such practices are not feasible, impervious cover limitations may be an effective tool. For example, impervious cover limitations is one of the more effective land use management tools, since nationwide research has consistently documented increases in pollutant loads with increases in impervious cover (see SC74, Roadway/Bridge Maintenance). The establishment of environmental reserves or buffers can also be very effective in protecting wetlands and riparian corridors (see SC76, Storm Channel/Creek Maintenance). Preserving existing vegetation (see ESC2, Construction Handbook) is another important concept in the effort to reduce negative water quality impacts.

Other land use management concepts include cluster zoning directing development and watershed planning. Cluster zoning concentrates development and construction to a limited portion of a site leaving the remaining portion undisturbed. Directing development to specific areas of a developing community can be an important investment in water quality protection. Directing heavy development away from environmentally sensitive areas can greatly reduce the detrimental impacts of nonpoint source pollution. Watershed planning identifies existing or potential water quality problems and specifies measures to prevent or mitigate water quality degradation.

Land Use Planning Methodology

The purpose of a comprehensive plan is to guide decisions regarding storm water quality for existing and future uses of land within the locality. Developing a land use plan for water quality management need not be a complex process. A basic schematic model involves:

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Additional Information — Land Use Planning/Management

- Phase 1 - Goals: Determination of clear-cut water quality goals by the municipality working with local public and private sector participants (advisory groups, planning commissions, etc.). Goals should act as a target (e.g. "no further degradation of local waters" or "minimize impact from total suspended solids", etc.) and as a mission statement for the community. Public participation and awareness should come from "watershed awareness" and "watershed identification". The commitment to the health of the watershed and improved water quality should be the first goal of any public education effort involving community participation in land use planning and management. Public involvement in setting these goals is critical to gaining public acceptance of the recommendations that follow in the process. Consideration of other municipal goals (e.g., affordable housing) should also be included.

- Phase 2 - Study: Gathering of pertinent data and the writing of a description of the planning area (municipality, county, watershed, etc.) and its associated problems to develop an understanding of the various water quality needs. If the planning area is not the watershed, describe the planning area's relation to the overall watershed.

- Phase 3 - Analysis and Synthesis: Working with local groups, the municipality determines and prioritizes the water quality needs as they relate to the watershed or planning area and forms the basis for his recommendations for the locality.

- Phase 4 - Recommendations: Future courses of action are developed to address the identified problems and needs determined previously.
  - Frequently new zoning ordinances and/or conditions of approval are required to manage land use.
  - Regulations can be adopted to plan the amount of impervious area after project or development completion.

- Phase 5 - Adoption: The recommendations are presented to a political body for acceptance and implementation.

- Phase 6 - Implementation: Recommendations adopted by the political body are implemented by the locality.
  - Managing the land use requires a mechanism to assess project and other development plans at various stages to insure compatibility with land use goals.
  - Environmental impact assessment procedures at the federal or state/local level can be used in conjunction with site plan review as a means to assess the impact to storm water runoff from projects.

Costs

Costs of construction and long-term maintenance and operations will vary depending on the water quality objectives and the BMPs incorporated into the comprehensive planning process. The costs to develop or modify a comprehensive plan to fully incorporate water quality objectives will be smaller compared to the potential construction and O & M costs. In fact, land use planning can be one of the most cost-effective means of storm water quality management as it provides a means of managing activities within a watershed consistent with water quality objectives.

Regulatory Issues

A broad array of regulatory issues are involved with land use planning and management at all governmental levels. Several federal policies and programs influence land use, some of which are: the National Environmental Policy Act (NEPA), the Clean Water Act (CWA), the Coastal Zone Management Act (CZMA), the Clean Air Act (CAA), and the State General Plan process and Subdivision Map Act.

NEPA influences land use by requiring environmental impact statements for federal actions on growth-shaping projects such as subsidies for highways, treatment facilities, power plants, etc. How a project will impact land use over time must be addressed in the NEPA process. The CWA affects decisions regarding the location of industrial facilities through the National Pollution Discharge Elimination System (NPDES) permit program. Industrial wastewaters (along with storm

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water runoff from most industrial facilities) must be permitted and treated in many instances to minimize impact on a watershed.

The CZMA was passed by Congress to assist states in developing institutions, plans, and procedures to manage land use in coastal areas. There are no sanctions against States that fail to prepare adequate coastal plans. The principal incentive for State action is the availability of federal grants under the act. Amendments to the CZMA in 1990 provide it much greater specificity regarding best management practices for storm water runoff. The amendments require the State to have a complete review of all its nonpoint source pollution programs, including urban storm water control. The amendments also require that the State demonstrate that enforceable mechanisms and policies are in place to control urban runoff, including those areas not part of a NPDES program.

The CAA can also have substantial impact on land use. Its pre-construction review requirements for major stationary sources of air-borne residuals can influence where industries locate.

The State has two major regulatory procedures: (1) the California Environmental Quality Act (CEQA) and (2) the Subdivision Map Act (Map Act). CEQA requires local municipal agencies to prepare environmental documentation or prepare statement of negative declaration regarding the significant environmental effects of a proposed project. While storm water pollution effects are not specifically required in the analysis, impacts on water, including diversions and runoff, are required to be addressed by CEQA and its guidelines (see Guidelines Appendix H and the environmental checklist form). The Map Act grants local governments the authority to implement policies related to environmental issues. These policies must be written with findings of fact supported by substantial evidence and must be consistent with the local agency's general plan. The Act also requires that the legislative body of a city or county deny approval of a tentative subdivision map if it makes the finding, among others, that "the design of the subdivision or the proposed improvements are likely to cause substantial environmental damage or substantially and avoidably injure fish or wildlife or their habitat".

At the local level, each agency is required to prepare a long-term, comprehensive general plan (General Plan). The General Plan is required to address seven elements; three of which often address water quality issues. These elements are the open space, conservation and land use elements. The conservation element may specifically cover "the prevention and control of the pollution of streams and other waters." The land use element is the principal portion of the General Plan that can affect water quality because it establishes the types, intensity, and density of development. Land use planning, zoning ordinances and subdivision regulations are the implementation tools of the General Plan. In addition, the General Plan can be a powerful tool for protecting water quality. The establishment of requirements for a erosion control ordinance, revegetation, and the other construction activity BMPs (see Construction Handbook) can have their basis in the General Plan/zoning process. Specific plans, where required, should provide as much specific detail as possible regarding land use management decisions and water quality issues.

Public Education /Participation

Establishing a comprehensive land use management plan requires a broad base of public support. The land use policies developed as a part of the planning process are frequently sensitive issues as they restrict the activities of land owners. As such, extensive public information programs are usually a necessity to educate the public regarding the positive environmental impacts of land use management. Citizens should be represented throughout the planning process and this can be accomplished through a citizens advisory group.

Limitations

Land use planning/management frequently addresses sensitive public issues and will generally develop policies that will not be universally accepted within the locality. As such, implementation of the necessary restrictions on certain land uses required to mitigate storm water pollution may not be politically feasible.

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Additional Information — Land Use Planning/Management

The various aspects of land use planning/management are designed to control development in specific ways. General Plans are designed to control the pace of development while zoning can restrict the types of permissible development. Poor planning often leads to "leap-frog" development whereby vacant land near a city's center is bypassed for less expensive land on the outskirts. Another limitation of the zoning ordinances is that development interests can obtain a "variance" which allows exemptions to the zoning ordinance, however variance can also be legitimately used to minimize or delete expensive improvements where it can clearly demonstrate that they are not necessary.

Examples of Effective Programs

Because of a strong desire to protect the pristine Edwards aquifer from degradation, the City of Austin, Texas, has chosen to manage the impact of new development in two fundamental ways: through treatment control requirements and impervious area minimization requirements. Austin, through its Comprehensive Watersheds Ordinance, requires that impervious cover on residential development in certain areas of the city be limited. Sedimentation and filtration ponds which will capture and treat the first one-half inch of runoff from a site are required for developments of higher intensity such as commercial developments.

In California, Orange County has used its planning process to establish conditions of approval that require water quality management plan to identify specific BMPs to control pollutants in runoff.

REFERENCES

City of Austin, "Environmental Criteria Manual: Land Development Code", City of Austin, Texas, 1989.

Florida Department of Environmental Regulation, "Florida Development Manual: A Guide to Sound Land and Water Management", Florida Department of Environmental Regulation, 1988.

Lazaro, Timothy R., "Urban Hydrology: A Multidisciplinary Perspective", Technomic Publishing, 1990.

Office of Planning and Research, "Planning, Zoning, and Development Laws," State of California Governor's Office, Office of Planning and Research, 1990.

Office of Planning and Research, "The California Environmental Quality Act", State of California- Governor's Office, Office of Permit Assistance, 1986.

Ortolano, Leonard, "Environmental Planning and Decision Making", Wiley & Sons, 1984.

State of California "1992 Subdivision Map Act", Consulting Engineers and Land Surveyors of California, 1992.

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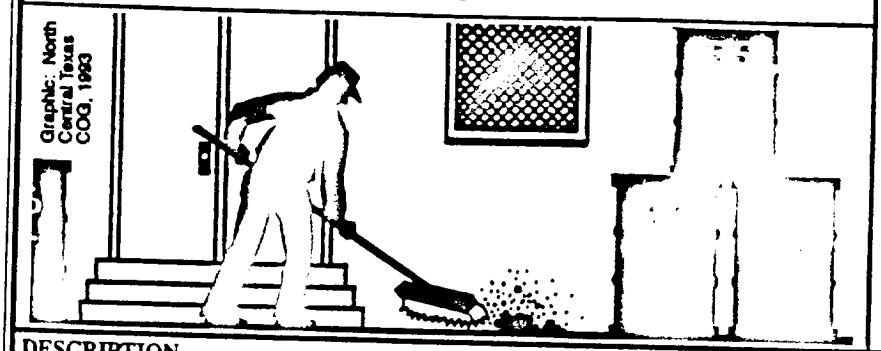
BMP: HOUSEKEEPING PRACTICES



Program Elements

- New Development
- (Residential)
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

Promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling potentially harmful materials such as fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals. Related information is provided in BMPs SC11, Safer Alternative Products; SC31, Household Hazardous Waste Collection; SC32, Used Oil Recycling; and the Spill Prevention and Cleanup BMPs (SC40/SC41). For information on specific activities at municipal facilities, see Chapter 4, Industrial Handbook.

APPROACH

- Pattern a new program after the many established programs from municipalities around the state and country. Integrate this best management practice as much as possible with existing programs at your municipality.
- This BMP has two key audiences, municipal employees and the general public.
- Implement this BMP in conjunction with SC11, Safer Alternative Products.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - The primary cost is for staff time as noted below.
- Regulations
  - There are no regulatory requirements to this BMP. Existing regulations already require municipalities to properly store, use, and dispose of hazardous materials.
- Administrative / Staffing
  - Staff to train municipal employees and to coordinate public education efforts.
- Equipment
  - There are no major equipment requirements to this BMP.
- Training
  - Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices. Personnel who use pesticides must be trained in their use. The California Department of Pesticide Regulation license pesticide dealers, certify pesticide applicators and conduct on-site inspections.

PUBLIC EDUCATION / PARTICIPATION

- Public awareness is a key to this BMP.

LIMITATIONS

- There are no major limitations to this best management practice.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ○ Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Housekeeping Practices

Municipal facilities should follow the best management practices outlined in Chapter 4 of the Industrial Handbook, most of which include good housekeeping measures. Municipalities should develop controls on the application of pesticides, herbicides, and fertilizers in public right-of-ways and at municipal facilities. Controls may include:

- List of approved pesticides and selected uses;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping and public notice procedures.

For the general public, municipalities should establish a public education program that provides information on such items as storm water pollution and the beneficial effects of proper disposal on water quality; reading product labels; safer alternative products; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The programs listed below have provided this information through brochures or booklets that are available at a variety of places including municipal offices, household hazardous waste collection events or facilities, and public information fairs.

The following discussion provides some general information on good housekeeping that may be provided to the general public. More specific information on particular chemicals may be found in the references listed below.

- Always use caution when handling any hazardous household product. Many products contain toxic chemicals that can cause severe injury or death.
- Store household hazardous products securely and away from children, pets, and sources of heat, sparks, and flames.
- Store products in their original containers and keep them well labeled. Do not store chemicals in food containers.
- Read and follow use instructions.
- Avoid contact with eyes and skin. Wear gloves and eye protection when using hazardous substances. Do not wear contact lenses which can absorb hazardous vapors.
- Work in only well ventilated areas.
- Use up all of the product before disposing or give extra to friends, neighbors or community groups.
- Do not dispose of household hazardous waste:
  - in trash,
  - down storm drains or into creeks,
  - down sink or toilet,
  - onto the ground, or
  - by burning.
- Do dispose of hazardous wastes at household hazardous waste collection events or facilities.

The California Integrated Waste Management Board's Recycling Hotline, 1-800-553-2962, provides information on household hazardous waste collection programs and facilities.

Examples of Effective Programs

There are a number of communities with effective programs. The most pro-active include Santa Clara County and the City of Palo Alto, the City and County of San Francisco, and the Municipality of Metropolitan Seattle (Metro).

REFERENCES

The Bay Begins at Your Door (Brochure), Santa Clara Valley Nonpoint Source Pollution Control Program, (No date).

Guide to Hazardous Products Around the Home (Booklet), Household Hazardous Waste Project, 1989.

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Additional Information — Housekeeping Practices

Hazardous Household Products: A Guide to the Disposal of Hazardous Household Products and the Use of Non-Hazardous Alternatives, California Department of Toxic Substance Control.

Household Cleaners and Polishes, Chemical Hazards in the Home (Brochure), Golden Empire Health Planning Center, (No date).

Solvents, Chemical Hazards in the Home (Brochure), Golden Empire Health Planning Center, (No date).

Take Me Shopping: A Consumer Guide to Safe Alternatives for Household Hazardous Products (Booklet), Santa Clara County and City of Palo Alto, 1992.

Your Guide to Less Toxic Shopping: Safer Alternatives for Your Home and Life! (Booklet), San Francisco Household Hazardous Waste Program, 1992.

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BMP: SAFER ALTERNATIVE PRODUCTS

Graphic: San Francisco Household Haz Waste Program, 1992

Program Elements

- New Development
- (Residential)
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

Promote the use of less harmful products. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products.

Related information is provided in SC10, Housekeeping Practices; SC31, Household Hazardous Waste Collection; SC32, Used Oil Recycling; and the Spill Prevention and Cleanup BMPs (SC40/SC41). For information on specific activities at municipal facilities, see Chapter 4, Industrial Handbook.

APPROACH

- Pattern a new program after the many established programs from municipalities around the state and country. Integrate this best management practice as much as possible with existing programs at your municipality.
- This BMP has two key audiences, municipal employees and the general public.
- Implement this BMP in conjunction with SC10, Housekeeping Practices.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - The primary cost is for staff time as noted below.
- Regulations
  - This BMP has no regulatory requirements. Existing regulations already require municipalities to reduce the use of hazardous materials. Safer alternatives for use by the general public are presented through education rather than required by regulation.
- Administrative / Staffing
  - Staff to educate municipal employees and to coordinate public education efforts.
- Equipment
  - There are no major equipment requirements to this BMP.
- Training
  - Municipal employees who handle potentially harmful materials should be trained in the use of safer alternatives.
  - Purchasing departments should be encouraged to procure less hazardous materials.

PUBLIC EDUCATION / PARTICIPATION

- Awareness is the key to this BMP. It promotes a willingness to try alternatives and to modify old behaviors.

LIMITATIONS

- Alternative products may not be available, suitable, or effective in every case.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ○ Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Safer Alternative Products

Employees at municipal facilities and the general public can both be educated about safer alternatives by using information developed by a number of municipalities and organizations including the programs listed below.

The following discussion provides some general information on safer alternatives. More specific information on particular hazardous materials and the available alternatives may be found in the references listed below.

- Automotive products - Less toxic alternatives are not available for many automotive products, especially engine fluids. But there are alternatives to car polishes, degreasers, windshield washer solution. Re-refined, recycled oil is also becoming available.
- Cleaners - Vegetable-based or citrus-based soaps are available to replace petroleum-based soaps/detergents.
- Paint products - Water-based paints, wood preservatives, stains, and finishes are available.
- Pesticides - Specific alternative products or methods exist to control most insects, fungi, and weeds.
- Fertilizers - Compost and soil amendments are natural alternatives.

Examples of Effective Programs

There are a number of communities with effective programs. The most pro-active include Santa Clara County and the City of Palo Alto, the City and County of San Francisco, and the Municipality of Metropolitan Seattle (Metro). The Bio-Integral Resource Center (BIRC) in Berkeley conducts research, and produces brochures and a newsletter on Integrated Pest Management (IPM).

REFERENCES

Note: Many of these references provide alternative products for materials that typically are used inside and disposed to the sanitary sewer as well as alternatives to products that usually end up in the storm drain.

Guide to Hazardous Products Around the Home (Booklet), Household Hazardous Waste Project, 1989.

Hazardous Household Products: A Guide to the Disposal of Hazardous Household Products and the Use of Non-Hazardous Alternatives, California Department of Toxic Substance Control (no date).

Heal the Bay, Safer Alternatives to Household Hazardous Waste, (no date).

Household Cleaners and Polishes, Chemical Hazards in the Home (Brochure), Golden Empire Health Planning Center, (No date).

Solvents, Chemical Hazards in the Home (Brochure), Golden Empire Health Planning Center, (No date).

The Bay Begins at Your Door (Brochure), Santa Clara Valley Nonpoint Source Pollution Control Program, (No date).

Take Me Shopping: A Consumer Guide to Safe Alternatives for Household Hazardous Products (Booklet), Santa Clara County and City of Palo Alto, (No date).

Your Guide to Less Toxic Shopping: Safer Alternatives for Your Home and Life! (Booklet), San Francisco Household Hazardous Waste Program, 1992.

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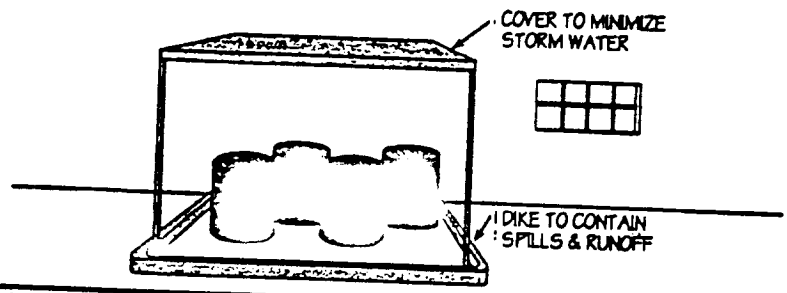
BMP: MATERIAL STORAGE CONTROL



Graphic: EPA, 1992

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice primarily covers material delivery and storage for municipal operations. For material storage related to the general public (e.g., storage of pesticides) refer to SC10 Housekeeping Practices. For other information on municipality handling of materials, see Spill Prevention and Cleanup BMPs (SC40/SC41) and Material Disposal and Recycling BMPs (SC30-SC32). The Industrial Handbook also contains material management information for industrial activities at municipal facilities.

APPROACH

- The key is to design and maintain material storage areas that reduce exposure to storm water:
  - Store materials inside or under cover on paved surfaces.
  - Use secondary containment.
  - Minimize storage and handling of hazardous materials.
  - Inspect storage areas regularly.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Will vary depending on the size of the facility and the necessary controls.
- Regulations
  - Storage of reactive, ignitible, or flammable liquids must comply with the Uniform Fire Code and the National Electric Code.
- Administrative / Staffing
  - Accurate and up-to-date inventories should be kept of all stored materials.
- Equipment
  - Keep an ample supply of spill cleanup materials near the storage area.
- Training
  - Employees should be well trained in proper material storage.

PUBLIC EDUCATION / PARTICIPATION

- Employee education is paramount for successful BMP implementation.

LIMITATIONS

- Storage sheds often must meet building and fire code requirements.

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ○ Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ● Training
- ◒ Administrative

● High ○ Low

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Additional Information — Material Storage Control

The following materials are commonly stored at municipal facilities:

- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials can pose the following risks:

- Injury to workers or visitors,
- Groundwater contamination,
- Soil contamination, and
- Storm water contamination.

Therefore, the following steps should be taken to minimize your risk:

- Employees trained in emergency spill cleanup procedures should be present when dangerous waste, liquid chemicals, or other wastes are delivered.
- Store materials inside or under cover whenever possible.
- Designate a secure material storage area that is paved with Portland cement concrete, free of cracks and gaps, and impervious in order to contain leaks and spills.
- Drums stored in an area where unauthorized persons may gain access must be secured to prevent accidental spillage, pilferage, or any unauthorized use.
- Whenever possible, store materials in secondary containment.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Storage of reactive, ignitible, or flammable liquids must comply with the local codes. Contact the Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- When designing a storage area, include measures to prevent and contain spills (see BMPs SP1/SP2).
- Keep an accurate, up-to-date inventory of the materials delivered and stored on-site.
- Keep your inventory down. Store only the amount you need, for only as long as you need it.
- Store as few hazardous materials on-site as possible.
- Handle hazardous materials as infrequently as possible.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees in proper storage measures.
- Keep the designated storage area clean and well organized.
- Conduct routine weekly inspections and check for external corrosion of material containers.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices, USEPA, July 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

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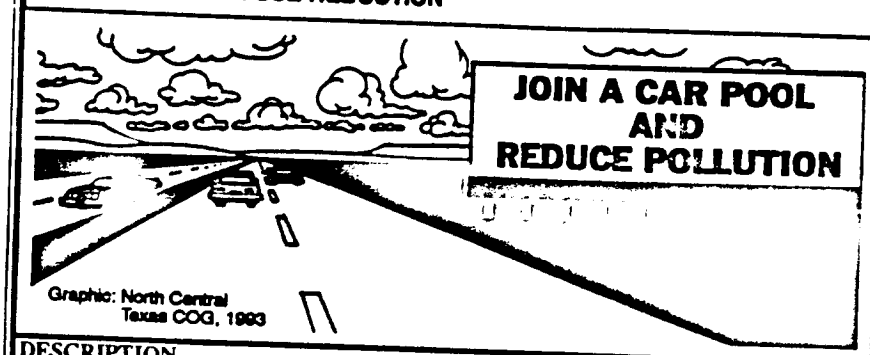
BMP: VEHICLE USE REDUCTION



Graphic: North Central Texas COG, 1993

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Reduce the discharge of pollutants to storm water from vehicle use by highlighting the storm water impacts, promoting the benefits to storm water of alternative transportation, and integrating initiatives with existing or emerging regulations and programs.

APPROACH

- Integrate this best management practice as much as possible with efforts being developed and implemented by government agencies and businesses to reduce vehicle use and improve air quality (e.g. County Congestion Management Agency). Integration will help avoid redundant and/or conflicting programs and be more effective and efficient.
- Establish trip reduction programs at major employers (government, large businesses).

REQUIREMENTS

- Cost Considerations
  - The primary cost is for staff time as noted below.
- Regulations
  - Support efforts to pass reasonable regulations at the State and local level (General Plans, land use plans, and zoning ordinances) aimed at reducing vehicle use and developing transit-oriented communities.
  - Support development of regional governing bodies to address the issue in a comprehensive way (multi-media, watershed-based approach).
- Administrative / Staffing
  - Requires at least one staff person to track, review, and comment on emerging legislation and programs.
- Equipment
  - There are no major equipment requirements for this BMP.
- Training
  - There are no training requirements for this BMP.

PUBLIC EDUCATION / PARTICIPATION

- Make the association in the public's mind that air pollution = water pollution.
- Educate the public and municipal employees about the water quality benefits of reduced vehicle use.
- Help coordinate public participation in ride sharing programs.

LIMITATIONS

- "Turf battles" may limit the level of cooperation and integration between departments and programs.
- The use of alternative transportation is highly dependent on its convenience and relative cost.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ◒ Regulatory
- ◒ Staffing
- ◒ Training
- ◒ Administrative

● High ○ Low

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Additional Information — Vehicle Use Reduction

Vehicle use is a major source of pollutants to surface waters via storm water runoff. Vehicles emit heavy metals, oil and grease and polynuclear aromatic hydrocarbons (PAHs) through exhaust, leaks, spills, corrosion, and wear and tear of parts. These pollutants are deposited on roadways and carried into receiving waters by runoff. In addition, vehicle use requires the creation of large impervious surface areas (highways, driveways, streets, parking lots) which create storm water quantity problems.

Implementation of the following measures to reduce vehicle use will have direct benefits to both storm water quality and quantity.

Reducing vehicle use begins with land use planning. The adoption and revision of General Plans should address this issue by promoting the establishment of transit-based communities or areas of existing communities. Frequently used public services (post offices, government offices, etc.) and private businesses (banks, restaurants, retail stores, etc.) should be located in "service hubs" near transportation corridors. Multiple, small service hubs should be established as opposed to fewer, large hubs to reduce travel time and thus promote alternative transportation. Municipalities that have prepared transportation plans under the Clean Air Act should review the plan, and amend it as necessary, to address storm water quality management.

Municipalities and large businesses with significant numbers of employees working in the same location should be encouraged to establish trip reduction programs. These programs encourage alternative transportation such as carpooling, buses, trains, bicycles, walking, etc. through incentives including monetary compensation, increased parking fees, and subsidized public transit passes. Telecommuting and compressed work schedules are also being used to reduce traffic-induced pollution.

Municipal staff responsible for storm water quality should have access to and meet with other municipal departments such as planning, transportation, and environmental health to promote integration of storm water issues into transportation planning and new programs. Coordination with County Congestion Management Agency (CMA) can provide a comprehensive effort to educate public regarding vehicle use, air quality and storm water quality.

Public education should highlight the benefits to storm water in public outreach pieces and campaigns such as "Leave Your Car at Home" and "Beat the Backup." The benefits to water quality of reduced vehicle usage are second only to the benefits to air quality. However, these benefits are often overlooked and must be continually reinforced.

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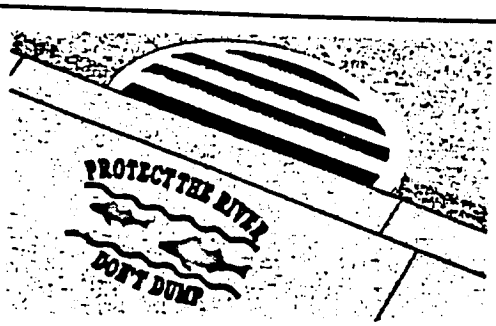
BMP: STORM DRAIN SYSTEM SIGNS



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Stenciling of the storm drain system (inlets, catch basins, channels, and creeks) with prohibitive language/graphic icons discourages the illegal dumping of unwanted materials.

APPROACH

- Create a volunteer work force to stencil storm drain inlets, and use municipal staff to erect signs near drainage channels and creeks.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Volunteer work force serves to lower program cost.
  - Stenciling kits require procurement of durable/disposable items.
  - Need for storage/maintenance of stenciling kits requires planning.
  - Program can aid in the cataloging of the storm drain system.
- Regulations
  - Develop and enforce an ordinance that requires inlets, catch basins, channels, and creeks to be fitted with anti-dumping, pollution prevention signs.
- Administrative/Staffing
  - Primary staff demand is for program setup to provide marketing and training.
  - Ongoing/follow-up staff time is minimal because of volunteer services.
  - Minimum 2 persons are required for high traffic areas, commercial and industrial zones.
  - Staff requirement at program headquarters for emergencies, questions, etc.
- Equipment
  - Storm drain stenciling kits.
- Training
  - Training sessions of approximately 10-15 minutes will cover stenciling procedures, including how to stencil, record keeping, problem drain notation, etc.
  - Proper health and safety protocol (buddy system, traffic, health concerns, etc.).

PUBLIC EDUCATION/PARTICIPATION

- Promote volunteer services (individual and business) through radio/television and mail-out campaigns.
- Public reporting of improper waste disposal by a HOTLINE number stenciled onto the storm drain inlet.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ○ Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ◒ Training
- ○ Administrative

● High ○ Low

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BMP: STORM DRAIN SYSTEM SIGNS (Continue)

LIMITATIONS

- Private property access limits stenciling to publicly-owned areas.
- Program is highly dependent on volunteer response.
- Storm drain inlets that are physically blocked will be missed or require follow-up.
- High traffic/commercial/industrial zones will be responsibility of city staff.
- Ongoing maintenance to maintain readable signs.

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Additional Information — Storm Drain System Signs

Storm drain system signs act as highly visible source controls that are typically stenciled directly adjacent to storm drain inlets. The signs contain brief statements that discourage the dumping of improper materials into the storm drain system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message. The intent of such a storm drain system stenciling program is to enhance public awareness of the pollutant effect on local receiving waters from storm water runoff and also to discourage individual's habitual waste disposal actions (e.g. automotive fluids and landscaping wastes).

Approach

An effectively implemented stenciling program encourages change in personal behavior and helps minimize non-point source pollutants from entering the storm drain system. An additional benefit is that waste and catch basin maintenance is minimized through the reduction of disposed materials into storm drain inlets. Finally, some stenciling programs include posting of community hotline numbers for effective reporting and monitoring of improper disposal practices, plus the encouragement of use of household hazardous waste collection and used oil recycling programs.

An important aspect of a stenciling program is the distribution of informational flyers that educate the neighborhood (business or residential) about storm water pollution, the storm drain system, and the watershed, and that provides information on alternatives such as recycling, household hazardous waste disposal, and safer products.

Storm drain inlet stenciling programs are generally handled through community volunteer efforts. Municipal staff must first organize, market, and provide training for program initialization. However, through an aggressive public education program, the majority of the labor should be generated through volunteer services. Successful programs have involved substantial input from business, civic, school, neighborhood, and environmental organizations. Encourage schools, churches, girl/boy scout troops, and environmental groups to add storm drain stenciling as a lesson/field trip to existing activities. This provides a ready-made labor force to use the stenciling materials developed by the municipality.

The stenciling project can be part of a larger volunteer "watershed awareness" public education program. Stenciling should be the easiest volunteer activity, or the first step in "watershed awareness" education, ultimately leading to an all volunteer water quality monitoring program. Municipal staff must initially provide an inventory of curb inlets and develop the stencil. The stenciled language is most effective if it represents a consistent message adopted from the city's public education department. Communities in California have used messages such as: "No Dumping, Flows to Bay", "Protect the Bay, Don't Dump", and "Dump No Waste, Flows to Bay." Program logos and generalized drawings of a fish or a bird may be added to provide a visual aid as well. Once the storm inlet language is determined, stencil painting kits must be ordered and training programs/instruction sheets may be developed.

The storm drain stenciling kits include stencil, paint, paint brush, plastic gloves, catch basin map, clipboard, instructions, liability release form, identification form, rags, whisk broom or brush, paper towels, trash bags, safety vests, and a 5-gallon bucket to hold materials.

Readability of stencils is critical to their effectiveness. Wherever possible stencils should be painted on a smooth surface such as cement, as opposed to asphalt. As with any painting, surface preparation is key to paint adhesion and thus readability and durability. Extra effort expended to clean the surface during the initial painting helps reduce the need for re-painting. Some programs have gone so far as to paint a background color first followed by the stencil in a contrasting color to increase readability.

Many communities use water-based latex exterior paint from their traffic control departments. Brands include: Fuller O'Brien, Arvoe Stripping Paint, Sherman-Williams Metalex, and All-Kids Traffic Paint. Spray paints should have a VOC rating of less than 250 (required by EPA). If there is concern over spray paints, a refillable paint brush called

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"Quick-Painter" may be used. It is easier to handle (children can use it), it is more legible than spray paint, and it also avoids the environmental problem of having to properly dispose of spray cans.

Because a stenciling program involves primarily volunteer services, liability release forms and volunteer identification notices should also be administered. Training sessions should be restricted to residential or low traffic areas for safety purposes. Municipal staff should be responsible for stenciling efforts in most commercial and industrial land use sectors. Regardless of the manpower, an attempt should be made to accurately log all curb inlets that have been stenciled, which will also aid the municipality's efforts to catalog the storm sewer system. Tracking of stenciled inlets and the overall cost of the program is necessary to monitor the success of the program. Municipal staff may be accessible during non-work hours to handle questions, provide instruction, and respond to emergency situations. Program generated waste materials should be centrally collected by municipal staff to ensure proper waste disposal.

Costs

One municipality from the State of Washington has estimated that stenciling kits cost approximately $50 each. Stencils may cost about $8 each including the die cost on an order of 1,000. Re-orders cost about $1/stencil. Stencil designs may be available from other communities. Stencil kits should be provided on a loan basis to volunteer groups free of charge with the understanding that kit remnants are to be returned.

Channel/Creek Signs

Channel and creek signs are another way of providing a pollution prevention message near the point of discharge. These signs can use the same language as the stencil, but are affixed to a metal or wood placard and mounted to a post. Sign installation requires a level of expertise and equipment that most volunteers do not possess, so public works staff time is an additional implementation cost.

New Development

For the private areas of a new development, the municipality may consider requiring developers to purchase and paint stencils near new inlets or catch basins, and to install channel/creek signs with a pollution prevention message. As an alternative, the developer could reimburse the municipality's costs to perform the work. In addition, the municipality can develop and enforce an ordinance that requires inlets, catch basins, channels, and creeks in new developments, both public and private, to be fitted with signs with a pollution prevention message.

Examples of Effective Programs

The City of Palo Alto has a combined volunteer/contractor program which greatly facilitates storm drain stenciling. The City retained the Conservation Corps to paint approximately 75% (2,000) of it's storm drains, leaving the 25% (700) of its drains in more residential areas to be done by volunteers. This strategy speeds up the stenciling, reduces the City's liability, supports a worthwhile program, and still allows plenty of storm drains for volunteers to paint.

The Association of Bay Area Governments (ABAG) sponsored a nine-county stenciling effort on Earth Day 1992. ABAG has up-to-date information on stencil and program development.

The stencil for the City of Huntington Beach includes the municipal code section number for illegal dumping to facilitate incident reporting and enforcement. In Santa Monica, the city provides a packet of material regarding storm water pollution including a catch basin stencil kit.

REFERENCES

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Additional Information — Storm Drain System Signs

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Regional Water Quality Control Plants' News, City of Palo Alto, California, 1991.

Storm Water Program Guidance Manual for the Puget Sound Basin, (Draft), City of Seattle, Washington, Drainage and Wastewater Utility, 1992.

Urban Runoff: A Pollution Abatement Program, Heal the Bay, Santa Monica, California, 1992.

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R0034060

BMP: HOUSEHOLD HAZARDOUS WASTE COLLECTION

COLLECTION CENTER

Graphic: North Central Texas COG, 1993

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Household hazardous wastes (HHW) are defined as waste materials which are typically found in homes or similar sources, which exhibit characteristics such as: corrosivity, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by the EPA.

APPROACH

- Collection Method Options
  - Permanent collection centers.
  - Periodic collection centers.
  - Mobile collection centers.
  - Curbside collection.
  - Combination of above systems.
- Frequency
  - Depends on collection program implemented (e.g., monthly, quarterly, etc.).
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Both collection and disposal can be very expensive.
  - Trained operators required.
  - Laboratory and detection equipment necessary.
  - Extensive record keeping required including dates, types, and quantities.
  - Many communities have deferred HHW programs due to high cost.
  - Ultimate cost depends on type of program chosen and available disposal costs.
- Regulations
  - Federal Regulations (RCRA, SARA, CERCLA) and State regulations regarding the disposal of hazardous waste.
  - Local ordinances to discourage improper disposal.
  - Municipalities required to have a HHW element within their integrated waste management plan.
- Administrative/Staffing
  - Minimum is 6 persons.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ◒ Training
- ◒ Administrative

● High ○ Low

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BMP: HOUSEHOLD HAZARDOUS WASTE COLLECTION (Continue)

PUBLIC EDUCATION/PARTICIPATION

- Educate public about hazardous materials in the home and consequences of improper use and/or disposal.
- Identify and promote use of non-hazardous alternatives.
- Identify proper storage and disposal methods.
- Promote HHW reuse and recycling.
- Promote participation in local HHW collection programs.
- Posters, handouts, and educational efforts aimed at local schools.
- Public service announcements (PSAs) on local television, radio, and newspapers.
- Utility bill inserts.
- Video or slide presentations at community organizations.
- Speakers bureau made up of local environmental professionals and recycling experts.
- Emergencies related to HHW should be reported to 911.

LIMITATIONS

- Limited to areas with convenient access to hazardous waste disposal facilities due to cost associated with transport.
- Cost.
- Significant liability issues involved with the collection, handling, and disposal of HHW.

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Additional Information — Household Hazardous Waste Collection

While it is generally recognized that the potential exists for hazardous household materials to come in contact with storm water runoff, it is unclear at present how significant this source of contamination is. As such, it is difficult to quantify the benefits to water quality from a household hazardous waste collection program. However, HHW collection is a preventative, rather than curative measure, and may reduce the need for more elaborate treatment controls.

Various studies have been undertaken to categorize the quantity and quality of HHW in the municipal solid waste stream. These studies indicate that 0.5% to 2.0% of the total municipal solid waste stream is household hazardous waste, the number typically used is 1.0% of the total municipal solid waste stream.

Targeted Constituents

Although there is potentially a very large list of materials which could qualify as HHW, the following is a listing of the most common HHW products:

- Drain openers
- Oven cleaners
- Wood and metal cleaners and polishes
- Automotive oil and fuel additives
- Grease and rust solvents
- Carburetor and fuel injection cleaners
- Starter fluids
- Batteries
- Paint thinners
- Paint strippers and removers
- Adhesives
- Herbicides
- Pesticides
- Fungicides/wood preservatives

Improperly disposed HHW can and does affect both surface water and ground water quality. Leakage of, spillage from, and improperly disposed hazardous materials can enter storm sewer systems and degrade water quality of receiving streams. As such, HHW collection would be expected to reduce the presence of toxic materials and heavy metals in storm water runoff.

Although the percentage of these materials in the solid waste stream is small, the large volume of solid waste generated daily indicates that a substantial amount of HHW is generated. The benefits to storm water quality from HHW collection is unknown at present, but best engineering judgement indicates a potential of up to 15 percent.

Pressures are mounting from a variety of sources for communities to implement HHW collection and disposal programs. Solid waste regulators, water quality regulators and environmental groups are pushing to restrict and control this type of waste. The ultimate goal of all concerned is a safer environment. Education, waste minimization, separate collection, and safe disposal are all parts of the solution. Education, however, is the foundation to a truly successful HHW program.

Approach

HHW programs are similar to recycling programs in that there are a number of alternatives available for material collection. In fact, HHW programs typically employ a variety of collection methods. Permanent or periodic collection centers are the most common but mobile collection centers and even curbside collection are used. Naturally, there are advantages and disadvantages with each program.

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Additional Information — Household Hazardous Waste Collection

Permanent Collection Centers

Permanent collection centers serve as drop-offs for HHW and are operated on scheduled days and times throughout the year. These facilities typically consist of a receiving area, collection area, and a packaging area. The receiving area is where participants are greeted, asked to complete paper work such as a program evaluation or a form stating what materials were brought to the site. The receiving area is also where materials are checked to make sure excluded or unidentified wastes are not collected. The collection area is restricted from the public and is where materials collect before they are sorted and packaged for transport to a Treatment/Storage/Disposal (TSD) facility. The packaging area is generally adjacent to or part of the collection area and is also restricted from the public. This area is where the waste is packaged in drums, manifested, and placed on a truck for transport. There should also be a dumpster for refuse and a separate area for storing materials which are to be recycled. Personnel required for permanent collection centers include a full-time administrator; volunteers or city staff to greet participants, direct traffic, and distribute program surveys; at least one specially trained hazardous waste professional to classify hazardous waste and to perform tests to determine the characteristics of hazardous waste; and trained personnel to sort and package the materials. The major advantage of a permanent location is that residents learn of its frequency of operation and its location. The major disadvantage is the time and cost required to site and permit the facility.

Periodic collection centers also serve as drop-offs for HHW and a very similar to permanent collection centers. The difference between the two programs is that periodic programs do not have permanent structures, are operated on various days and times during the year, are located at various locations within a community, and do not require a permit. Personnel required is very similar to that required for a permanent collection center; however, materials must be removed from the area within a relatively short time period after collection which typically requires the staff from a TSD facility. The major disadvantage of periodic programs are the inconsistent days and hours of operation and the large number of personnel required.

Mobile Collection Centers

Mobile collection centers allow more flexibility of location and times of operation. A mobile collection center consists of a trailer equipped to properly receive and package HHW. Mobile collection centers are typically operated on a fixed scheduled, such as on weekends, but rotate to various locations throughout a community or county. Although trained professionals are necessary to accept, process, and package the HHW, volunteers are often used to help route traffic, distribute surveys and other general assistance. One advantage of mobile collection centers is there ability to reach large numbers of people and cover large geographic areas. One disadvantage is that the waste must be managed immediately.

Curbside Collection

Curbside collection programs operate in a manner similar to regular refuse pick-up service in that HHW are placed at the curb and are collected at a scheduled time. The collection vehicle goes from door-to-door and separates and packages the materials. The advantages of this type of program is that it eliminates the need for household to transport their waste and it encourages participation because of its convenience. However, these programs do not service large numbers of people within a short time frame, are very labor intensive, and very expensive. Curbside collection programs are usually only used for single materials such as used motor oil to eliminate the need for segregation of materials.

Combined Program

HHW collection programs involving a combination of the above programs are often used by communities. For instance, a permanent collection center can be established to serve a densely populated area, curbside collection can be used to collect HHW from elderly or disabled persons, and a mobile collection center can be used to service the outlying or rural area outside of the densely populated area.

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Additional Information — Household Hazardous Waste Collection

Conditionally Exempt Small Quality Generators (CESQG)

As a result of AB2641 (1990), California Health and Safety Code Section 25158.1 was amended to allow CESQG or Very Small Quantity Generator (VSQG) waste to be accepted at HHW collection programs. CESQGs or VSQGs are businesses that generate less than 100 kilograms of hazardous waste per month. A recent USEPA memorandum (EPA Policy Directive No. 9574.00-02) clarified regulatory and permitting issues in the Federal regulation (40 CFR 261.5). As a result, a number of programs in California are starting to accept CESQG waste including San Francisco, Marin County, and Santa Monica.

A pilot program can be very useful in determining the right program for the municipality. Carefully scheduling when to conduct a HHW program will contribute to its success. Collection programs are often held at specific times of the year such as spring or late summer/fall. Such scheduling takes into account "spring cleaning" by homeowners and end of summer cleaning. Also, before conducting a HHW collection program, it is important to determine what wastes will be accepted, what wastes will be excluded, and the quantities of wastes that will be accepted. A contingency plan should be developed to address the handling of excluded waste if it turns up during the collection program. HHW programs are expensive and fraught with regulatory issues and liability concerns. Professional guidance should be sought when planning a HHW program.

HHW Recycling, Reuse, and Source Reduction

Once the waste is collected, it can either be reused (via waste exchanges), recycled, or disposed. Although many types of waste can be recycled, the recycling options for each waste type are limited. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled are either incinerated or disposed of at properly permitted landfills. The best source reduction technique is to use alternative nonhazardous household products. Source reduction is part of the education and public information program emphasis.

Implementation Requirements

HHW collection programs can be very expensive. Below is a list of ways to reduce program costs.

- In-kind services and donations of material, equipment and labor from businesses, government and community groups have greatly reduced the cost of pilot programs. Such services have been provided not only for actual collection and disposal, but for publicity and community education campaigns. Donations of newspaper advertising space, public service announcements, and inserts in utility bills can minimize costs as well as increase publicity.
- In addition, discount rates on supplies and disposal fees that are not available to private generators of hazardous wastes are often provided by waste haulers and disposal companies to community collection programs.
- Recycling waste oil by giving it to a service station or by selling it directly to a commercial recycler can reduce disposal costs and potentially generate some revenue.
- Using reconditioned Department of Transportation (DOT) certified drums can reduce project costs.
- Donating usable products (i.e., latex paints and pesticides) to responsible organizations can also minimize disposal costs.

Program financing can be accomplished through the following mechanisms:

- Service charges - either using existing service charges such as utility bills if a reserve fund has been accumulated or by an increase in utility bills such as refuse collection or sewer bills;
- Solid waste enterprise funds - these funds generally finance solid waste activities from fees collected;
- Fees for hazardous material use permits - establish a permit program for businesses that use hazardous materials and use funds for inspections, enforcement, spill response, and collection;
- Tipping fees - increase tipping fees at landfills;
- User fees - most HHW collection programs are free of charge to participants; however a fee schedule can be developed for excess quantities per household or for households outside of the service area; and
- County taxes on disposal facilities.

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Additional Information — Household Hazardous Waste Collection

Administrative/staffing requirements include the following:

- At least 1 specially trained hazardous waste professional.
- Trained personnel for sorting and packaging.
- 1 full time administrator.
- 1 operator for each curbside collection vehicle.
- For contracted programs, 1 full time public administrator, contractor provides other operators.
- Education coordinator (may be included in duties of recycling coordinator).

Public Education

Education is the most important element of HHW programs. In general, the public is unaware of the problems caused by over-use and improper disposal of HHW. In addition, the public does not recognize the toxicity of many products commonly used in and around homes. Educational and public relations programs should include the following goals:

- Increase public awareness of hazardous products commonly found in homes, as well as, the potential health impacts of these products;
- Educate homeowners on availability of less toxic alternative materials;
- Encourage homeowners to minimize the use of and exposure to toxic or hazardous materials;
- Educate the public on the best methods of handling and disposing of these products; and
- Promote participation in HHW collection and recycling programs.

Public education regarding HHW must be an ongoing process rather than a one-time media blitz. Some of the more effective methods used to promote HHW programs include:

- Educational curriculum at public and private schools,
- Public service announcements on local television and radio stations,
- Utility bill inserts,
- Speakers and presentations at local community organization gatherings,
- Slide shows and videos provided for community use, and
- Telephone hotlines.

Limitations

Liability issues to be considered:

- Short term - injury and/or property damage during collection or disposal.
- Long term - injury and/or property damage after disposal.
- Possible to shift short term liability to hazardous waste management contractor.
- Long term liability remains with the community.

Examples of Effective Programs

San Francisco, CA. This is one of the oldest (1988) and most convenient permanent collection centers in the country. In 1991, more than 8,800 residents brought over 123,000 containers containing more than 56,000 gallons of hazardous waste to the facility. The program is publicized on an ongoing basis via; utility bill inserts, tax bills, Yellow Pages, newspapers including Spanish and Chinese, bus signs, voter's pamphlet, point-of-purchase tear-off sheets, and display booths. Over 60% of the waste was recycled, about 25% burned as fuel, 10% incinerated, 2% neutralized, and less than 2% sent to the landfill.

Palo Alto, CA. The Regional Water Quality Control Plant hosts a periodic program on the First Saturday of each month from 9-12. Staffing is handled by a private HHW collection contractor with usually one municipal employee present at each event. About 3% of the approximately 65,000 residents are present at any given event. Publicity for the events is ongoing with regular announcements in the local newspaper one week before each month's event. Information is also provided through utility bill inserts and at City offices. More than two-thirds of participants learn of the program through the inserts.

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Additional Information — Household Hazardous Waste Collection

Santa Monica, CA. The Santa Monica Household Hazardous Waste Recycling and Collection Center is also one of the longest running programs in the country. The center is open 8-12, Wednesday through Saturday. The program is expanding to include Conditionally Exempt Small Quality Generators and residents of Culver City. In 1991-92, 2,900 participants (7% of households) disposed of 174,000 pounds of HHW at a program cost of $248,000.

The California Integrated Waste Management Board (IWMB) has a Recycling Hotline that provides information on household hazardous waste collection programs/facilities. Call (800) 553-2962 for more information.

Seattle/King County, WA. This program is a mobile collection program that was initiated in 1989. A private company was contracted to provide this service, which consists of a mobile unit that stays at a site for two weeks, the moves to another location. Annually, 24 site visits occur over two consecutive 3-day weekends each. The initial operation consisted of two waste unloading lanes, a processing area, a lab, a staff vehicle, an equipment van, and a waste hauling semi-trailer. Staff from the private lab company pack and bulk all wastes over two consecutive weekends at a site. The general operating schedule is from noon to 7:00 p.m. on Thursdays and Fridays and 10:00 a.m. to 5:00 p.m. on Saturdays over two consecutive weekends at the site. Staffing includes a site supervisor/chemist, hazardous waste specialist, and hazardous waste technician classifications. Publicity is provided through radio, TV, flyers, newspaper articles, and other community publicity. In the six month period from September, 1989 through March, 1990, the program collected 66,059 gallons of HHW.

REFERENCES

California Integrated Waste Management Board, Household Hazardous Waste Program, (916) 255-2354, distributes the folloing publications:

- The 20 Most Frequently Asked Questions Regarding Household Hazardous Waste, IWMB, 1990.
- Recommendations for Developing Permanent HHW Collection Facilities, IWMB, 1990.
- Guidelines for Household Hazardous Waste Collection Days, IWMB, 1989.
- Household Hazardous Waste Fact Sheets, IWMB, 1990.

Collecting Household Hazardous Wastes at Wastewater Treatment Plants: Case Studies, EPA 430/09-90-016, USEPA, 1990.

Hazardous Household Products: A Guide to the Disposal of Hazardous Household Products and the Use of Non-Hazardous Alternatives, California Department of Toxic Substance Control (no date).

Household Hazardous Waste: What You Should and Shouldn't Do, Water Environment Federation, 1987.

San Francisco Household Hazardous Waste Collection Facility, Fourth Year-1991. Annual Report, City and County of San Francisco, 1992.

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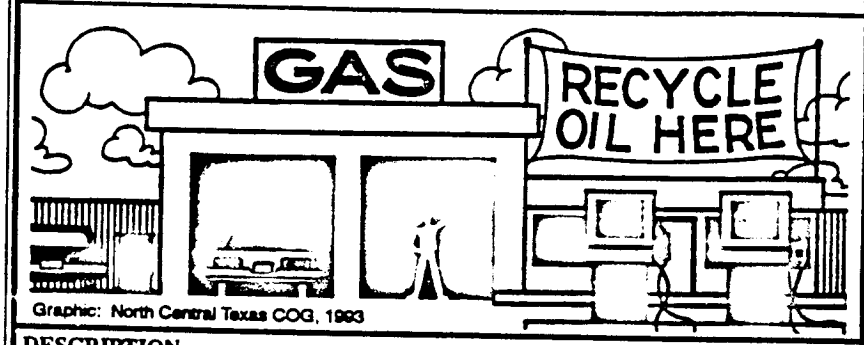
BMP: USED OIL RECYCLING



Graphic: North Central Texas COG, 1993

Program Elements

- New Development
- (Residential)
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- (Illegal Discharges)

DESCRIPTION

Used oil recycling is a responsible alternative to improper disposal practices such as dumping oil in the sanitary sewer or storm drain system, applying oil to roads for dust control, placing used oil and filters in the trash for disposal to landfill, or simply pouring used oil on the ground.

APPROACH

- Set up a municipal collection center funded by the city.
- Contract out the collection and hauling of used oil to a private hauler/recycler.
- Utilize the automobile service industry for collection of used oil.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - A collection facility or curbside collection may result in significant costs
  - Commercial locations (automobile service stations, quick oil change centers, etc.) as collection points eliminate hauling and recycling costs for city
  - Staffing costs are minimal when using commercial locations as collection points; staffing costs are higher if city performs collection services.
- Regulations
  - California Oil Recycling Enhancement Act requires the California Integrated Waste Management Board to pay recycling incentive not less than $.04/quart to curbside collection programs and certified used oil collection centers after April 1, 1993.
  - Comply with all applicable State and Federal regulations regarding storage, handling, and transport of petroleum products.
  - Municipalities required to have a used oil recycling element within their integrated waste management plan.
- Administrative/Staffing
  - Staffing requirements are minimal if collection/recycling is contracted out to a used oil hauler/recycler or required at commercial locations.

PUBLIC EDUCATION/PARTICIPATION

- Create procedures for collection such as; collection locations and schedule, acceptable containers, and maximum amounts accepted.
- Promote public participation through the use of posters, handouts, brochures, and announcements in the print and broadcast media; provide list of commercial recyclers.
- Develop incentive programs for commercial locations and used oil haulers/recyclers.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ◒ Training
- ○ Administrative

● High ○ Low

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BMP: USED OIL RECYCLING (Continue)

LIMITATIONS

- Availability of reliable, licensed used oil haulers and recyclers.
- Requires continuous public education.
- Used oil/hazardous waste separation requirement under Federal law.
- Meeting zoning, fire, and health and safety laws associated with collecting used oil.

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Additional Information -- Used Oil Recycling

The two basic factors to be addressed during the implementation of a used oil recycling program are: 1) Used oil collection, and 2) Hauling/disposal.

One commonly used oil collection alternative is a temporary "drop-off" site on designated collection days. The public is notified that used oil can be brought to these specific locations on special collection days. Collection days may become more frequent as funding becomes available. Volunteers from local service groups can be used to help staff these sites. As programs mature, a permanent central collection facility may be used to collect and store used oil. This permanent facility can be used as a drop-off point and as a central terminal where curbside collection or mobile collection vehicles are stored. The decision to construct or design a permanent facility and/or employ curbside collection should be well planned and thought out. Permanent staffing and collection/hauling schedules will be required.

Some communities rely solely on private collectors such as automobile service stations, quick oil change centers and auto parts stores to serve as collection sites.

Well before oil collection commences, reliable local used oil haulers and recyclers should be contacted. As recommended by EPA, the hauler should have valid licenses and operate in a safe and environmentally responsible manner; maintain records of quantities of used oil collected, delivered, and handled; and deliver used oil to reputable management facilities. Used oil recyclers should be in compliance with all applicable State and Federal requirements.

Public Education

Information about used oil recycling programs can be made available through fact sheets, point of sale flyers distributed by retailers, during volunteer events such as storm drain stenciling, volunteer water quality monitoring, and creek and coastal clean ups.

Examples of Effective Programs

The California Integrated Waste Management Board has a Recycling Hotline, (800) 553-2962, that provides information and recycling locations for used oil. There are numerous locations throughout the State of California that accept used oil. The Household Hazardous Waste Collection Facility (HHWCF) operated by the Sanitary Fill Co. in San Francisco is a prominent used oil collection and recycling program. Chief Auto Parts has a national used oil recycling program - call (800) 245-9000 for more information. Exxon Corp. also has a national program - call (800) 732-1100 for more information.

Another nationally recognized used oil program is Project R.O.S.E. (Recycled Oil Saves Energy), operated by the University of Alabama and funded by the Science, Technology and Energy Division of the Alabama Department of Economic and Community Affairs. Call (800) 392-8098 for more information. For information about oil recyclers, call the National Oil Recyclers Association (NORA) at (202) 962-3000.

REFERENCES

Used Oil Recycling, EPA/530/SW-88-047, U.S. EPA, March 1988.

Used Oil Recycling, EPA/530-SW-89-006, U.S. EPA, November 1988.

How to Set Up a Local Program To Recycle Used Oil, EPA/530-SW-89-039A, U.S. EPA, May 1989.

Letter Correspondence, University of Alabama, National Oil Recyclers Association, Brochure.

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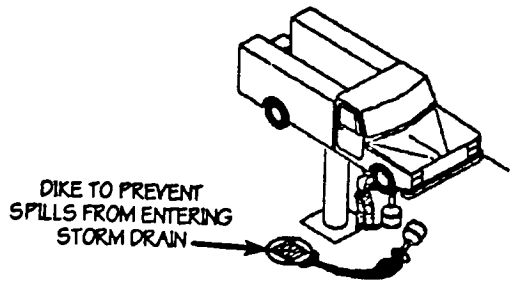
BMP: VEHICLE LEAK AND SPILL CONTROL



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This BMP covers only prevention and cleanup of spills from vehicles. SC41 contains information on prevention and cleanup of spills from aboveground storage tanks. See SC4 in the Industrial Handbook for more information regarding BMPs for vehicle maintenance shops (such as municipal service centers or corporation yards).

APPROACH

Vehicles will leak and spill fluids. The key is to reduce the frequency and severity of leaks and spills, and when they do occur, to prevent or reduce the environmental impacts.

- Perform fluid removal and changes inside or under cover on paved surfaces.
- Properly store hazardous materials and waste.
- Have spill cleanup supplies readily available.
- Clean up spills and leaks immediately.
- Use dry cleanup methods.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.
- Regulations
  - This is not a major element of this best management practice.
- Administrative / Staffing
  - This BMP has no major administrative or staffing requirements.
- Equipment
  - Keep ample supplies of spill control and cleanup materials at municipal facilities, near storage and maintenance areas.
  - Update spill cleanup materials as changes occur in the types of chemicals on-site.
- Training
  - Training is crucial to reducing the frequency, severity, and impacts of leaks and spills.

PUBLIC EDUCATION / PARTICIPATION

- Encourage the general public to regularly inspect and maintain their vehicles.

LIMITATIONS

- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops (such as municipal service centers or corporation yards).

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.

Reporting

- Report spills to local agencies, such as the fire department; they can assist in cleanup.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the runon of storm water and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

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Vehicle and Equipment Fueling

- Design the fueling area to prevent the runon of storm water and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to a sump.
  - Pave fueling area with concrete rather than asphalt.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Municipal Spill Prevention/Response

For the purposes of developing a spill prevention and response program to meet the storm water regulations, municipalities should use information provided in this fact sheet, SC41, and the spill prevention/response portions of the fact sheets in Chapter 4, Industrial Hanbook, for specific activities. The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g. Fire Department);
- Develop procedures to prevent/mitigate spills to storm drain systems;
- Identify responsible departments;
- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures; and
- Address spills at municipal facilities, as well as public areas.

Examples of Effective Programs

The City of Palo Alto includes spill prevention and control as a major element of its highly effective program for commercial and municipal vehicle maintenance shops.

REFERENCES

Water Quality Best Management Practices Manual, City of Seattle, 1989.

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices, USEPA, July 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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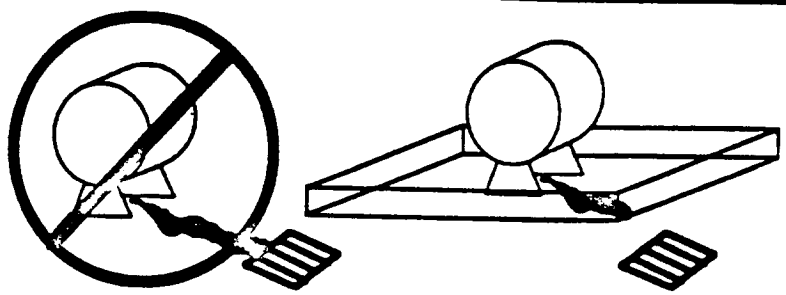
BMP: ABOVEGROUND TANK LEAK AND SPILL CONTROL



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ○ Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ● Training
- ○ Administrative

● High ○ Low

SC41

Best Management Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from aboveground storage tanks by installing safeguards against accidental releases, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.

APPROACH

- Integrate efforts with existing aboveground petroleum storage tank programs through the local Fire Department and Health Department; and area and business emergency response plans through the City, County, or Fire District.
- Use engineering safeguards to reduce the chance for spills.
- Perform regular maintenance.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Will vary depending on the size of the facility and the necessary controls.
- Regulations
  - State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure Plan (SPCC) Plan (Health & Safety Code Chapter 6.67).
  - State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.
  - Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- Administrative / Staffing
  - This BMP has no major administrative or staffing requirements.
- Equipment
  - Keep ample supplies of spill control and cleanup materials at municipal facilities.
  - Update your spill cleanup materials as changes occur in the types of chemicals stored on-site.
- Training
  - Employees should be well-trained in spill prevention and cleanup.

PUBLIC EDUCATION / PARTICIPATION

- Employees should be educated about aboveground storage tank requirements.

LIMITATIONS

- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

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Additional Information — Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating storm water with many different pollutants. Materials spilled, leaked, or lost from tanks may accumulate in soils or on impervious surfaces and be carried away by storm water runoff.

The most common causes of unintentional releases are:

- Installation problems,
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves),
- External corrosion and structural failure,
- Spills and overfills due to operator error, and
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa.

Storage of reactive, ignitible, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements.

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be paved with Portland cement concrete, free of cracks and gaps, and impervious in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater.
- The area inside the curb should slope to a drain.
  - For used oil or dangerous waste, a dead-end sump should be installed in the drain.
  - All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
  - Accumulated storm water in petroleum storage areas should be passed through an oil/water separator.

Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. The plan should include (see the Health & Safety Code for specific requirements):

- Description of the facility, owner and address, activities and chemicals present,
- Facility map,
- Notification and evacuation procedures,
- Cleanup instructions, and
- Identification of key spill response personnel.

Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the plan and the plan should be readily available.

Operator errors can be prevented by using engineering safeguards and thus reducing accidental releases of pollutants. Safeguards include:

- Overflow protection devices on tank systems to warn the operator to automatically shutdown transfer pumps when the tank reaches full capacity,
- Protective guards (bollards) around tanks and piping to prevent vehicle or forklift damage, and
- Clearly tagging or labeling all valves to reduce human error.

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Additional Information — Aboveground Tank Leak and Spill Control

Maintenance is critical to preventing leaks and spills. Conduct routine weekly inspections and:

- Check for external corrosion and structural failure,
- Check for spills and overfills due to operator error,
- Check for failure of piping system (pipes, pumps, flanger, coupling, hoses, and valves),
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa,
- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets, and
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- During the wet season, accumulated storm water should be released frequently.
- Periodically, integrity testing should be conducted by a qualified professional.

REFERENCES

Water Quality Best Management Practices Manual, City of Seattle, 1989.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices, USEPA, July 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Stormwater Management Manual for the Puget Sound Basin (The Technical Manual): Volume IV - Urban Land Use BMPs, Washington State Department of Ecology, 1992.

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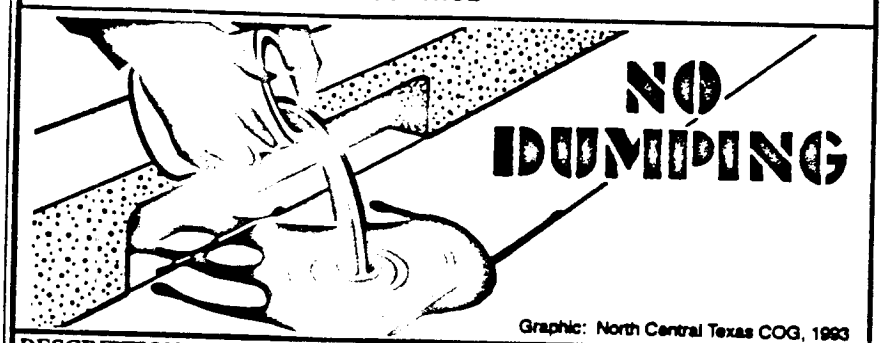
R0034076

BMP: ILLEGAL DUMPING CONTROL



Graphic: North Central Texas COG, 1993

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- (Illegal Discharges)

DESCRIPTION

Implement measures to detect, correct, and enforce against illegal dumping of pollutants on streets and into the storm drain system and creeks. The remedial focus of this best management practice contrasts with the preventative focus of the Material Disposal and Recycling BMPs (SC30-SC32) in this chapter. Illegal discharges through physical connections are addressed in BMPs SC60-SC62 (Illicit Connection Controls).

APPROACH

- Public awareness is the key to this BMP. Train municipal employees and educate the general public to recognize and report illegal dumping.
- Deputize municipal staff with the authority to write environmental tickets.
- Establish system for tracking incidents.
- Use the quick reference on disposal alternatives at the end of this fact sheet (Table 4.1) to train municipal employees and to educate businesses, contractors, and the general public in proper and consistent methods for disposal.

REQUIREMENTS

- Cost Considerations
  - The primary cost is for staff time as noted below. The cost depends on how aggressively a program is implemented.
  - Municipal cost for containment and disposal may be borne by the discharger.
- Regulations
  - Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Administrative / Staffing
  - Requires technical staff to detect and investigate illegal dumping violations, and to coordinate public education.
  - Legal staff is required to pursue prosecution of significant cases.
- Equipment
  - A database is useful for defining and tracking the magnitude of the problem.
- Training
  - Training of technical staff in identifying and documenting illegal dumping incidents is required.

PUBLIC EDUCATION / PARTICIPATION

- Awareness of the issue accomplishes two things. The receiver of the information understands the issue and therefore is unlikely to cause a problem, plus their awareness often helps detect other violations.

LIMITATIONS

- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Illegal Dumping Control

Substances illegally dumped on streets and into the storm drain system and creeks include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. All of these wastes can cause storm water and receiving water quality problems as well as clog the storm drain system itself.

One of the keys to success is increasing the number of people on the street who are aware of the problem and who have the tools to at least identify the incident, if not correct it. There are a number of ways of accomplishing this:

- Train municipal staff from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report the incidents.
- Deputize municipal staff who may come into contact with illegal dumping with the authority to write illegal dumping tickets for offenders caught in the act (see below).
- Educate the public. As many as 3 out of 4 people do not understand that in most communities the storm drain does not go to the wastewater treatment plant. Unfortunately, with the heavy emphasis in recent years on public education about solid waste management, including recycling and household hazardous waste, the sewer system (both storm and sanitary) has been the likely recipient of cross-media transfers of waste.
- Provide the public with a mechanism for reporting incidents such as a hot line and/or door hanger (see below).
- Help areas where incidents occur more frequently set up environmental watch programs (like crime watch programs).
- Another mechanism for public reporting is volunteer water quality monitoring. Volunteers can be trained to notice and report the presence and suspected source of an observed pollutant to the appropriate public agency.

The establishment of a system for tracking incidents will help identify:

- Illegal dumping "hot spots",
- Types and quantities (in some cases) of wastes,
- Patterns in time of occurrence (time of day/night, month, or year),
- Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills), and
- Responsible parties.

A tracking system also helps manage the program by indicating trends, and identifying who, what, when, and where efforts should be concentrated.

Examples of Effective Programs

The Bureau of Street Cleaning and Urban Forestry in the City and County of San Francisco has authorized a force of three Environmental Patrol Officers to issue citations enforcing the municipal litter codes. San Francisco is planning on extending this authority to other employees including industrial waste inspectors.

The City of Palo Alto has developed a public participation program for reporting dumping violations. When a concerned citizen or public employee encounters evidence of illegal dumping, a door hanger (similar in format to hotel "Do Not Disturb" signs) is placed on the front doors in the neighborhood. The door hanger notes that a violation has occurred in the neighborhood, informs the reader why illegal dumping is a problem, and notes that illegal dumping carries a significant financial penalty. Information is also provided on what citizens can do as well as contact numbers for more information or to report a violation.

The Port of Long Beach has a state of the art database incorporating storm drain infrastructure, potential pollutant sources, facility management practices, and a pollutant tracking system.

The State Department of Fish and Game has a hotline for reporting violations called CalTIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).

The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

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REFERENCES

Hazardous Waste Alert; A Citizen's Guide to Enforcement, California Department of Toxic Substances Control, 1990.

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TABLE 4.1 QUICK REFERENCE - DISPOSAL ALTERNATIVES
(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use. **ALTERNATIVES ARE LISTED IN PRIORITY ORDER.**

Key: HHW — Household hazardous waste (Government-sponsored drop-off events)
POTW — Publically Owned Treatment Plant
Reg.Bd. — Regional Water Quality Control Board (Oakland)
"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance			
Excess paint (oil-based)	1. Recycle/reuse. 2. Dispose as hazardous waste.		1. Recycle/reuse. 2. Take to HHW drop-off.
Excess paint (water-based)	1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, dispose as hazardous waste.		1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, take to HHW drop-off
Paint cleanup (oil-based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste.		Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Take to HHW drop-off.
Paint cleanup (water-based)	Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.		Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.
Empty paint cans (dry)	1. Remove lids, dispose as trash.		1. Remove lids, dispose as trash.
Paint stripping (with solvent)	1. Dispose as hazardous waste.		1. Take to HHW drop-off.
Building exterior cleaning (high-pressure water)	1. Prevent entry into storm drain and remove offsite 2. Wash onto dirt area, spade in 3. Collect (e.g. mop up) and discharge to sanitary sewer	POTW	
Cleaning of building exteriors which have HAZARDOUS MATERIALS (e.g. mercury, lead) in paints	1. Use dry cleaning methods 2. Contain and dispose washwater as hazardous waste (Suggestion: dry material first to reduce volume)		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Non-hazardous paint scraping/ sand blasting	1. Dry sweep, dispose as trash		1. Dry sweep, dispose as trash
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste		1. Dry sweep, take to HHW drop-off
Soil from excavations during periods when storms are forecast	1. Should not be placed in street or on paved areas 2. Remove from site or backfill by end of day 3. Cover with tarpaulin or surround with hay bales, or use other runoff controls 4. Place filter mat over storm drain Note: Thoroughly sweep following removal of dirt in all four alternatives.		
Soil from excavations placed on paved surfaces during periods when storms are not forecast	1. Keep material out of storm conveyance systems and thoroughly remove via sweeping following removal of dirt		
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud 2. Use silt ponds and/or similar pollutant reduction techniques when flushing pavement		
Soil erosion, sediments	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant immediately.		
Fresh cement, grout, mortar	1. Use/reuse excess 2. Dispose to trash		1. Use/reuse excess 2. Dispose as trash
Washwater from concrete/mortar (etc.) cleanup	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Rinsewater from concrete mixing trucks	1. Return truck to yard for rinsing into pond or dirt area 2. At construction site, wash into pond or dirt area		
Non-hazardous construction and demolition debris	1. Recycle/reuse (concrete, wood, etc.) 2. Dispose as trash		1. Recycle/reuse (concrete, wood, etc. 2. Dispose as trash
Hazardous demolition and construction debris (e.g. asbestos)	1. Dispose as hazardous waste		1. Do not attempt to remove yourself. Contact asbestos removal service for safe removal and disposal 2. Very small amounts (less than 5 lbs) may be double-wrapped in plastic and taken to HHW drop-off
Saw-cut slurry	1. Use dry cutting technique and sweep up residue 2. Vacuum slurry and dispose off-site. 3. Block storm drain or berm with low weir as necessary to allow most solids to settle. Shovel out gutters; dispose residue to dirt area, construction yard or landfill.		
Construction dewatering (Nonturbid, uncontaminated groundwater)	1. Recycle/Reuse 2. Discharge to storm drain		
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1. Recycle/reuse 2. Discharge to sanitary sewer 3. As appropriate, treat prior to discharge to storm drain	POTW Reg. Bd.	
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW	POTW	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair 2. If dumpster is used for liquid waste, use plastic liner		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse)		
Dumpster cleaning water	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer 2. Clean on site and discharge through grease interceptor to sanitary sewer	POTW POTW	
Cleaning driveways, paved areas * (Special Focus = Restaurant alleys Grocery dumpster areas) * Note: Local drought ordinances may contain additional restrictions	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer). 3. Same as 2 above, but with rinsewater (2c)(no soap) discharged to storm drain.		1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, follow this 3-step process: a. Clean up leaks with rags or absorbents; dispose as hazardous waste. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer.
Steam cleaning of sidewalks, plazas * * Note: Local drought ordinances may contain additional restrictions	1. Collect all water and pump to sanitary sewer. 2. Follow this 3-step process: a. Clean oil leaks with rags or adsorbents b. Sweep (Use dry absorbent as needed) c. Use no soap, discharge to storm drain		
Potable water/line flushing Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching creeks		
Super-chlorinated (above 1 ppm) water from line flushing	1. Discharge to sanitary sewer 2. Complete dechlorination required before discharge to storm drain		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Landscape/Garden Maintenance			
Pesticides	1. Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash 2. Dispose unused pesticide as hazardous waste		1. Use up. Rinse containers, use rinsewater as pesticide. Dispose rinsed container as trash. 2. Take unused pesticide to HHW drop-off
Garden clippings	1. Compost 2. Take to Landfill		1. Compost 2. Dispose as trash.
Tree trimming	1. Chip if necessary, before composting or recycling		1. Chip if necessary, before composting or recycling
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.	POTW	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.
Acid or other pool/spa/fountain cleaning	1. Neutralize and discharge to sanitary sewer	POTW	
Swimming pool, spa filter backwash	1. Reuse for irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer		1. Use for landscape irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer
Vehicle Wastes			
Used motor oil	1. Use secondary containment while storing, send to recycler.		1. Put out for curbside recycling pickup where available 2. Take to Recycling Facility or auto service facility with recycling program 3. Take to HHW events accepting motor oil
Antifreeze	1. Use secondary containment while storing, send to recycler.		1. Take to Recycling Facility
Other vehicle fluids and solvents	1. Dispose as hazardous waste		1. Take to HHW event
Automobile batteries	1. Send to auto battery recycler 2. Take to Recycling Center		1. Exchange at retail outlet 2. Take to Recycling Facility or HHW event where batteries are accepted
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer		1. Use holding tank, dispose to sanitary sewer.

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Vehicle Wastes (cont'd)			
Vehicle Washing	1. Recycle 2. Discharge to sanitary sewer, never to storm drain	POTW	1. Take to Commercial Car Wash. 2. Wash over lawn or dirt area 3. If soap is used, use a bucket for soapy water and discharge remaining soapy water to sanitary sewer.
Mobile Vehicle Washing	1. Collect washwater and discharge to sanitary sewer.	POTW	
Rinsewater from dust removal at new car fleets	1. Discharge to sanitary sewer 2. If rinsing dust from exterior surfaces from appearance purposes, use no soap (water only); discharge to storm drain.	POTW	
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags or absorbents 2. Sweep, using granular absorbent material (cat litter) 3. Mop and dispose of mopwater to sanitary sewer.		
Other Wastes			
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer	POTW	1. Dispose to sanitary sewer
Roof drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer 2. If no contamination is present, discharge to storm drain		
Cooling water Air conditioning condensate	1. Recycle/reuse 2. Discharge to sanitary sewer	POTW	
Pumped groundwater, infiltration/ foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer 3. Treat and discharge to storm drain	Reg. Bd. POTW Reg. Bd.	
Fire fighting flows	If contamination is present, Fire Dept. will attempt to prevent flow to stream or storm drain		

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Table 4.1 (Continued)
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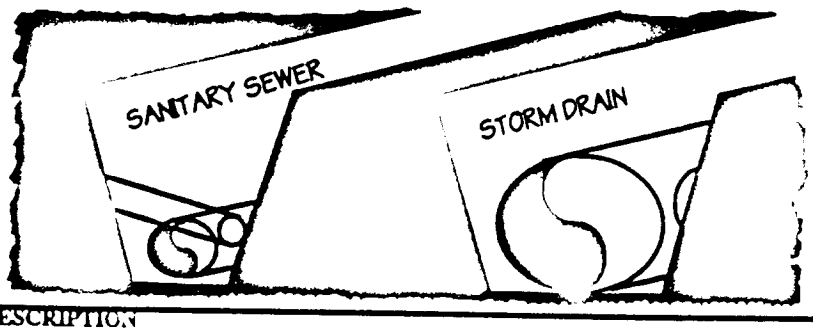
DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Other Wastes (cont'd)			
Kitchen Grease	1. Provide secondary containment, collect, send to recyler. 2. Provide secondary containment, collect, send to POTW via hauler.	POTW	1. Collect, solidify, dispose as trash
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer. 2. Clean outside in container or bermed area with discharge to sanitary sewer.		
Clean-up wastewater from sewer back-up	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer. (no rinse-water may flow to storm drain)		

R0034085

BMP: ILLICIT CONNECTION-PREVENTION



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Prevent unwarranted physical connections to the storm drain system from sanitary sewers, floor drains, etc. through regulation, regular inspection, testing, and education.

APPROACH

The following steps are components of this BMP:

- Ensure that existing municipal building and plumbing codes prohibit non-storm water physical connections to the storm drain system.
- Require visual inspection at new land developments during the construction phase.
- Develop a schedule and allocation of staff and resources to implement prevention program.
- Develop documentation and record keeping protocols to track inspections and catalog the storm drain system.
- Use techniques such as zinc chloride smoke testing, fluorometric dye testing and television camera inspection to verify physical connections.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Zinc chloride smoke, fluorometric dye testing and television camera inspection.
  - Additional labor and equipment cost for verification of plumbing connections.
- Regulations
  - Ensure that existing building and plumbing codes prohibit inappropriate physical connection to the storm drain system and provide adequate legal authority to prevent illicit connections.
  - Implement procedures to inspect and verify that new construction development does not illegally interface with storm drain system.
- Administrative/Staffing
  - Building, plumbing, and drainage system inspectors must verify and document that inappropriate discharges do not physically connect to storm drain system.
  - Zinc chloride smoke, fluorometric dye testing, or television inspection may be necessary for verification.
  - Additional staff time required for verification and documentation of proper connections to storm drain system.

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ○ Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ○ Training
- ◒ Administrative

● High ○ Low

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BMP: ILLEGAL CONNECTION PREVENTION (Continue)

PUBLIC EDUCATION/PARTICIPATION

- Community awareness program (using various media) targeting appropriate audiences (homeowners, businesses, contractors, etc.) to warn against improper connections to the storm drain system and encourage public reporting of illegal connections through the community hotline telephone number.
- Community notification required for zinc chloride smoke and fluorometric dye testing in targeted areas.

LIMITATIONS

- Proper connections may be verified on date of inspection, but could be altered afterwards by "boot legged" connections.
- Cost for inspection equipment.
- Removal of illicit connection from storm drain system to sanitary sewer may require approval of local sewering agency.

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R0034087

Additional Information — Illicit Connection-Prevention

Improper physical connections to the storm drain system can occur in a number of ways, such as overflow cross-connects from sanitary sewers and floor drains from businesses like auto shops and restaurants.

Illegal connections can occur in new as well as existing development. Improper connections in areas of new development can be prevented through inspection and verification techniques. The first measure of prevention is to make sure that existing municipal building and plumbing codes prohibit any unwarranted, non-permitted physical connections to the storm drain system. Building and plumbing code inspectors, in addition to new land development project inspectors, must visually inspect to ensure that illegal connections are not being physically tied to the storm conveyance system. A schedule, proper documentation, and record keeping is essential to the function of such inspections. The schedule and documentation helps catalog the storm drain system and is required by the regulations. Visual inspection, however, is not a very reliable means of verifying the status of new physical connections and their final destination. Continued monitoring throughout the entire construction phase would be necessary to guarantee that new physical connections between the sanitary sewers and storm drains had been prevented though the inspection process.

Requirements to Implement

In order to most accurately verify and prevent new physical connection tie-ins to the storm drain system, some of the more labor and equipment intensive techniques used for illegal connection detection should be utilized (See SC61, Illicit Connection Detection and Removal). Zinc chloride smoke and fluorometric dye testing are the most effective verification technologies. Fluorescent dye testing involves the introduction of a dye such as fluorescein in a discharge point suspected of exhibiting an illicit connection. The dye is flushed down with clear water. Downstream points are observed for the presence of dye. If dye comes through, then an illicit connection has been identified.

Smoke tests may also be used to trace illicit connection. Smoke tests may be conducted without water and can be used to trace connections upstream as well as downstream. Smoke is introduced at either a discharge point or an outfall and "flushed" through the system with fans. Caution and effective communication are important during smoke testing so the presences of smoke is not perceived as an indication of a fire by those unaware of the test.

In situations where dye or smoke tests fail to identify illicit connections, an internal visual inspection of the system may be necessary. Manual visual and television camera inspection of storm drain piping can be utilized in the verification process. These techniques are expensive for most municipalities and therefore may not always be feasible. Arrangements to coordinate and share inspection equipment between municipal wastewater departments and building/plumbing/new development code inspectors may be a solution and become an integral part of the inspection process.

Public awareness and education programs can facilitate a compliance effort to prevent new storm water system connections. Such programs targeted towards contractors and developers can help minimize such activity in areas of new development. Local media awareness campaigns can warn against new connections to the stormdrain system. Community notification would be necessary in the vicinity of areas targeted for zinc chloride smoke or fluorometric dye verification testing for potential new connections.

REFERENCES

Cross-connection Investigations For Storm Water Permit Applications, Lalor, M.M. et. al., WPCF Annual Conference, 1991.

Draft Manual of Practice - Identification of Illicit Connections, USEPA, Permits Division (EN-336), 1990.

Municipal Storm Water Discharge Management Program, City of Stockton, California, 1992.

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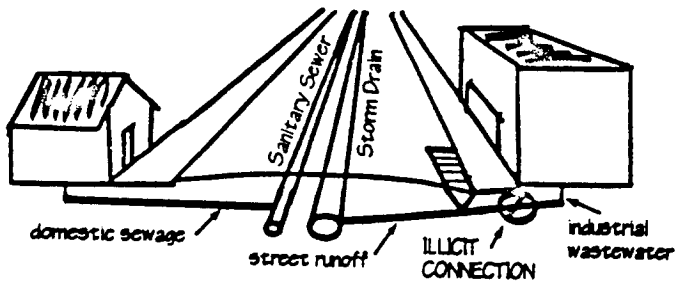
R0034088

BMP: ILLICIT CONNECTION-DETECTION AND REMOVAL



Graphic: after Minnesota Pollution Control Agency, 1989

Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Implement control procedures for detection and removal of illegal connections from the storm drain conveyance system. Procedures include field screening, follow-up testing, and complaint investigation.

APPROACH

- Field screening program.
- Sampling program.
- Zinc chloride smoke testing (suspected source testing).
- Fluorometric dye testing (suspected source testing).
- Television camera inspection.
- Physical inspection testing.
- Citizens' complaint on the community hotline to report suspected illegal connections.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Program initialization costs for procuring necessary equipment and training.
  - Exploration of equipment sharing with municipal wastewater departments.
  - Illegal connection location techniques are very labor and equipment intensive.
- Regulations
  - Enact ordinance granting "right-of-entry" to locate potentially responsible parties.
- Administrative/Staffing
  - Minimum 2-person teams required for field screening and sampling activities.
  - Larger staff teams required for zinc chloride smoke and fluorometric dye testing, or television camera inspection and physical inspection with confined space entry.
  - Staffing of a community hotline telephone number.
  - Program coordination needed for emergencies, record keeping, etc.
- Training
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
  - Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ○ Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ● O&M Costs
- ◒ Regulatory
- ● Staffing
- ○ Training
- ◒ Administrative

● High ○ Low

SC61

Best Management Practices

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BMP: ILLICIT CONNECTION-DETECTION AND REMOVAL (Continue)

- Equipment
  - Personal protective equipment (PPE), (hard hats, boots, plastic gloves, coveralls).
  - Sampling containers/equipment.
  - EPA-recommended storm water test kits.
  - Zinc chloride smoke and dispersal fans.
  - Fluorometric dye and fluorometer (optional).
  - Pipeline television camera with videocassette recorder.
  - Self-contained breathing apparatus (SCBA).
  - Oxygen/combustible and hydrogen sulfide gas meters.
  - Vehicle(s).
  - Walkie talkies.

PUBLIC EDUCATION/PARTICIPATION

- Encouragement of public reporting of improper waste disposal or evidence of illicit connections.
- Community notification required in targeted areas for zinc chloride smoke or fluorometric dye testing.

LIMITATIONS

- Private property access rights needed to perform field screening/testing along storm drain system right-of-ways.
- Requirements of municipal ordinance authority for suspected source verification testing necessary for guaranteed rights of entry.

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Additional Information — Illicit Connection-Detection and Removal

Control procedures for detection and removal of existing illegal connections tied to storm drain conveyance systems involves a multi-phased effort. Evidence of illegal connections is generally only detectable at storm drain outfall (end-of-pipe) locations. Therefore, the initial phase of source identification is through a field screening program, a sampling program, or a combined effort of both programs. A reactionary mechanism, based on citizens' complaint reporting, also serves as a preliminary identification of a potential illegal connection source. Secondary or follow-up phases of illegal connection identification require further investigations upgradient of pipelines or drainage ways to isolate illegal system tie-ins.

Field Screening

The field screening program should continue work conducted as part of the Part 1 permit application process and provide for continued field screening during the term of the permit. The program should include details on:

- Departmental responsibility,
- Frequency of inspections,
- Procedures and equipment,
- Documentation,
- Criteria for identifying and setting priorities, and
- Maps and check lists.

The field screening effort should also reconsider whether any of the non-storm water discharges listed in Table 4.1 (see SC50) are sources of pollutants.

The initial control procedure typically begins with a routine field screening program during dry weather conditions. EPA defines dry weather conditions as a time period of 72 hours or more in which no greater than one-tenth inch of rainfall was received in the areas of investigation. Presence of dry weather flow or other suspect visual or odorous characteristics that are typical of normal conditions should be noted in field logbooks for documentary purposes. The field screening process may involve either:

- Notation of visual observations at suspect outfalls,
- Field-testing of dry weather flows with an EPA-approved storm water test kit for copper, chlorine, phenol, detergents/surfactants and pH, or
- Sample collection for analytical testing of suspected parameters.

The intent of the routine field screening program is to identify outfalls that have characteristics of illegal connections. Identified suspect outfalls may then be monitored on a more frequent field screening basis or if evidence is primarily conclusive, then a follow-up storm drain system investigation may commence.

Follow-Up

Storm drain investigations generally begin at suspect outfalls and work upgradient until either the source is identified or there is no evidence to warrant further investigation. The detection process may be expedited by field screening every other manhole, open channel outfall, or combination thereof to most quickly isolate the potential source. Bisecting watersheds and working up or down gradient, dependent on observed conditions, has also been used effectively to expeditiously isolate the approximate location of an illegal connection. Isolation of an illegal connection within the storm drain piping requires utilization of one or more of the following location techniques:

- Fluorometric Dye Testing (see SC60 for brief description).
- Zinc Chloride Smoke Testing (see SC60 for brief description).
- Pipeline Television Camera Inspection.
- Physical Inspection Testing (pipes >39 inches).

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Additional Information — Illicit Connection-Detection and Removal

A municipal program for sharing resources (Fluorometric dye, zinc chloride smoke, TV inspection equipment) between the wastewater and storm water departments can greatly reduce the capital budget expenditures associated with such an important program. Otherwise, capital outlays would be very substantial if the municipality chooses to separately fund the equipment procurement for the individual public works departments. Even with a resource sharing program, illegal connection location techniques require a substantial capital commitment in labor and equipment provisions.

Generally, a municipal ordinance requirement is necessary for granting "rights of entry" to pinpoint principal responsible parties (PRP) through smoke or dye testing verification techniques. Otherwise, in-pipe television camera inspection or physical pipeline inspection are required in lieu of a municipal ordinance granting access for verification of suspected illegal connections. Physical inspection of larger pipes requires trained personnel, certified for confined space entry. Once located, the illegal connection should be corrected by being plugged using "In-situ Form" or equivalent connection removal processes. The PRP should be served a Notice of Violation regarding the illegal connection, fined for the violation, and provide reimbursement for the cost of correcting the illegal connection.

Public Education/Participation

Public education programs will also aid in the monitoring of illegal connections by making individuals aware of evidence of unwarranted discharges to the storm drain system. A community hotline for reporting such evidence can greatly supplement the storm water department's field screening efforts. The usage of smoke or dye testing requires notification of the public in the immediate areas to be tested.

Examples of Effective Programs

City of Stockton, Municipal Storm Water Discharge Management Program contains a comprehensive program element created to prevent, detect, and eliminate illegal connections to storm drains.

City of Fort Worth, Texas, Drainage Water Pollution Control Program. An "action" oriented program designed for corrective measures utilizing innovative biotoxicity testing. Staffing requirements are one full time person per year for a total labor cost of $30,000. Equipment, supplies, and services cost approximately $50,000 per year.

REFERENCES

"The Illicit Connection-EPA Storm Water Regulations Field Screening Program and the City of Houston's Successful Screening System." Presented at Texas Water Pollution Control Association Conference, Glanton, Theo et al., 1991.

Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems - A User's Guide, R. Pitt and M. Lalor, USEPA, 1992.

National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Final Rule. 40 CFR Parts 122, 123, and 124, U.S. EPA, Federal Register 55 (222), November 16, 1990.

Operational Guide, City of Fort Worth, Texas, Drainage Water Pollution Control Program, Department of Public Health, 1989.

Ozone Disinfection and Treatment of Urban Storm Drain Dry-Weather Flows, Santa Monica Bay Restoration Project, 1992.

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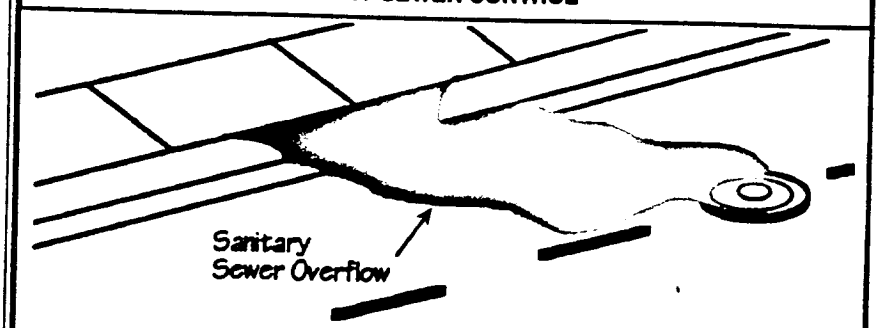
R0034092

BMP: LEAKING SANITARY SEWER CONTROL



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Implement control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from sanitary sewers into the storm drain conveyance system. Procedures include field screening, follow-up testing, and complaint investigation. Also, implement controls to reduce pollutant loadings from on-site sewage disposal systems (OSDS).

APPROACH

- Identify dry weather infiltration and inflow first. Wet weather overflow connections are very difficult to locate.
- Locate wet weather overflows and leaking sanitary sewers using conventional source identification techniques.
- Coordinate with ongoing infiltration and inflow (I & I) program to locate sources of exfiltration during I & I inspections.
- Design, site, operate, and maintain OSDS to prevent nutrient/pathogen loadings to surface waters and to reduce loadings to groundwater.

REQUIREMENTS

- Cost Considerations
  - Program costs for procuring necessary equipment and training.
  - Departmental cooperation recommended for sharing or borrowing staff resources and equipment from municipal wastewater department.
  - Infiltration, inflow, and wet weather overflows from sanitary sewers are very labor and equipment intensive to locate.
- Regulations
  - Enact ordinance granting "right-of-entry" to locate potentially responsible parties.
- Administrative/Staffing
  - Minimum 2-person teams to perform field screening and associated sampling.
  - Larger teams required for zinc chloride smoke testing, fluorometric dye testing, television camera inspection and physical inspection with confined space entry.
  - Program coordination required for handling emergencies, record keeping, etc.
- Training
  - OSHA-required Health and Safety Training 29 CFR 1910.120 plus annual Refresher Training (as needed).
  - OSHA Confined Space Entry training, (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
  - Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ○ Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ● O&M Costs
- ○ Regulatory
- ● Staffing
- ○ Training
- ◒ Administrative

● High ○ Low

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Best Management Practices

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- Equipment
  - Personal protective equipment (PPE) (hard hats, boots, plastic gloves, coveralls).
  - Sampling containers/equipment.
  - EPA-recommended storm water test kits.
  - Zinc chloride smoke and dispersal fans.
  - Fluorometric dye and fluorometer (optional).
  - Pipeline television camera with videocassette recorder.
  - Self-contained breathing apparatus (SCBA).
  - Oxygen/combustible gas meters.
  - Vehicle(s).
  - Walkie talkies.

LEAKING SANITARY SEWER DETECTION TECHNIQUES

- Field screening program (including field analytical testing).
- Fluorometric dye testing.
- Zinc chloride smoke testing.
- Television camera inspection.
- Nessler Reagent test kits for ammonia detection.
- Citizens' hotline reporting of wet weather sanitary overflow.

PUBLIC EDUCATION/PARTICIPATION

- Public awareness program through local media identifying problem of sanitary infiltration, inflow, and wet weather overflows into storm drain system.
- Community response hotline for reporting observed sanitary infiltration or leaks and wet weather sanitary overflows into storm drain system.
- Public notification required for zinc chloride smoke/fluorometric dye testing in targeted areas.

LIMITATIONS

- Private property access rights needed to perform field screening/testing along storm drain right-of-ways.
- Requirements of municipal ordinance authority for suspected source verification testing necessary for guaranteed rights of entry.

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Additional Information — Leaking Sanitary Sewer Control

Source identification control procedures include the conventional methods used for illicit connection detection within the storm water conveyance system. Conventional source identification techniques used for pinpointing leaking sanitary sewers include: dry weather field screening programs, fluorometric dye testing, zinc chloride smoke testing and in-pipe television camera inspection. The dry weather field screening program should include a field testing technique involving the use of Nessler's Reagent for ammonia presence/absence.

Ammonia is present in raw wastewater in significant concentrations and serves as a good indicator parameter for presence of wastewater in dry weather flows. Detected dry weather flows may be tested by obtaining 100 ml water samples and adding one to two drops of the commercially available Nessler's Reagent. If no response is noted within one minute and the water remains clear, it indicates no ammonia is present in the dry weather discharge. Any colormetric response ranging from light green (lowest concentration) to yellow, to orange, to brown (highest concentration) is indicative of the presence of ammonia.

If a positive indication of ammonia occurs, field screening should continue from outfalls or manholes upgradient in order to isolate the approximate location of a sanitary sewer leak. The usefulness of this field testing method is in its inexpensive ability to trace and locate wastewater infiltration. If budget allows, analytical testing may also be implemented to quantify or verify the potential wastewater leakage.

Once the approximate location is determined, then the smoke/dye/TV inspection techniques may be utilized to accurately locate and correct the leaking sanitary sewer piping. Community notification of planned flurometric dye and zinc chloride smoke testing is necessary prior to performance of these location techniques.

On-Site Sewage Disposal Systems

New on-site sewage disposal systems should be designed, located, and installed away from open waterbodies and sensitive resources such as wetlands and floodplains. A protective separation between the OSDS and groundwater should also be established. OSDSs should be operated and maintained to prevent surface water discharges and reduce pollutant loadings to groundwater. Inspection of OSDSs should occur regularly and repairs made immediately. New or replacement plumbing fixtures should be of the high efficiency type.

Public Education

Community awareness programs should be implemented for monitoring sanitary sewer wet weather overflows. A citizen's hotline for reporting observed overflow conditions would greatly supplement the storm water department's field screening efforts and serve to help remediate chronic wet weather sanitary sewer system overflows.

Examples of Effective Programs

City of Stockton, Municipal Storm Water Discharge Management Program contains a comprehensive program element created to prevent, detect, and eliminate illegal connections to storm sewers.

City of Fort Worth, Texas, Drainage Water Pollution Control Program. An "action" oriented program designed for corrective measures utilizing innovative biotoxicity testing. Staffing requirements are one full time person per year for a total labor cost of $30,000. Equipment, supplies and services costs approximately $50,000 per year.

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Additional Information — Leaking Sanitary Sewer Control

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Infiltration/Inflow Study, City of Austin, Texas, 1986.

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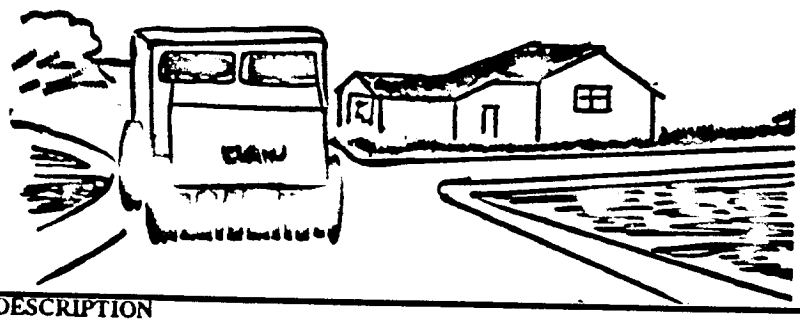
R0034096

BMP: STREET CLEANING



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- (Illegal Discharges)

DESCRIPTION

Reduce the discharges of pollutants to storm water from street surfaces by conducting street cleaning on a regular basis.

APPROACH

- Prioritize cleaning to use the most sophisticated sweepers, at the highest frequency, and in areas with the highest pollutant loading.
- Restrict street parking prior to and during sweeping.
- Increase sweeping frequency just before the rainy season.
- Proper maintenance and operation of sweepers greatly increases their efficiency.
- Keep accurate operation logs to track program.
- Reduce the number of parked vehicles using regulation.

REQUIREMENTS

- Cost Considerations
  - A street cleaning program requires a significant capital and O&M budget. Sweeper capital costs range from $65,000 to $120,000, with a useful life of about 4 years. A careful review of cleaning efficiency should be performed before increased cleaning is proposed.
- Regulations
  - Densely populated areas or heavily used streets may require parking regulations to clear streets for cleaning.
- Administrative / Staffing
  - Sweeper operators, maintenance, supervisory, and administrative personnel are required.
  - Traffic control officers may be required to enforce parking restrictions.
  - Skillful design of cleaning routes is required for program to be productive.
  - Arrangements must be made for disposal of collected wastes.
- Equipment
  - Mechanical broom sweepers, vacuum sweepers, combination sweepers, and street flushers.
- Training
  - Operators must be trained in proper sweeper operation.

PUBLIC EDUCATION / PARTICIPATION

- The general public should be educated about the need to obey parking restrictions and use litter receptacles to reduce street litter.

LIMITATIONS

- No currently available conventional sweeper is effective at removing oil and grease.
- Mechanical sweepers are not effective at removing finer sediments.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ● O&M Costs
- ◒ Regulatory
- ● Staffing
- ◒ Training
- ◒ Administrative

● High ○ Low

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Additional Information — Street Cleaning

Approach

- Parked cars are the major obstacle to effective mechanical sweeping.
- Effectiveness may also be limited by street condition, traffic congestion, presence of construction projects, climatic conditions, and condition of curbs.
- Sweepers effective at removing smaller particles may generate respirable particulate matter (less than 10 microns) (i.e., dust) that would lead to concerns over worker and public safety.
- Number of passes and frequency:
  - Increase the sweeping frequency for streets with high pollutant loadings, especially in high traffic and industrial areas.
  - Increase the sweeping frequency just before the wet season to remove sediments accumulated during the summer.
  - Increase the sweeping frequency for streets in special problem areas such as special events, high litter or erosion zones.
  - To achieve 30% removal of street dirt, the sweeping interval must be no more than 2 times the average interval between storms. To reach 50% removal, sweeping must occur 1/2 to 1 times the average interval between storms.
  - Sweeping appears most effective in areas with distinct wet and dry seasons (e.g. California).
- Equipment type and operation:
  - Vacuum or regenerative air sweepers are more effective at removing the finer sediments which often bind a higher proportion of heavy metals.
  - Sweeper operation is critical to performance. Speeds of 6-8 mph are optimal. In addition, brush adjustment, rotation rate, and sweeping pattern also affect removal efficiencies.
- Source reduction:
  - Enforce construction erosion controls in urban areas.
  - Improve street conditions to increase sweeping effectiveness.
  - Enlist the help of citizens to keep yard waste, used oil, and other wastes out of the gutter.
  - Require construction contractors to implement storm water pollution prevention plans (see Construction Handbook).
- Maintenance:
  - Replace worn parts as necessary.
  - Install main and gutter brooms of the appropriate weight.
- Record Keeping/Tracking:
  - Keep accurate logs of the number of curb-miles swept.
  - Record the amount of waste collected.
  - Consider implementing employee deputization and spill tracking measures in ID1, Illegal Dumping Control, in conjunction with this BMP to facilitate control of illegal dumping.

Equipment Selection

There are advantages and disadvantages to the two common types of sweepers. The best choice depends on your specific conditions. Many communities find it useful to have a compliment of both types in their fleet.

Mechanical Broom Sweepers - More effective at picking up large debris and cleaning wet streets. Less costly to purchase and operate. Create more airborne dust.

Vacuum Sweepers - More effective at removing fine particles and associated heavy metals. Ineffective at cleaning wet streets. Noisier than mechanical broom sweepers which may restrict areas or times of operation. May require an advance vehicle to remove large debris.

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Additional Information — Street Cleaning

A third piece of equipment used by some municipalities also has its advantages and disadvantages:

Street Flushers - Not affected by biggest interference to cleaning, parked cars. May remove finer sediments, moving them toward the gutter and storm water inlets. For this reason, flushing fell out of favor and is now used primarily after sweeping. Flushing may be effective for combined sewer systems. Presently street flushing is not allowed under most NPDES permits.

Cross-Media Transfer of Pollutants

The California Air Resources Board (ARB) has established state ambient air quality standards including a standard for respirable particulate matter (less than or equal to 10 microns in diameter, symbolized as PM_{10}). In the effort to sweep up finer sediments to remove attached heavy metals, municipalities should be aware that fine dust, that cannot be captured by the sweeping equipment and becomes airborne, could lead to issues of worker and public safety.

Examples of Effective Programs

In the City and County of San Francisco, ninety percent of the streets are swept at least once per week, and some sections are swept two to three times per week. San Francisco is also converting as much of its fleet as possible to vacuum sweepers.

REFERENCES

Best Management Practices for Street Cleaning (Draft), Maintenance Subcommittee, Alameda County Urban Runoff Clean Water Program, 1992.

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Characterizing and Controlling Urban Runoff Through Street and Sewerage Cleaning, EPA/600/2-85/038, PB85-186500, USEPA, 1985.

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Guide to Nonpoint Source Pollution Control, USEPA, 1987.

Mustard, M.H., Ellis, S.R. and Gibbs, J.W., "Runoff and Washoff Loads from Rainfall - Simulation Experiments on a Street Surface and a Native Pasture in the Denver Metropolitan Area, Colorado, USGS, Open-File Report 84-820, 1985.

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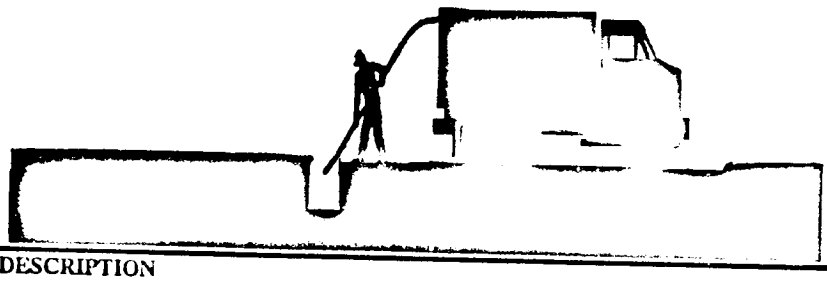
R0034099

BMP: CATCH BASIN CLEANING



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- (Illegal Discharges)

DESCRIPTION

Maintain catch basins and storm water inlets on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basins' sediment trapping capacity. A catch basin is distinguished from a storm water inlet by having at its base a sediment sump designed to catch and retain sediments below the overflow point. This fact sheet focuses on the cleaning of accumulated sediments from catch basins.

APPROACH

- Aggressively enforce anti-littering and illegal dumping ordinances.
- Catch basins should be cleaned regularly to reduce the possibility of sediment and pollutant loading from the flushing effect of storm water inflow.
- Prioritize maintenance to clean catch basins and inlets in areas with the highest pollutant loading.
- Keep accurate operation logs to track program.

REQUIREMENTS

- Cost Considerations
  - An aggressive catch basin cleaning program could require a significant capital and O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is implemented.
- Regulations
  - There are no regulatory requirements for this BMP. Municipal codes should include sections prohibiting the disposal of soil, debris, refuse, hazardous waste, and other pollutants into the storm drain system, and prohibiting littering.
- Administrative / Staffing
  - Two-person teams may be required to clean catch basins with vactor trucks.
  - Arrangements must be made for proper disposal of collected wastes.
- Equipment
  - Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as eductors, vacuums, or bucket loaders.
- Training
  - Crews must be trained in proper maintenance, including record keeping and disposal.

PUBLIC EDUCATION / PARTICIPATION

- Educate contractors (cement, masonry, painting) and utility employees (telephone, cable, gas and electric) about proper waste (solid and liquid) disposal.

LIMITATIONS

- There are no major limitations to this best management practice.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ● O&M Costs
- ○ Regulatory
- ● Staffing
- ◒ Training
- ◒ Administrative

● High ○ Low

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Additional Information — Catch Basin Cleaning

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper functioning. Clogged catch basins are not only useless but may act as a source of sediments and pollutants. In general, the keys to effective catch basins are:

- At least annual inspections. Municipal staff should inspect public and private facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC30, Storm Drain System Signs).
- Clean catch basins in high pollutant load areas just before the wet season to remove sediments and debris accumulated during the summer.
- Keep accurate logs of the number of catch basins cleaned.
- Record the amount of waste collected.
- Consider implementing employee deputization and spill tracking measures in SC50, Illegal Dumping Control, in conjunction with this BMP to facilitate control of illegal dumping.

Public education should be implemented in conjunction with the public education effort in SC50, Illegal Dumping Control, to raise awareness of the problem. Information in the Construction Handbook regarding waste management (BMPs CA20-CA24) may be used to develop a program for contractors.

REFERENCES

Best Management Practices for Storm Drainage Facilities (Draft), Maintenance Subcommittee, Alameda County Urban Runoff Clean Water Program, 1992.

Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota, Minnesota Pollution Control Agency, 1989.

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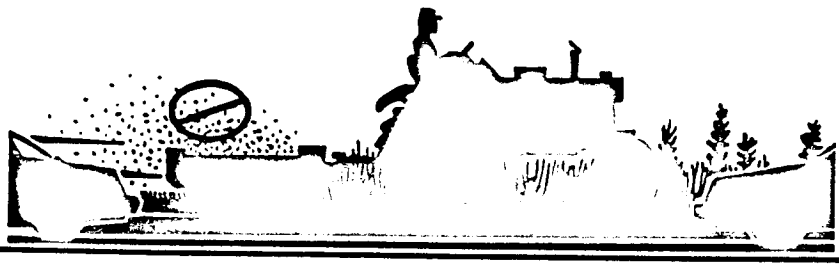
BMP: VEGETATION CONTROLS

Graphic: North Central Texas COG, 1993



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. Mechanical vegetation control methods are discussed herein, vegetation control by herbicides are addressed in BMP SC10 of this chapter. Mechanical vegetation control includes leaving existing vegetation, cutting less frequently, handcutting, planting low maintenance vegetation, collecting and properly disposing of clippings and cuttings, and educating employees and the public.

APPROACH

- Areas of Concern
  - Steep slopes.
  - Vegetated drainage channels.
  - Creeks.
  - Areas adjacent to catch basins.
  - Detention/retention basins.
- Areas Exempt
  - Flat or relatively flat vegetated areas.
  - Areas not adjacent to drainage structures.
  - Areas screened from drainage structures by vegetation.

REQUIREMENTS

- Cost Considerations
  - Possible minor cost impact of upgrading certain mowing equipment for bagging.
  - Possible cost impact for additional laborers involved in hand cutting and picking up clippings.
- Regulations
  - Local municipal anti-dumping ordinances.
- Administrative/Staffing
  - Possible need for additional labor to hand cut and pick up clippings from areas where mechanical cutting and collection is not practicable.
  - Train landscape contractors and municipal employees re. vegetation controls.

PUBLIC EDUCATION/PARTICIPATION

- Promote volunteer services to create litter collection groups (such as Adopt-a-Stream).
- Educate public regarding anti-dumping practices (fold into existing household hazardous waste program), and impact of erosion from new construction.

LIMITATIONS

- Does not address problems associated with herbicide use.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ○ Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Regulatory
- ○ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Vegetation Controls

Mechanical control of vegetation includes mowing, "bush-bogging", and hand cutting. Large scale mowing is typically done by tractor-type mowers similar to farm machinery. "Bush-bogging" usually refers to tractor mounted mowing equipment with hydraulically mounted cutting machinery. On smaller areas, lawn tractors or push mowers may be used. In areas that are inaccessible by machinery, such as steep grades and rocky terrain, hand cutting using gas powered weed trimmers and scythes may be used.

Clippings and cuttings are the primary waste produced by mowing and trimming. Clippings and cuttings are almost exclusively leaf and woody materials. In some cases, litter may be intermingled with the clippings along public right-of-ways. The objective of this BMP is to minimize transportation of clippings and cuttings into the storm water conveyance system.

Clippings/cuttings carried into the storm water system and receiving streams can degrade water quality in several ways. Suspended solids will increase causing turbidity problems. Since most of the constituents are organic, the biological oxygen demand will increase causing a lowering of the available oxygen to animal life. In areas where litter and other solid waste pollution exists, toxic materials may be released into receiving streams with a resulting degradation of water quality.

A related problem exists with the illegal dumping of clippings/cuttings in or near drainage facilities. Often, landscapers and private maintenance people will discover that clippings/cuttings can easily be disposed of by dumping them down a nearby ravine or on the slope of a creek or drainage channel. This practice introduces a large quantity of decaying organic matter into the storm water collection system that is subsequently carried to receiving streams during the next storm.

Measures to improve the disposition of clippings/cuttings are simple and inexpensive. For the most part, the solution to this problem involves behavior modification through education. Awareness of the problem is the first step toward the solution.

Firstly and for new developments in particular, the easiest and least expensive measure is to leave the existing vegetation in place. Native vegetation typically requires much less maintenance than introduced vegetation. Secondly, consider mowing or trimming vegetation, both native and introduced, less frequently, thereby generating less waste. Thirdly, if introduced vegetation is necessary, consider planting low maintenance grasses and shrubs. Another advantage to these strategies is considerable water savings.

Once this vegetative waste is generated the main concern is to avoid transport of clippings/cuttings to receiving water bodies. It is necessary to pick up and properly dispose of clippings/cuttings on the slopes and bottom of drainage facilities, including storm water detention/retention facilities. In addition, the presence of clippings/cuttings in and around catch basins should be avoided by either using bagging equipment or manually picking the material up. Clippings/cuttings on flat surfaces are generally not transported by storm water runoff unless the event is particularly intense. Therefore, it is not necessary to pick up or bag clippings/cuttings on flat or nearly flat surfaces. Municipal operators should be trained to use good judgement in determining whether clippings/cuttings should be collected or left in place.

Mowing should be performed at optimal times. Mowing should not be performed if significant rain events are predicted.

Mulching mowers may be recommended for certain areas. Mulching mowers should be encouraged for homeowners in flat areas. Mulching mowers have the added benefit of reducing the fertilizer demand through reuse of organic material. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.

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Additional Information — Vegetation Controls

Municipal anti-dumping ordinances should be enacted or reinforced (if necessary) so that private dumping of vegetative debris is not allowed. It is important that these ordinances be clear and enforceable.

Education and public participation are important elements in control of this unacceptable practice. Information regarding this subject should be incorporated into other local environmental education programs such as the household hazardous waste education program and pesticide education efforts.

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities.

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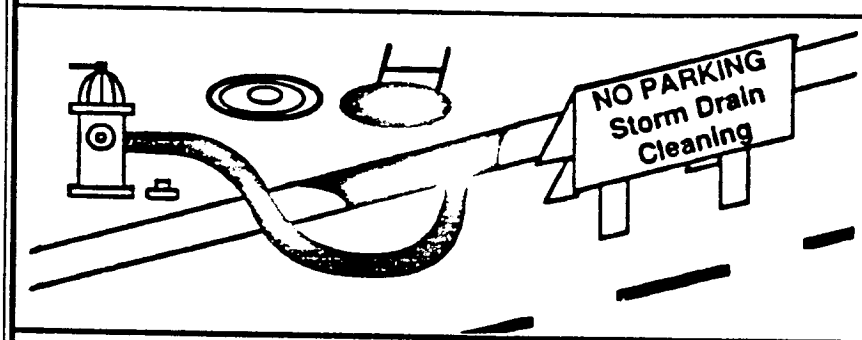
BMP: STORM DRAIN FLUSHING



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

A storm drain is "flushed" with water to suspend and remove deposited materials. Flushing is particularly beneficial for storm drain pipes with grades too flat to be self-cleansing. Flushing helps ensure pipes convey design flow and removes pollutants from the storm drain system.

APPROACH

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Whenever possible, flushed effluent should be collected and pumped to the sanitary sewer for treatment.

REQUIREMENTS

- Cost Considerations
  - Unless flushing to a dry/wet detention area, the collection of liquid and sediments may be costly in terms of pollutant removal benefits.
- Regulations
  - Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous waste, and other pollutants that may hinder the designed conveyance capacity of the storm drain system.
- Administrative/Staffing
  - Minimum 2-person teams needed for routine sediment removal and flush water collection.
  - Equipment operators required.
- Equipment
  - Water source (water tank truck, fire hydrant).
  - Sediment collector (eductor/vacuum truck, dredge).
  - Inflatable devices to block flow.
  - Sediment/turbidity containment/treatment equipment required if flushing to an open channel.

PUBLIC EDUCATION/PARTICIPATION

- If large scale flushing activities are undertaken, local residents should be informed in advance.
- The public should be educated about the purpose of storm drains and the problems created by illegal dumping.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ● O&M Costs
- ○ Regulatory
- ● Staffing
- ◒ Training
- ○ Administrative

● High ○ Low

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BMP: STORM DRAIN FLUSHING (Continue)

LIMITATIONS

- Most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity).
- Available water source.
- May have difficulty finding downstream area to collect sediments.
- Requires liquid/sediment disposal.
- Disposal of flushed effluent to sanitary sewer may be prohibited in some areas.

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R0034106

Additional Information — Storm Drain Flushing

Sanitary sewer flushing is a common maintenance activity used to improve water quality discharge in areas with combined sewer systems, after extended dry periods where insufficient flow fails to move along heavier particles. The same principles that make sanitary sewer flushing effective can be used to flush storm drains. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as to an open channel, to another point where flushing will be initiated, or over to the sanitary sewer and on to the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. The deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce the impacts of storm water pollution, a second inflatable device, placed well downstream, may be used to re-collect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to re-collect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75 percent for organics and 55-65 percent for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

REFERENCES

Dry Weather Deposition and Flushing for Combined Sewer Overflow Pollution Control, U.S. EPA, EPA-600/2-79-133, August 1979.

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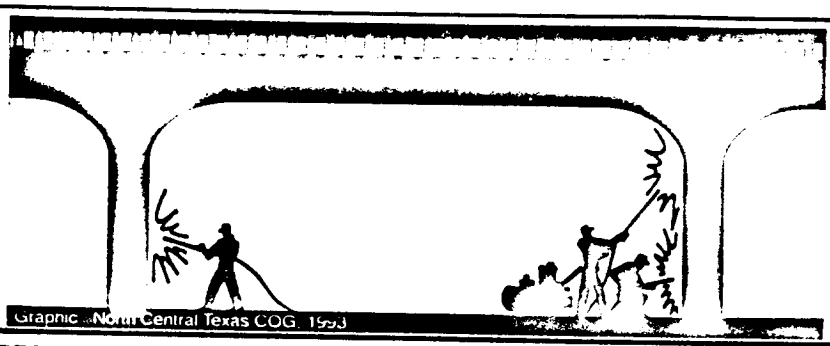
R0034107

BMP: ROADWAY/BRIDGE MAINTENANCE



Program Elements

- *New Development*
- *Residential*
- *Commercial Activities*
- *Industrial Activities*
- *Municipal Facilities*
- *Illegal Discharges*

DESCRIPTION

Address storm water pollution from roadway and bridge maintenance on a site-specific basis. The disposition and subsequent magnitude of pollutants found in road and bridge runoff is variable and affected by climate, surrounding land use, roadway or bridge design, traffic volume, and frequency and severity of accidental spills.

This BMP focuses on maintenance. For information on roadway construction, see the Construction BMP Handbook.

APPROACH

- Prevent or reduce the discharge of pollutants to storm water from roadway and bridge maintenance by paving as little area as possible, designing bridges to collect and convey storm water, using measures to prevent runon and runoff, properly disposing of maintenance wastes, and training employees and subcontractors.

REQUIREMENTS

- Cost Considerations
  - In general, this is a low cost BMP.
- Regulations
  - Consider requiring new bridges to incorporate treatment control BMPs (Chapter 5) in the design.
- Administrative / Staffing
  - This BMP has no major administrative or staffing requirements.
- Equipment
  - Keep ample supplies of drip pans or absorbent materials on-site.
- Training
  - Instruct employees and subcontractors to ensure that measures to reduce the storm water impacts of roadway/bridge maintenance are being followed.
  - Require engineering staff and/or consulting A/E firms to address storm water quality in new bridge designs or existing bridge retrofits.

PUBLIC EDUCATION / PARTICIPATION

- This is not a significant element of this BMP.

LIMITATIONS

- The minimization of impervious areas may be limited by minimum required widths for roadways, shoulders, etc.
- The siting of new bridges is limited by available land, socioeconomic, fiscal, and political issues.

Targeted Constituents

- ● *Sediment*
- ● *Nutrients*
- ● *Heavy Metals*
- ○ *Toxic Materials*
- ○ *Floatable Materials*
- ● *Oxygen Demanding Substances*
- ○ *Oil & Grease*
- ● *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Regulatory*
- ○ *Staffing*
- ◒ *Training*
- ○ *Administrative*

● *High* ○ *Low*

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Additional Information — Roadway/Bridge Maintenance

Roadways

Roadway maintenance often involves the use of concrete or asphalt to either create impervious surface areas or to repair existing roadways. Maintenance may also include the application of herbicides, the painting of stripes, and the application of deicing chemicals and sand in the winter. The easiest and least expensive measure to reduce storm water pollution from roadways is to:

- Minimize impervious area. The creation of impervious surface areas causes storm water quantity and quality problems. See SC1 (Land Use Planning/Management) in this Chapter and ESC2 (Preservation of Existing Vegetation) in Chapter 5 of the Construction Handbook for more information.

If paving is necessary the following steps will help reduce the impacts to storm water:

- Avoid paving during wet weather.
- Regularly repair potholes and worn pavement to reduce sediment loading.
- Store materials away from drainage courses to prevent pollution of storm water runon (see SC20 Material Storage Control).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs designed to divect runoff or trap/filter sediment (see Chapter 5, Construction BMP Handbook).
- Leaks and spills from paving equipment can contain toxic levels of heavy metals, oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See CA32 (Vehicle and Equipment Maintenance) and CA12 (Spill Prevention and Control) in the Construction Handbook for more information.
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.
- Shovel or vacuum saw-out slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- If paving involves Portland cement concrete, see CA23 (Concrete Waste Management) in the Construction Handbook for more information.
- If paving involves asphaltic concrete:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Properly dispose of this waste by referring to CA20 (Solid Waste Management) in the Construction Handbook.
  - Old asphalt must be disposed of properly. Collect and remove all broken asphalt and recycle whenever possible.
- If paving involves mixing concrete with an on-site mixing plant, follow the storm water permitting requirements for industrial activities.

In addition to the specific paving measures above, the following general measures should also be implemented.

- Sweep and vacuum heavily travelled roadways to remove accumulated sediment and debris (See SC70, Street Cleaning).
- Ensure proper handling, application, and disposal of pesticides, fertilizers, and paints (See SC10, Housekeeping Practices).
- Do not over-apply deicing salt and sand, and routinely calibrate spreaders.
- Near reservoirs, restrict the application of deicing salt and redirect any runoff away from reservoirs.
- Consider using alternative products (fertilizers, pesticides, paints, deicing agents) (See SC11, Safer Alternatives).
- Train employees and subcontractors to reduce the discharge of wastes during roadway maintenance.

Bridges

Bridges that carry vehicular traffic generate some of the more direct discharges of runoff to surface waters. Bridge scupper drains cause a direct discharge of untreated storm water into receiving waters and have been shown to carry relatively high concentrations of pollutants. Bridge maintenance also generates wastes that may be either directly

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deposited to the water below or carried to the receiving water by storm water. The following steps will help reduce the storm water impacts of bridge maintenance:

- Site new bridges so that significant adverse impacts to wetlands, sensitive areas, critical habitat, and riparian vegetation are minimized.
- Design new bridges to avoid the use of scupper drains and route runoff to land for treatment control. Existing scupper drains should be cleaned on a regular basis to avoid sediment/debris accumulation.
- Reduce the discharge of pollutants to surface waters during maintenance by using suspended traps, vacuums, or booms in the water to capture paint, rust, and paint removing agents. Many of these wastes may be hazardous. Properly dispose of this waste by referring to CA21 (Hazardous Waste Management) in the Construction Handbook.
- Train employees and subcontractors to reduce the discharge of wastes during bridge maintenance.

REFERENCES

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control ; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

The Florida Development Manual: A Guide to Sound Land and Water Management, State of Florida, Department of Environmental Regulation, 1988.

Hot-Mix Asphalt Paving Handbook, US Army Corps of Engineers, AC 150/5370-14, Appendix I, July 1991.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, USEPA, 1991.

Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992.

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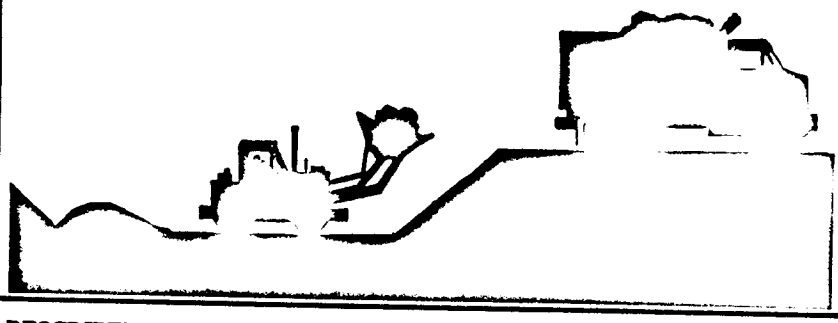
BMP: DETENTION/INFILTRATION DEVICE MAINTENANCE



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- (Municipal Facilities)
- Illegal Discharges

DESCRIPTION

Proper maintenance and siltation removal is required on both a routine and corrective basis to promote effective storm water pollutant removal efficiencies for wet/dry detention pond and infiltration devices.

APPROACH

- Remove silt after sufficient accumulation.
- Periodically clean accumulated sediment and silt out of pre-treatment inlets.
- Infiltration device silt removal should occur when the infiltration rate drops below 1/2 inch per hour.
- Removal of accumulated paper, trash, and debris should occur every six (6) months or as needed to prevent clogging of control devices.
- Vegetation growth should not be allowed to exceed 18 inches in height.
- Mow the slopes periodically and check for clogging, erosion and tree growth on the embankment.
- Corrective maintenance may require more frequent attention (as required).

REQUIREMENTS

- Cost Considerations
  - Frequent sediment removal can be labor intensive and costly. However, properly designed ponds allow for easy removal of accumulated sediments at relatively minor cost.
  - Cost of waste material for transport and disposal.
- Administrative/Staffing
  - Two-person teams may be needed for routine silt removal and excavation.
  - Program manager needed to track maintenance activities and provide field assistance.
  - Staff team needed for corrective maintenance activities.
- Regulations
  - Permits may be required by Corps or Engineers, Fish & Wildlife or State Fish & Game.
- Equipment
  - Vehicles, dump trucks, bulldozers, trackhoes, excavators, mowers, weed trimmers, sickles, machetes, shovels, rakes, and personal protective equipment (PPE), (goggles, dust masks, coveralls, boots, gloves).
- Training
  - Appropriate excavation and maintenance procedures.
  - Proper waste disposal procedures.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ◒ Staffing
- ○ Training
- ○ Administrative

● High ○ Low

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BMP: DETENTION/INFILTRATION DEVICE MAINTENANCE (Continue)

PUBLIC EDUCATION/PARTICIPATION

- Create a public education campaign to explain the function of wet/dry detention pond/infiltration devices and their operational requirements for proper effectiveness
- Encourage the public to report wet/dry detention pond/infiltration devices needing maintenance

LIMITATIONS

- Wet detention pond dredging can produce slurried waste that often exceeds the requirements of many landfills
- Frequent sediment removal is labor and cost intensive

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Additional Information — Detention/Infiltration Device Maintenance

Maintenance

Proper maintenance of detention pond and infiltration device systems is a source control procedure necessary to ensure effective storm water pollutant removal efficiency. Routine and corrective maintenance needs should be monitored after storms for proper function of wet ponds, extended detention basins, and infiltration device structures. Proper maintenance of these structures requires periodic silt/sediment and trash debris removal, as well as timely vegetation control. Detention basin silt removal should occur when the accumulated depth exceeds six (6) inches on average in basins without sediment traps. In basins with sediment traps, silt removal should occur when accumulation exceeds four (4) inches.

More frequent sediment removal is recommended, especially in areas where roadway drainage provides a significant runoff component. High accumulation rates of heavy metal contaminants (lead, zinc, copper) have been identified in these BMP structures adjacent to high traffic areas. In order to avoid situations of hazardous waste disposal, sediment dredging and excavation should be given frequent priority.

Maintenance crews may require access vehicles, dump trucks, bulldozers, and dredging/excavation equipment. Manual use equipment (such as rakes, shovels, sickles, machetes) may suffice for maintenance of dry detention ponds and infiltration device systems. Staffing will require a minimum of two (2) person crews for health and safety reasons and effective structural BMP maintenance. A program manager should oversee operations either in the field or be readily accessible for providing procedural advice or direction. For corrective maintenance activities, a contingent team of field staff should be ready to mobilize for remedial action.

A public awareness campaign for educating the community of the operational and maintenance requirements of these BMP structures for pollutant removal effectiveness would assist in the monitoring of these systems. A community phone number for the reporting of structures - public and private - in need of maintenance would help to provide corrective maintenance as required.

REFERENCES

Florida Development Manual: A Guide to Sound Land and Water Management, Storm water and Erosion and Sediment Control BMPs for Developing Areas, Florida Department of Environmental Regulation, 1988.

Environmental Criteria Manual, Design Guidelines for Water Quality Control, City of Austin, Texas, 1989.

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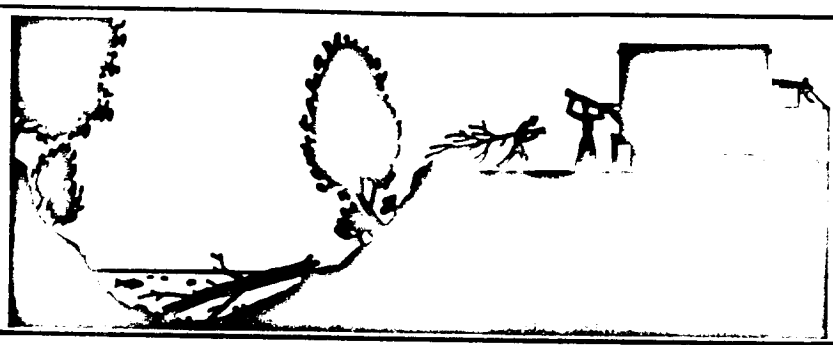
BMP: STORM CHANNEL/CREEK MAINTENANCE



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- Municipal Facilities
- Illegal Discharges

DESCRIPTION

Reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. Modify channel characteristics to enhance pollutant removal and/or hydraulic capacity.

APPROACH

- Identification of illegal dumping hot spots; regular inspection and clean up of hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Posting "No Littering" signs with a phone number for reporting a dumping in-progress.
- Adoption and enforcement of substantial penalties for illegal dumping and disposal.
- Modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to enhance channel/creek aesthetic and habitat value.
- Maintenance of accurate logs to evaluate materials removed and improvements made.

REQUIREMENTS

- Cost Considerations
  - Purchase and installation of signs.
  - Cost of vehicle(s) to haul illegally-disposed items and material to landfills.
  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.
  - Purchase of landfill space to dispose of illegally-dumped items and material.
  - Capital and maintenance costs for channel modifications.
- Regulations
  - Adoption of substantial penalties for illegal dumping and disposal.
- Administration/Staffing
  - Larger municipalities should commit at least one full-time staff person; smaller municipalities at least one part-time staff person. Additional staff as-needed.
- Equipment and Materials (see discussion above).
- Training
  - Channel maintenance and use of heavy equipment.
  - Identification and handling of hazardous materials/wastes.

PUBLIC EDUCATION/PARTICIPATION

- Education on the need for proper disposal of refuse.
- Notification of penalties for illegal dumping/disposal.

LIMITATIONS

- Clean-up activities may create a slight disturbance for local aquatic species.
- Access to items and material on private property may be limited.
- Trade-offs may exist between channel hydraulics and water quality/riparian habitat.
- Worker/public safety may be at risk in crime-ridden or homeless-populated areas.
- If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Regulatory
- ◒ Staffing
- ● Training
- ○ Administrative

● High ○ Low

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Additional Information — Storm Channel/Creek Maintenance

Clean-up Activities

Although illegally dumped items have not been quantified in terms of their contribution to storm water runoff pollution, the potential exists for significant reductions in runoff metals loadings as a result of comprehensive storm channel and creek maintenance. Potentially significant sources of toxic pollutants in storm channels and creeks may include the following:

- Car bodies and automotive scrap,
- Car batteries,
- Tires,
- Hazardous materials/waste,
- Various metallic items (shopping carts, furniture, appliances, etc.),
- Animal waste, and
- Wastes from homeless people encampments.

In addition to the obvious benefit of reducing pollutants in storm water runoff, an equally important benefit of channel/creek maintenance is the dramatic aesthetic improvement achieved by removing all illegally-dumped wastes from a given stretch of a storm channel or creek. Use of such areas for illegal dumping creates an eyesore and reflects poorly on a community that might otherwise be making a conscientious effort to improve the environment. Consequently, storm channel/creek maintenance efforts should not focus solely on removing those items known to pose a threat to water quality. Instead, the effort should be directed toward all illegally dumped materials, including common household trash, litter, and non-metallic and/or inert materials of all kinds. In this way, water quality improvement and significant aesthetic enhancement can both be achieved.

Channel Modification/Improvement

Urbanization, particularly land clearing and construction, tends to disrupt stream equilibrium, by temporarily intensifying sediment yield to streams. In addition to the cleanup practices described above, implementation of the erosion and sediment control BMPs presented in the Construction Handbook can also significantly reduce the effects of urbanization on streams.

It should be noted that any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a stream or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

Flow Management

Flow management has been one of the principal motivations for designing urban stream corridors in the past. Such needs may or may not be compatible with the storm water quality goals in the stream corridor.

Downstream flood peaks can be suppressed by reducing throughflow velocity. This can be accomplished by reducing gradient with grade control structures or increasing roughness with boulders, dense vegetation, or complex banks forms. Reducing velocity correspondingly increases flood height, so all such measures have a natural association with floodplain open space. Flood elevations laterally adjacent to the stream can be lowered by increasing throughflow velocity.

However, increasing velocity increases flooding downstream and inherently conflicts with channel stability and human safety. Where topography permits, another way to lower flood elevation is to lower the level of the floodway with drop structures into a large but subtly excavated bowl where flood flows are allowed to spread out.

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Additional Information — Storm Channel/Creek Maintenance

Stream Corridor Planning

Urban streams receive and convey storm water flows from developed or developing watersheds. Planning of stream corridors thus interacts with urban storm water management programs. If local programs are intended to control or protect downstream environments by managing flows delivered to the channels, then it is logical that such programs should be supplemented by management of the materials, forms, and uses of the downstream riparian corridor. Any proposal for stream alteration or management should be investigated for its potential flow and stability effects on upstream, downstream, and laterally adjacent areas. The timing and rate of flow from various tributaries can combine in complex ways to alter flood hazards. Each section of channel is unique, influenced by its own distribution of roughness elements, management activities, and stream responses.

Flexibility to adapt to stream features and behaviors as they evolve must be included in stream reclamation planning. The amenity and ecology of streams may be enhanced through the landscape design options of 1) corridor reservation, 2) bank treatment, 3) geomorphic restoration, and 4) grade control.

Corridor reservation - Reserving stream corridors and valleys to accommodate natural stream meandering, aggradation, degradation, and overbank flows allows streams to find their own form and generate less ongoing erosion. In California, open stream corridors in recent urban developments have produced recreational open space, irrigation of streamside plantings, and the aesthetic amenity of flowing water.

Bank treatment - The use of armoring, vegetative cover, and flow deflection may be used to influence a channel's form, stability, and biotic habitat. To prevent bank erosion, armoring can be done with rigid construction materials, such as concrete, masonry, wood planks and logs, riprap, and gabions. Concrete linings have been criticized because of their lack of provision of biotic habitat. In contrast, riprap and gabions make relatively porous and flexible linings. Boulders, placed in the bed reduce velocity and erosive power.

Riparian vegetation can stabilize the banks of streams that are at or near a condition of equilibrium. Binding networks of roots increase bank shear strength. During flood flows, resilient vegetation is forced into erosion-inhibiting mats. The roughness of vegetation leads to lower velocity, further reducing erosive effects.
Structural flow deflection can protect banks from erosion or alter fish habitat. By concentrating flow, a deflector causes a pool to be scoured in the bed.

Geomorphic restoration - Restoration refers to alteration of disturbed streams so their form and behavior emulate those of undisturbed streams. Natural meanders are retained, with grading to gentle slopes on the inside of curves to allow point bars and riffle-pool sequences to develop. Trees are retained to provide scenic quality, biotic productivity, and roots for bank stabilization, supplemented by plantings where necessary.

A restorative approach can be successful where the stream is already approaching equilibrium. However, if upstream urbanization continues, new flow regimes will be generated that could disrupt the equilibrium of the treated system.

Grade Control - A grade control structure is a level shelf of a permanent material, such as stone, masonry, or concrete, over which stream water flows. A grade control structure is called a sill, weir, or drop structure, depending on the relation of its invert elevation to upstream and downstream channels.

A sill is installed at the preexisting channel bed elevation to prevent upstream migration of nickpoints. It establishes a firm base level below which the upstream channel can not erode.

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A weir or check dam is installed with invert above the preexisting bed elevation. A weir raises the local base level of the stream and causes aggradation upstream. The gradient, velocity, and erosive potential of the stream channel are reduced. A drop structure lowers the downstream invert below its preexisting elevation, reducing downstream gradient and velocity. Weirs and drop structure control erosion by dissipating energy and reducing slope velocity.

When carefully applied, grade control structures can be highly versatile in establishing human and environmental benefits in stabilized channels. To be successful, application of grade control structures should be guided by analysis of the stream system both upstream and downstream from the area to be reclaimed.

Examples of Effective Programs

The California Department of Water Resources began the Urban Stream Restoration Program in 1985. The program provides grant funds to municipalities and community groups to implement stream restoration projects. The projects reduce damages from streambank and watershed instability and floods while restoring streams' aesthetic, recreational, and fish and wildlife values.

In Buena Vista Park, upper floodway slopes are gentle and grassed to achieve continuity of usable park land across the channel of small boulders at the base of the slopes.

The San Diego River is a large, vegetatively lined channel, which was planted in a variety of species to support riparian wildlife while stabilizing the steep banks of the floodway.

REFERENCES

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-328, Journal of Soil and Water Conservation.

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Chapter 8

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5. TREATMENT CONTROL BMPs

INTRODUCTION

This chapter describes specific treatment control Best Management Practices (BMPs) for removing pollutants in storm water from urbanized areas.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Suitable Applications
- Selection Criteria
- Limitations
- Design and Sizing Considerations
- Construction/Inspection Considerations
- Maintenance Requirements
- Cost Considerations

The side bar presents information on which BMP considerations, targeted constituents, and an indication of the level of effort and costs to implement. The remainder of the fact sheet provides further information on some or all of these topics, and provides references for additional guidelines.

BMP fact sheets are provided for each of the following controls:

Treatment Control BMPs

TC1 Infiltration
TC2 Wet Ponds
TC3 Constructed Wetlands
TC4 Biofilters
TC5 Extended Detention Basins
TC6 Media Filtration
TC7 Oil/Water Separators and Water Quality Inlets
TC8 Multiple Systems

GENERAL PRINCIPLES

There are several general principles that are applicable to all treatment control BMPs.

- **Priority should be given to source control:** Source control BMPs are generally (but not always) less expensive than treatment control BMPs. Also, treatment control BMPs will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

- **Recognize the unique California climate:** With few exceptions most storm water treatment experience has been in "wet" states where vegetation can be maintained without irrigation. In contrast, California's climate is semi-arid with the exception of the north coast. The treatment control BMPs that require vegetative cover may not be practical for many areas of California unless irrigation is provided. Also, design criteria have emerged from research of facilities located in climates where the rainfall season is coincident with the growth of vegetation. However, in California, the wet season does not occur during the primary growth season. Caution must be used in using design criteria that have been developed elsewhere in the nation.

- **Design Storm Size:** It is commonly thought by those unfamiliar with urban runoff quality management that design storms for sizing water quality controls should be the same as those used for the design of drainage facilities. This is not true. The damage done to a receiving water by the pollutant wash-off of a 25 year storm (commonly used to size a drainage system) is inconsequential to the

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potential hydraulic damage. Of concern to water quality control are the small frequent events, smaller than the 1-year storm, that carry the vast majority of runoff and pollutants. There is little or no incremental benefit from sizing facilities to treat the extreme events.

- **Bare and erosive soils may affect treatment control BMPs:** Protection of natural watercourses requires that sediment transport not be altered for the watercourse. Therefore, consideration must be given to transport loads. In addition, many residential developments in California have open space areas covered by native vegetation. Because of the semi-arid climate, the vegetation is thin allowing for erosion during severe storms. These higher than normal sediment loads may adversely impact the performance and maintenance requirements of treatment control BMPs.

- **Consider the characteristics of pollutants in storm water:** The presence and concentration of pollutants is highly variable, both within and between storms. Pollutants come in two forms, particulate and dissolved. Some treatment control BMPs will only remove particulates. Various vegetated BMPs such as wet ponds are purported to remove dissolved pollutants as well as particulates. Vegetated treatment control BMPs have mechanisms that theoretically should also remove both forms, however, the data confirming the theory are limited and sometimes contradictory.

- **Incorporate multiple use objectives:** Opportunities abound to integrate storm water treatment needs with other management objectives such as the use of wet ponds and constructed wetlands for passive recreation, wildlife habitat, flood detention, and ground water recharge.

- **Maintenance is very important:** All of the treatment control BMPs described in Chapter 5 are passive systems, that is, they operate without the need for mechanical or chemical systems. Nonetheless, maintenance is very important for the facilities to operate effectively.

- **Factors to Consider:** Each fact sheet lists seven general factors that are the most common considerations in selecting a treatment control BMP. In every case, all treatment control BMPs <u>must</u> be compatible with existing flood control objectives.

  - Slope: Certain BMPs cannot be placed on or near steep slopes as the ponding of water or velocity of flow may cause instability or excessive erosion.

  - Area Required: Most BMPs require considerable area, although some can be placed underground.

  - Soil: Infiltration systems must be located on suitable soils; vegetation requires good soils; wet pond bottoms require impermeable soils.

  - Water Availability: BMPs using vegetation for pollutant removal may require water during the dry season.

  - Aesthetics and safety: Where visible or accessible to the public, aesthetics or safety can be a concern with some BMPs.

  - Hydraulic Head: A few BMPs require a drop in water elevation which site topography may not provide.

  - Environmental Side Effects: Considerations for mosquito breeding, ground water contamination, as well as opportunities for aquatic wildlife and passive recreation.

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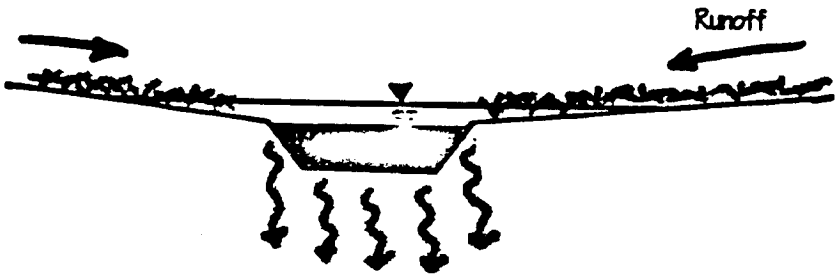
BMP: INFILTRATION



Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

EXPERIENCE IN CALIFORNIA

Infiltration ponds have been used by many local jurisdictions and CalTrans in the Central Valley for about three decades.

SELECTION CRITERIA

- Need to achieve high level of particulate and dissolved pollutant removal.
- Suitable site soils and geologic conditions; low potential for long-term erosion in the watershed.
- Multiple management objectives (e.g., ground water recharge or runoff volume control).

LIMITATIONS

- Loss of infiltrative capacity and high maintenance cost in fine soils.
- Low removal of dissolved pollutants in very coarse soils.
- Not suitable on fill sites or steep slopes.
- Risk of ground water contamination in very coarse soils, may require ground water monitoring.
- Should not use until upstream drainage area is stabilized.
- Infiltration facilities could fall under Chapter 15, Title 23, of California Code of Regulations regarding waste disposal to land.

DESIGN AND SIZING CONSIDERATIONS

- Volume sized to capture a particular fraction of annual runoff.
- Pretreatment in fine soils.
- Emergency overflow or bypass for larger storms.
- Observation well in trenches.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Protect infiltration surface during construction.
- Vegetation of pond sides to prevent erosion.
- Frequent inspection for clogging during construction.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

TC1

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BMP: INFILTRATION (Continue)

MAINTENANCE REQUIREMENTS

- Remove sediment at frequency appropriate to avoid excessive concentrations of pollutants and loss of infiltrative capacity.
- Frequent cleaning of porous pavements.
- Maintenance is difficult and costly for underground trenches.

COST CONSIDERATIONS

- Potential for high maintenance costs due to clogging.

TC1

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Additional Information — Infiltration

General Information

Where conditions are suitable infiltration systems may be the preferred choice because storm water is placed into the ground thereby reducing excess runoff and providing groundwater recharge.

Infiltration systems include:

- Infiltration basin which is an open surface pond or underground vault (Figure 1A)
- Infiltration trench which is an underground chamber filled with rock, also called a rock well (Figure 1B).
- Dry well or "vertical" infiltration trench (Figure 1C)
- Porous pavement both asphalt and concrete (Figure 1D).
- Concrete grid and modular pavement which are lattice grid structures with grassed, pervious material placed in the openings (Figure 1E).

Infiltration basins are generally used for areas less than five acres but can handle tributary areas up to 50 acres if the soil is very permeable. The other systems are suitable only for small sites of a few acres. Porous pavement and concrete grids should only be used in low traffic areas like parking areas. Studies have shown that porous pavement is strong and will last as long as conventional pavement (Field, et al, 1982; Gburek and Urban, 1980). Experience in Florida and Maryland indicates that concrete porous pavement performs better than porous asphalt.

Infiltration systems should be considered where dissolved pollutants are of concern. However, satisfactory removal efficiencies require soils that contain loam. Coarse soils are not effective at removing dissolved pollutants and fine particulates before the storm water reaches the ground water aquifer.

Infiltration basins and trenches may not be feasible if there are pervious areas in the watershed prone to erosion because of steepness, thin cover, and/or erosive soils. The infiltration surface may clog rapidly creating an unacceptable maintenance burden. For the same reason, infiltration systems cannot be used when construction is in progress since standard soil erosion and sediment control BMPs are ineffective at controlling silts. Consequently, infiltration systems may not be feasible if the development in the tributary watershed is to occur over several construction seasons.

Local jurisdictions may not feel that infiltration systems are appropriate on industrial sites where spills of hazardous chemicals can occur. However, spill control procedures may provide satisfactory control (Chapter 4). Care should be taken when considering the multiple objectives of using infiltration systems for water quality treatment, ground water recharge, and flood control. Infiltration basins, trenches, and porous pavement can meet storm water detention requirements.

Three concerns with infiltration systems are clogging, accumulation of metals, and ground water contamination. Infiltration systems have been used successfully on sandy soils in the Central Valley of California and Long Island, New York for many years without operational problems. In both instances the primary objectives are ground water recharge and flood control, not water quality treatment.

Problems can be expected with infiltration systems placed in finer soils. The State of Maryland has emphasized these systems for about 10 years where they have been installed in soils with infiltration rates as low as 0.27 inches per hour. A recent survey (Lindsey, et al., 1991) found that a third of the facilities examined (177) were clogged and another 18% were experiencing slow infiltration. Dry wells that treat roof runoff had the fewest failures (4%) and porous pavement the most (77%). Dry wells may have the lowest failure rate because they only handle roof runoff. The primary causes of failure appear to be inadequate pretreatment and lack of soil stabilization in the tributary watershed, as well as poor construction practices (Shaver, pers. comm.). Erosion of the slopes of infiltration ponds was a significant problem in almost half the facilities surveyed. Problems have occurred in the Central Valley with facilities placed on finer soils, as in the case of Modesto. (Tulloch, pers. comm.).

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Additional Information — Infiltration

Based on a review of several studies of infiltration facilities in sandy and loamy soils concluded that "monitoring ... has not demonstrated significant contamination ... although highly soluble pollutants such as nitrate and chloride have been shown to migrate to ground water" (USEPA, 1991). However, pollution has been found in ground water where infiltration devices are in coarse gravels (Adophson, 1989; Miller, 1987).

Site Selection Considerations (infiltration basin)

- Recommended minimum preconstruction infiltration rates have ranged from 0.25 to 4 inches per hour.
- One state (Ecology, 1992) has specified a maximum clay content (30%) and a minimum cation exchange capacity (5 meq).
- Not less than three feet separation from seasonal high ground water, much greater distance if soils are very coarse.
- Avoid steep (25%) slopes or other geologic conditions that would be made unstable by the infiltrating water.
- Not less than four feet separation from bedrock.
- Impact on local groundwater including recharge potential, water quality, etc.

Stahre and Urbonas (1988) have presented a site selection procedure, if the site first passes the above criteria. Presented in Table 1A is a point system. If the site receives less than 20 points it is considered unsuitable; more than 30 points is considered excellent. This procedure is used to enhance infiltration performance and minimize clogging.

Design

The degree of treatment achieved by infiltration is a function of the amount of storm water that is captured and infiltrated over time. This relationship for various areas in California is shown in Appendix D. The figures in Appendix D were developed using the hydrological model STORM.

The procedure to determine the volume of infiltration basin is as follows: (1) select the appropriate figure in Appendix D; (2) determine for the catchment the percentage of impervious area directly connected to the storm drain system; (3) choose a capture goal, and read the required unit basin storage (acre-ft. per acre) required for the infiltration basin (to provide performance similar to the other treatment control BMPs in Chapter 5, a reasonable capture goal for infiltration systems is 80%.); (4) multiply this unit figure times the total acreage of the catchment and convert to cubic feet. When using the above approach to size an infiltration trench, remember to increase the volume of the trench to account for the rock.

To calculate the minimum surface area of the infiltration system obtain the infiltration rate at the site using appropriate techniques. This value is then used in the following equations:

$$A_m = V/D_m \qquad (1)$$

where: A_m = minimum area required (ft^2)
V = volume of the infiltration basin (ft^3)
D_m = maximum allowable basin depth (ft)

The maximum allowable depth is determined from the equation:

$$D_m = 40I/12S \qquad (2)$$

where: I = site infiltration rate in inches per hour
S = safety factor

The safety factor accounts for the uncertainty of whether the infiltration test measures the real infiltration rate. Recommendations have ranged from 2 to 10 (consult your local Soil Conservation Service Office). The coefficient of 40 refers to the recommended drawdown time in hours. This is a reasonable drawdown time, given that the average time

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between storms during the wet season in California is on the order of 200 hours, except in Northern California where it is about 80 hours. A longer drawdown time may cause anaerobic conditions in the underlying soil or the production of algae during the warmer months that would clog the soil. A shorter drawdown time reduces the volume of the facility, but increases the required surface area. Appendix D contains figures for two drawdown times: 24 and 40 hours. In most of the State, reducing the drawdown time does not significantly reduce the volume.

Suggested references on the design of porous pavement include Maryland (1984) and Florida (1988).

Additional design considerations

- For basins and trenches, pretreat the storm water to remove the floatables and settleable solids, particularly when placing these systems in finer soils. Pretreatment can be accomplished with any of the other treatment control BMPs in this handbook.

Communities and CalTrans have used infiltration systems in the Central Valley for more than two decades without pretreatment. Clogging has not been a problem with well maintained systems discharging to sands and courser soils, suggesting that pretreatment is of limited value. Pretreatment when infiltrating to finer soils is suggested by the experience of Maryland described previously. An infiltration facility sized only for treatment is much smaller than one sized for flood control and therefore may be more susceptible to clogging. Communities in the Central Valley (Fresno, Modesto) require a retention volume that captures the 100 year event, or about 20,000 ft^3 per impervious tributary acre. In comparison, above Equation (1) will provide a volume in the range of 2,000 ft^3 per impervious acre.

For small systems treating less than a few acres of pavement, pretreatment can be accomplished with a Type 2 catch basin and a submerged outlet. The diameter and depth of the sump should be at least four times the diameter of the outlet pipe to the infiltration system (Lager, et al., 1977). See Figure 1C. The catch basin cover should be stenciled "dump no waste".

Additional design considerations for basins include:

- Do not locate on fill sites, or on or near steep slopes
- Energy dissipation at inlet to minimize erosion
- Vegetate the slopes for the same reason
- Vegetate the bottom to reduce tendency to clog with fines
- Freeboard of 1 foot
- Side slopes of at least 3:1 for safety, and for ease of mowing (4:1 slopes are prefered)
- Incorporate bypass or overflow for large events
- Provide dedicated access to the basin bottom (minimum 4:1) for maintenance vehicles

Vegetating the slopes and bottom will be difficult unless the facility can be irrigated during the summer. Drought tolerant ground cover species may be more suitable. See TC4 Biofilters for recommended species.

Additional design considerations for trenches include:

- Do not locate on fill sites, or on or near steep slopes
- A 4 inch or 6 inch diameter observation well with locking cap, to check for loss of infiltrative capacity
- 6 inch sand layer or geofabric at the bottom
- Geofabric around trench walls to prevent soils from migrating into the trench rock matrix
- Geofabric 12 inches below ground surface with 3/4 rock placed on top, which serves as filter for coarse solids
- Backfill and filter rock should be clean washed aggregate 1 inch to 3 inches diameter
- Incorporate bypass or overflow for large events
- Provide dedicated access for maintenance vehicles

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Additional Information — Infiltration

For porous pavement, experience in Maryland suggest that asphalt pavement has continuous plugging problems and a limited life. Frequent maintenance is required. For drywells where access for maintenance is difficult if not impossible pretreatment of the storm water is highly recommended. Such pretreatment may include biofilters, sumps, etc. Consultation with the local jurisdiction regarding the design of drywells is required.

Construction

It is very important to protect the natural infiltration rate by using light equipment and construction procedures that minimize compaction. Storm water must not be allowed to enter the facility until all construction in the catchment area is completed and the drainage area is stabilized. If this prohibition is not feasible in particular situations, do not excavate the facility to final grade until after all construction is complete upstream. Leave one foot of native soil in the basin which can be removed in layers as it clogs. Disking the surface frequently during this period may be beneficial. After final grading the final surface should also be disked. With trenches, make sure the rock fill does not become dirty while temporarily stored at the site.

The local jurisdiction may also specify that the infiltration rate of the facility be within a certain percentage of the preconstruction rate before the facility is approved or accepted.

Maintenance

Inspect the facility at least annually and after extreme events. If there is still water in the pond or trench 72 hours after a storm it is time to clean the facility. A concern is restrictions on the disposal of the sediment removed from an infiltration basin due to contamination. Limited studies suggest that this is not a problem, particularly if source-control BMPs are effective. The Fresno Metropolitan Flood Control District found noticeable accumulation of pollutants in the surface layer in infiltration basins that had not been cleaned for about 20 years although the levels were still below toxic thresholds. The basins are now cleaned at least once every three years. Limited studies of the bottom sediments in wet and extended detention ponds indicate that toxicity limits specified by final disposal regulations are not exceeded (see TC2 Wet Ponds).

Pretreatment may reduce maintenance costs by capturing gross settleable solids and floatables in a smaller space that can be more easily cleaned. Maintenance techniques for basins include rototilling, disking and deep ripping.

Porous pavement should be cleaned at least quarterly by vacuum sweeping and high pressure washing.

See Maryland (1984) and Florida (1988) for additional guidance on the design, construction, and maintenance of infiltration systems.

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TABLE 1A. POINT SYSTEM FOR EVALUATING INFILTRATION SITES

1. Ratio between tributary connected impervious area (AIMP) and the infiltration area (AINF):
   - AINF > 2 AIMP
     20 points
   - AIMP < AINF < 2 AIMP
     10 points
   - 0.5 AIMP < AINF < AIMP
     5 points

2. Nature of surface soil layer:
   - Course soils with low ratio of organic material
     7 points
   - Normal humus soil
     5 points
   - Fine grained soils with high ratio of organic material
     0 points

3. Underlaying soils:
   - If the underlaying soils are courser than surface soil, assign the same number of points as for the surface soil layer assigned under item 2 above.
   - If the underlaying soils are finer grained than the surface soils, use the following points:
   - Gravel, sand of glacial till with gravel or sand
     7 points
   - Silty sand or loam
     5 points
   - Fine silt or clay
     0 points

4. Slope (S) of the infiltration surface:
   - S < 0.07 ft/ft
     5 points
   - 0.07 < S < 0.20 ft/ft
     3 points
   - S > 0.20 ft/ft
     0 points

5. Vegetation cover:
   - Healthy natural vegetation cover
     5 points
   - Lawn is well established
     3 points
   - Lawn is new
     0 points
   - No vegetation, bare ground
     -5 points

6. Degree of traffic on infiltration surface:
   - Little foot traffic
     5 points
   - Average foot traffic (park, lawn)
     3 points
   - Much foot traffic (playing fields)
     0 points

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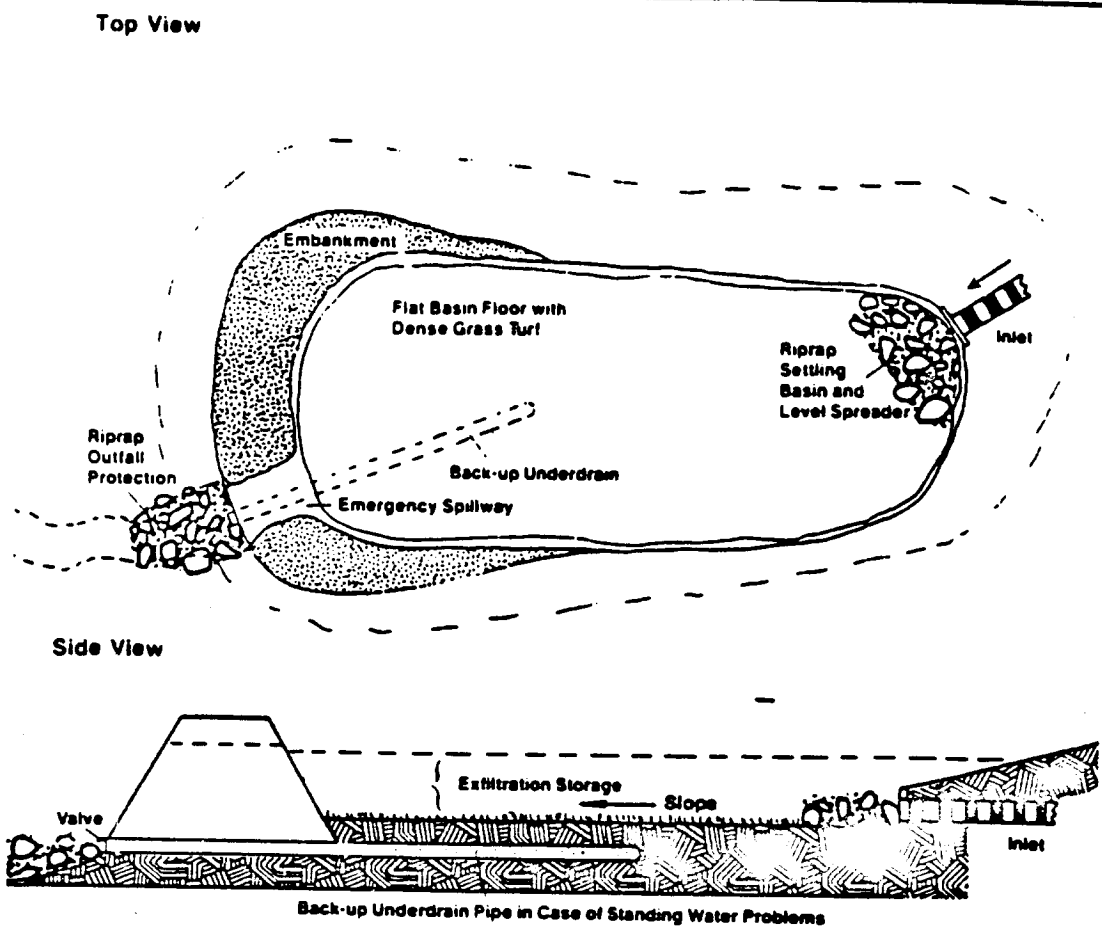
Additional Information — Infiltration



Source: Schueler (1987)

NOTE:

1. Backup underdrain is not used in most applications because plugging occurs in soil above the drain.
2. An infiltration basin can also be excavated (typically 2 to 6 feet deep) as long as the bottom of the basin is 3 feet above high seasonal water table.

FIGURE 1A. INFILTRATION BASIN

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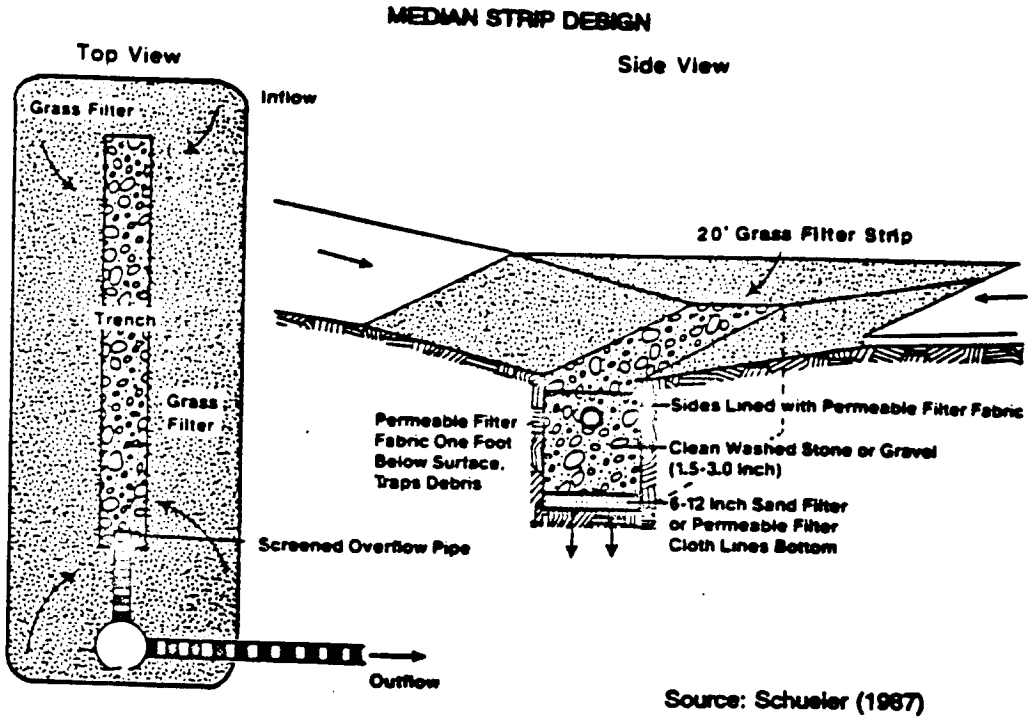

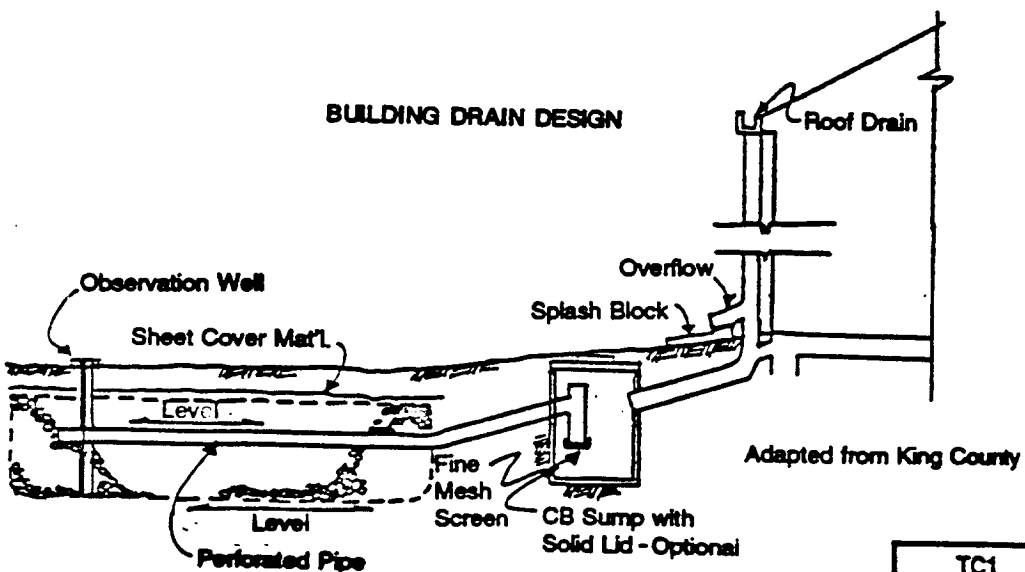

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FIGURE 1B. INFILTRATION TRENCHES

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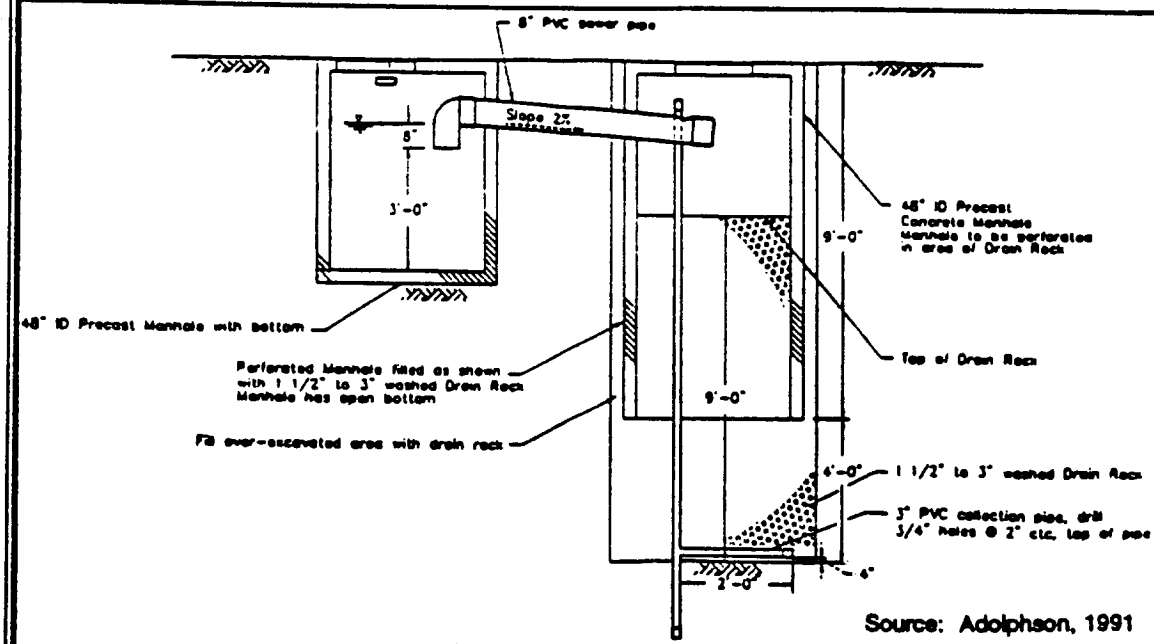
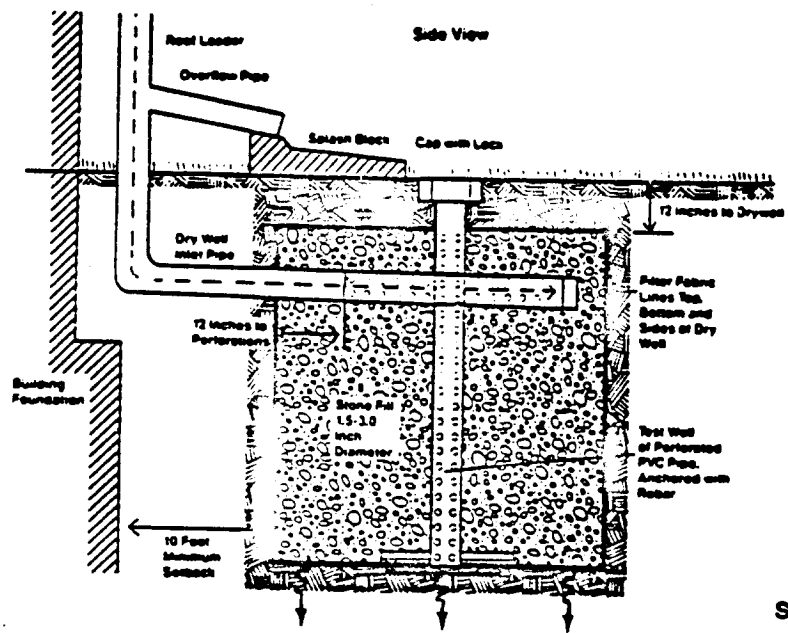


Source: Adolphson, 1991

WITH PRETREATMENT



Source: Schueler, 1987

Note: See discussion on page 5-6 regarding design considerations.

WITHOUT PRETREATMENT

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FIGURE 1C. DRYWELL CONFIGURATIONS

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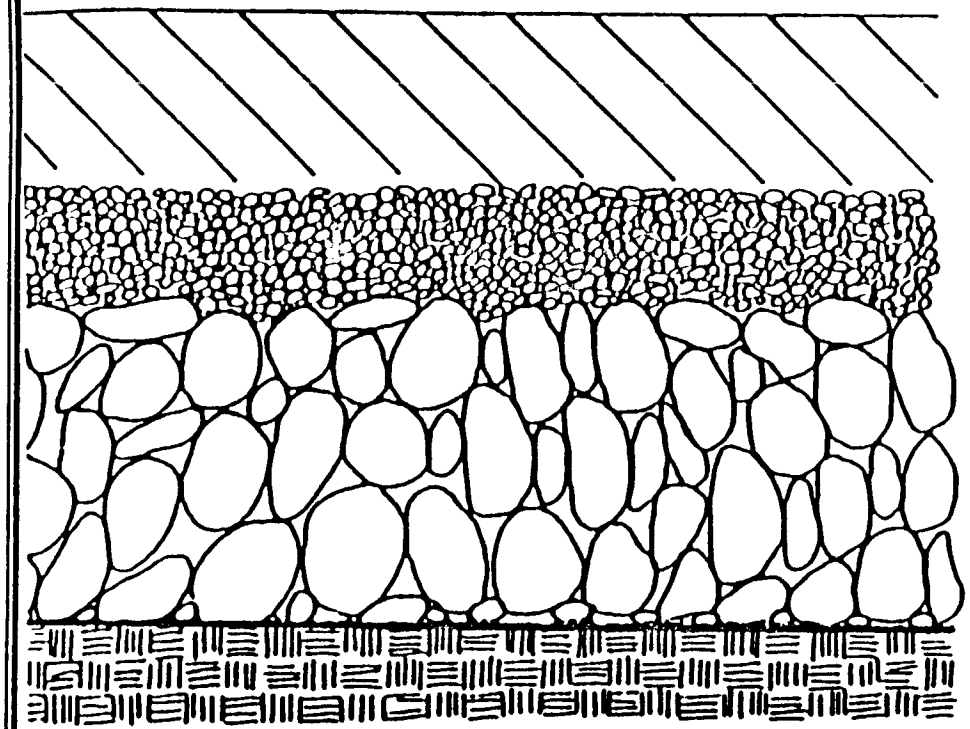

POROUS ASPHALT SURFACE COURSE
1/2" to 3/4" Aggregate
asphaltic mix

2.5 to 4" thickness typical

FILTER COURSE
1/2" Aggretate
2" Thickness

RESERVOIR BASE COURSE
1" to 2" Aggregate
Voids volume is designed for
runoff Retention

Thickness is based on storage
required

FILTER FABRIC

EXISTING SOIL
Minimal compaction to retain
porosity and permeability

Source: City of Rockville, Maryland

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FIGURE 1D. POROUS ASPHALT PAVING TYPICAL SECTION

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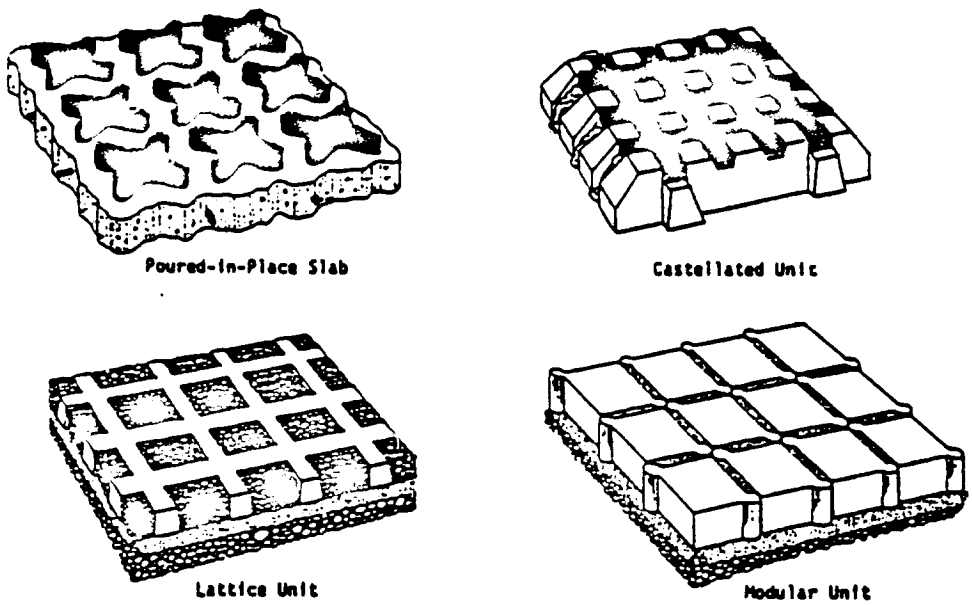

Source: State of Florida

FIGURE 1E. TYPES OF GRID AND MODULAR PAVEMENTS

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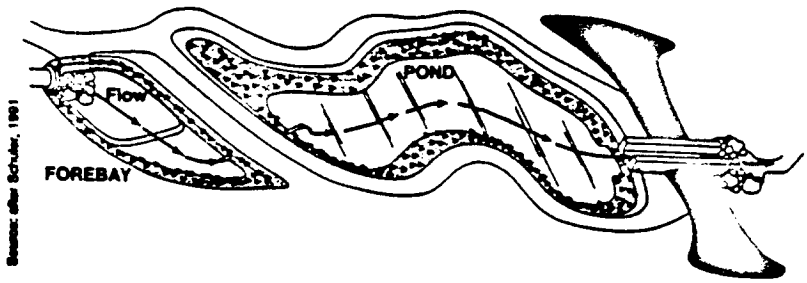
BMP: WET PONDS



Source: after Schueler, 1991

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

A wet pond has a permanent water pool to treat incoming storm water. An enhanced wet pond includes a pretreatment sediment forebay

CALIFORNIA EXPERIENCE

There are regional flood control basins in California that function like wet ponds or constructed wetlands (TC3).

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation (e.g., bird watching, wildlife habitat).

LIMITATIONS

- Concern for mosquitoes and maintaining oxygen in ponds.
- Cannot be placed on steep unstable slopes.
- Need base flow or supplemental water if water level is to be maintained.
- Infeasible in very dense urban areas.
- In California the wet season is coincident with minimal plant growth.
- Could be regulated as a wetlands or under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.
- Pending volume and depth, pond designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Wet pool volume determined by Figures 2B and C.
- Water depth of 3 to 9 feet.
- Wetland vegetation, occupying 25-50% of water surface area.
- Design to minimize short-circuiting.
- Bypass storms greater than two year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be careful when installing wetland vegetation.

MAINTENANCE REQUIREMENTS

- Remove floatables and sediment build-up.
- Correct erosion spots in banks.
- Control mosquitoes.
- May require permits from various regulatory agencies, e.g. Corps of Engineers.

COST CONSIDERATIONS

- Costs for providing supplemental water may be prohibitive.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Best Management Practices

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Additional Information — Wet Ponds

General

The major features of a wet pond are shown in Figure 2A. It is essentially a small lake with rooted wetland vegetation along the perimeter. The permanent pool of water provides a quiescent volume for continued settling of particulate contaminants and uptake of dissolved contaminants by aquatic plants between storms. The wetland vegetation is present to improve the removal of dissolved contaminants and to reduce the formation of algal mats. However, given the need to minimize the impact on space, it may be cost-effective to use vertical concrete retaining walls which would not allow for emergent vegetation.

The average depth of the wet pool is generally 3 to 9 feet, although greater depths are possible with artificial mixing. The objective is to avoid thermal stratification that could result in odor problems. Gentle artificial mixing may be needed in small ponds because they are effectively sheltered from the wind.

The wet pond could be allowed to dry during the summer months. Allowing the wet pond to dry has not been tried elsewhere but seems feasible since the pond need not operate during the summer months. The major problem with this concept will likely be aesthetics rather than performance.

Wet ponds are of interest where the removal of the dissolved constituent fraction is of concern, particularly nutrients and metals. Dissolved contaminants are removed by a combination of processes: physical adsorption to bottom sediments and suspended fine sediments, natural chemical flocculation, and uptake by aquatic plants. A wet pond with concrete sides and floor would therefore not likely provide any advantage over the non-vegetative treatment control BMPs. The relative importance of each mechanism is not well understood. Very limited data prevents a definitive conclusion as to the effectiveness of wet ponds in removing dissolved contaminants. Reduction in the dissolved fraction of phosphorus and some metals have been observed but this does not necessarily mean it is removed in the pond. It may be incorporated into algae or absorbed onto fine particulate matter which exits the facility in the effluent. If the primary removal mechanism is biological, wet ponds may not be particularly effective in removing dissolved contaminants in California because most storms occur during winter when plant growth is minimal.

Wet pond may be preferred where the secondary objective of aesthetics or passive recreation is important. The rooted vegetation along the pond edges will provide some habitat for wetland animals. Wet ponds are generally not feasible in dense urban areas due to the unavailability of land unless a park or open space is available and the pond can be designed to achieve recreational or aesthetic objectives. Wet ponds may have several side effects that may be considered unacceptable in certain situations. Placed in residential developments, the wet pool may be considered a safety hazard for small children although the incidence of drowning is rare where these facilities are in place. Fencing the facility for protection can be aesthetically displeasing and diminishes the value of the pond for passive recreation.

Another concept is the extended detention wet pond in which the outlet of the facility is restricted so as to retain a treatment design storm on top of the wet pool for a specified time. It is believed this added measure improves performance. The effect of restricting the outflow is to reduce the overflow rate during the storm increasing the capture of settleable solids. However, the majority of settling occurs between rather than during the storms. The extended detention zone may therefore provide little incremental benefit. If vertical space is available the concept could be employed because the added cost may be nominal. See TC5 Extended Detention Basins on how to determine the extended detention volume.

Design

Two methods have been proposed for the sizing of wet ponds: one predicated on the removal of particulate contaminants only (USEPA, 1986) and one predicated on the removal of phosphorus as well (Florida, 1988; Maryland, 1986). The first method relates the removal efficiency of suspended solids to pond volume. The second method provides a detention

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time of 14 days based on the wettest month to allow sufficient time for the uptake of dissolved phosphorus by algae and the settling of fine solids where the particulate phosphorus tends to be concentrated. The criterion of 14 days comes from Kast et al., 1983 who observed that in lakes at least 14 days is needed for significant algal growth during the growing season. In much of the United States including Maryland and Florida the growing season is coincident with significant rainfall. But this is not the situation in California where essentially all of the rainfall occurs from November through April. Consequently, the removal of phosphorus and fine solids will not be as high as the literature indicates.

Sizing the Permanent Pool

Figure 2B shows the relationship between performance and the long-term removal efficiency for average conditions in California (USEPA (1986) as adapted in FHWA (1989)). V_b/V_r is the ratio of the volume of the wet pond to the volume of the runoff of the mean storm event from the tributary watershed. The depth of the mean storm for various areas of California is shown in Figure 2C. The recommended performance goal is 80%. The volume of the pond is therefore calculated as follows:

$$V_b = 3S_d A_i 43560/12 = 10890 S_d A_i \qquad (1)$$

where: V_b = pond volume (ft^3)
S_d = mean storm depth (inches)
A_i = impervious acres in the tributary watershed

For A_i the engineer may use total impervious acres in the watershed; directly connected impervious acres more correctly represents the area being treated and would allow a smaller facility. If the jurisdiction has the runoff coefficient for the watershed but not the impervious acreage, multiply the total acreage of the watershed times the runoff coefficient to obtain a value for A_i. Although these variations are not equivalent, they are reasonable given the uncertainty of the methodology and expected pond performance.

This volume should be compared with the 14 days detention time criterion and the more conservative volume (i.e., larger volume) should be used for sizing.

Adding Detention Storage to the Permanent Pool

Some investigators believe that detention volume added above the permanent pool enhances pool performance. The State of Florida, for example, requires one basin inch of detention storage be added to the permanent pool and be bled down over a 60 hour period. This requirement, however, adds considerably to the size of the basin, and the literature does not indicate that water quality performance is improved. Therefore detention storage should be added only if the pond is to be used for drainage control in addition to water quality control. As with extended detention, consideration should be given to bypassing the facility for flows greater than the two year storm so that bed load is not trapped in the pond.

A perforated riser outlet recommended by the Denver Urban Drainage and Flood Control Districts is illustrated in Figures 2D and 2E. Other outlet concepts are illustrated in TC5, Extended Detention Basins, Figure 5B.

Additional Considerations

- Place wetland vegetation around the pond perimeter and near the outlet.

Rooted vegetation around the pond perimeter serves several functions (Figure 2A). It enhances the removal of dissolved pollutants (see T3, Constructed Wetlands); it may reduce the formation of floating algal mats; it reduces the risk of people falling into the deeper areas of the pond; and, it provides some habitat for insects, aquatic life, and wetland

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wildlife. The "shelf" for the vegetation should be about 10 feet wide with a water depth of 1 to 2 feet. The total area of the "shelf" should be 25-50% of the water surface area. Vegetation near the exit will assist settling of solids. An alternative is a rock filter which is used in many wastewater oxidation ponds where loss of algae in the effluent is a common problem during the growth season (Rich, L., 1988).

If mosquites are of particular concern, it would be advisable to inhibit the growth of emergent wetland vegetation around the perimeter by using steep slopes, say, 2:1, and by minimizing the amount of pond area that has a depth less than 18". Gambusia (mosquito fish) can also be planted in larger ponds but the water level must be maintained to insure their survival during the dry season.

If placement of wetland vegetation along the perimeter is not feasible consider the use of devices that retain non-rooted wetland species (Limnion, undated; Zirschky, et al, 1980). Non-rooted vegetation is more effective than rooted vegetation in removing dissolved nutrients and metals (see TC3 Constructed Wetlands). The vegetation grows within the device which is periodically removed and cleaned thereby removing the contaminants from the facility. The system developed by Limnion is in use in several artificial lakes in California to control nutrients.

- Except for very small facilities, include a forebay to facilitate maintenance.
- Use side slopes of at least 3:1 or flatter unless vertical retaining walls are used.
- Except for very small facilities, provide access to the forebay (slope of 4:1 or less), to the outlet, and around the pond perimeter for cleaning.

About 10 to 25% of the surface area determined in the above procedure should be devoted to the forebay. The forebay can be distinguished from the remainder of the pond by one of several means: a lateral sill with rooted wetland vegetation, two ponds in series, differential pool depth, rock-filled gabions or retaining wall, or a horizontal rock filter placed laterally across the pond. If there are small watersheds of five acres or less draining directly into the wet pond, consider grass biofilters (TC4) or incorporate small fore bays at each inlet.

- Use energy dissipation at the inlet to avoid erosion, to promote settling in the forebay and to minimize short-circuiting.
- Use a length to width ratio of at least 3:1 to minimize short-circuiting.

Short circuiting must be minimized. This can be accomplished by using a generally rectangular configuration with a length to width ratio of a least 3:1 and by placing the inlet and outlet at opposite ends. The inlet and outlet can be placed at the same end if baffling is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the pond to have an irregular shape, the pond area and volume should be increased to compensate for the dead spaces.

Inlet design may affect a facility's hydraulic efficiency. The traditional approach of deadheading the inlet pipe directly into the pond is not satisfactory. Experience with wastewater treatment indicates that it is best to have multiple inlets spaced equal to the depth of the pond, with a perforated baffle located in front of the inlets at a distance from one to two times the pond depth (Kleinschmidt, 1961). However, this concept is not practical with storm water treatment systems. A possible compromise that should significantly reduce short-circuiting in which the flow is split by a T or Y (Kleinschmidt, 1961) with the horizontal rock filter serving as perforated baffle. A lateral bench with wetland vegetation as shown in Figure 2A should also work. The area between the inlet and the filter becomes the forebay. Placing large rocks at each inlet will dissipate the energy and spread the water more effectively across the forebay.

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Additional Information — Wet Ponds

- Minimize water loss by infiltration through the pond bottom.

To maintain the wet pool to the maximum extent possible excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner.

- Freeboard of 1 foot.
- With earthen walls, place an antiseep collar around the outlet pipe.
- The outlet should incorporate an antivortex device if the facility is large (A 100 year storm must safely pass through or around the device).

The settleable solids concentration of storm water is relatively low, obviating the need for adding depth to the facility for sediment storage. However, if a significant portion of the tributary area is prone to erosion, it may be appropriate to increase the size and/or depth of the fore bay for sediment storage.

The sides of an earthen wall should be vegetated to avoid erosion. Drought tolerant groundcover species should be used if irrigation can not occur during the summer. See TC4, Biofilters regarding recommended plant species.

Maintenance

Check at least annually and after each extreme storm event. The facility should be cleaned of accumulated debris. The banks of surface ponds should be checked and areas of erosion repaired. Remove nuisance wetland species and take appropriate measures to control mosquitoes. Solids should be removed when 10 to 15% of the storage capacity has been lost.

Limited studies (Dewberry and Davis, 1990; Meiorin, 1991; Florida, 1991; Livingstone, pers. comm.) of the bottom sediments indicate that toxicity limits specified by final disposal regulations are not exceeded. Concentrations observed by Dewberry and Davis (1990) were less than 1/1000 of toxicity limits. If this problem is occurring it suggests that source control BMPs need to be improved or spills/illegal dumpings are occurring on a wide spread scale. Frequent cleaning of the fore bay will help.

Metal uptake by plants and fish has been examined (Meiorin, 1991) at the experimental facility in Fremont, California. Accumulation of zinc was found in fish liver and manganese in plant tissue. No accumulation was found with copper, lead, chromium, or nickel. These results may not be representative inasmuch as 94% of the watershed was open space, agriculture or low density residential.

Rock filters placed at the outlets of oxidation ponds have a short life due to clogging by algae (Rich, 1988). However, it can be expected that algal growth will be significantly less in wet ponds given the lower concentration of phosphorus in storm water, and therefore clogging should not be a problem. If algal blooms are excessive consider alum treatment or the use of devices that retain non-rooted vegetation as discussed above.

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Additional Information — Wet Ponds

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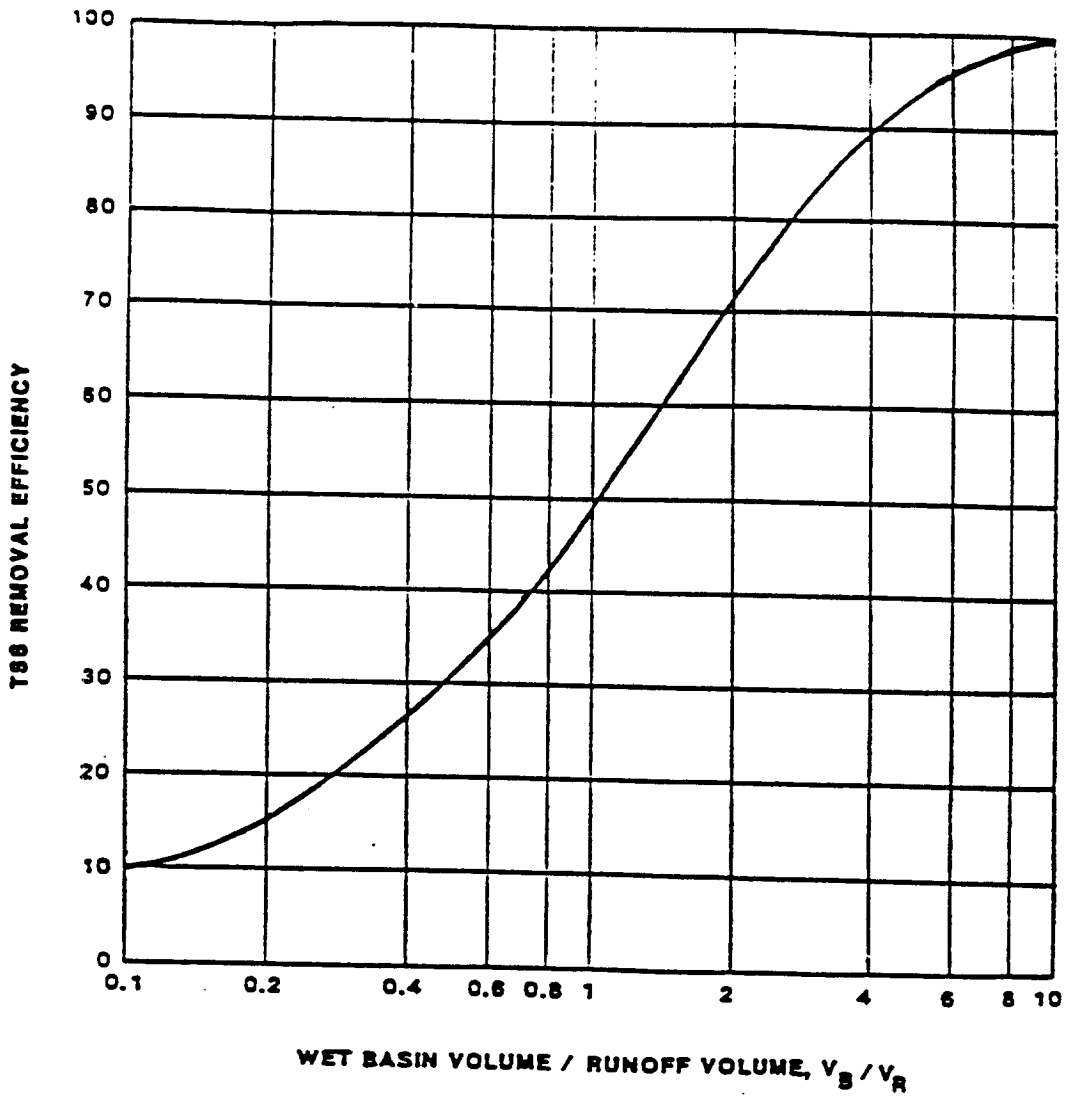

Source: FHWA (1989)

FIGURE 2B. TSS REMOVAL VERSUS V_B/V_R RATIO

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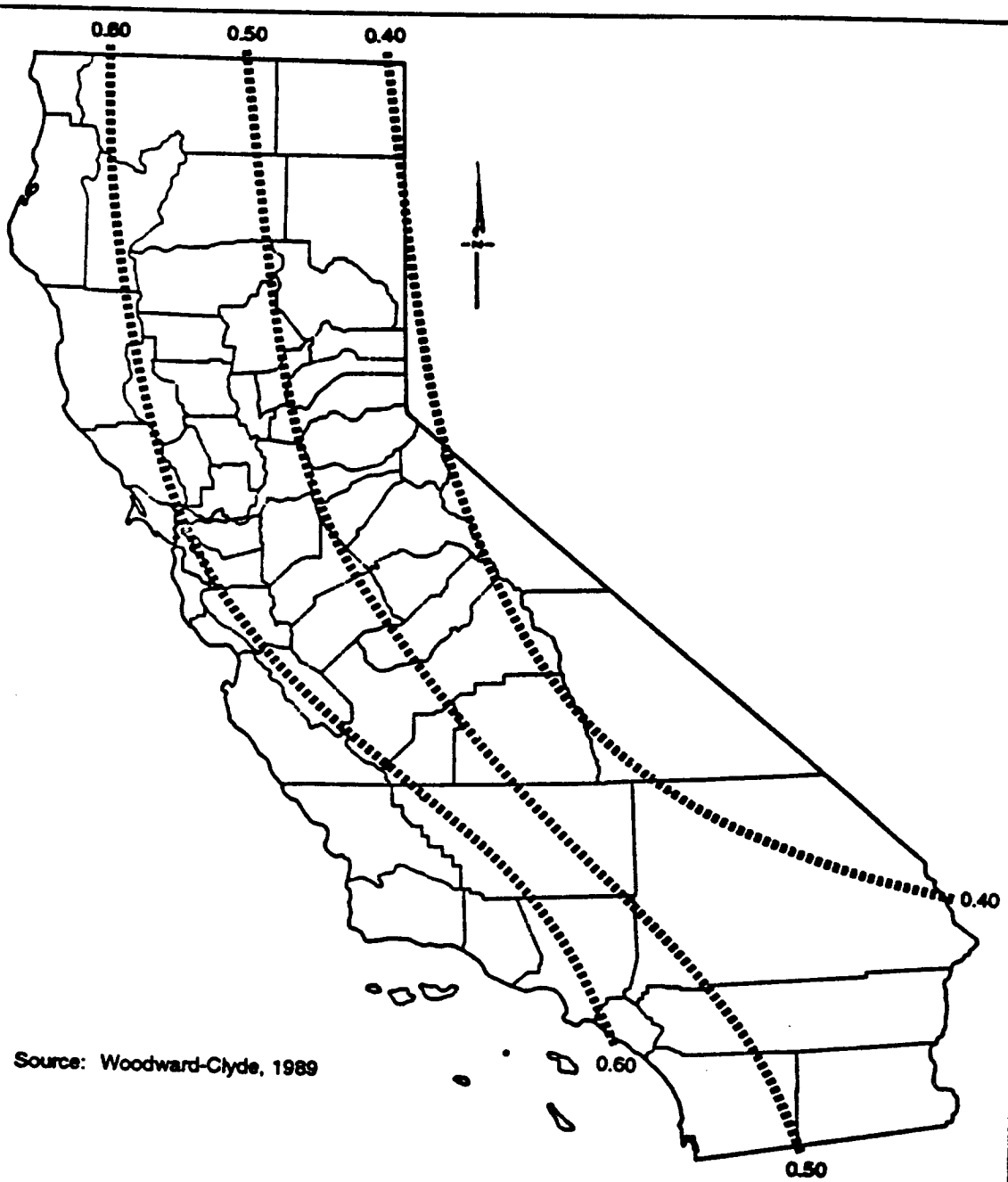

Source: Woodward-Clyde, 1989

FIGURE 2C. AVERAGE STORM EVENT DEPTH (INCHES)

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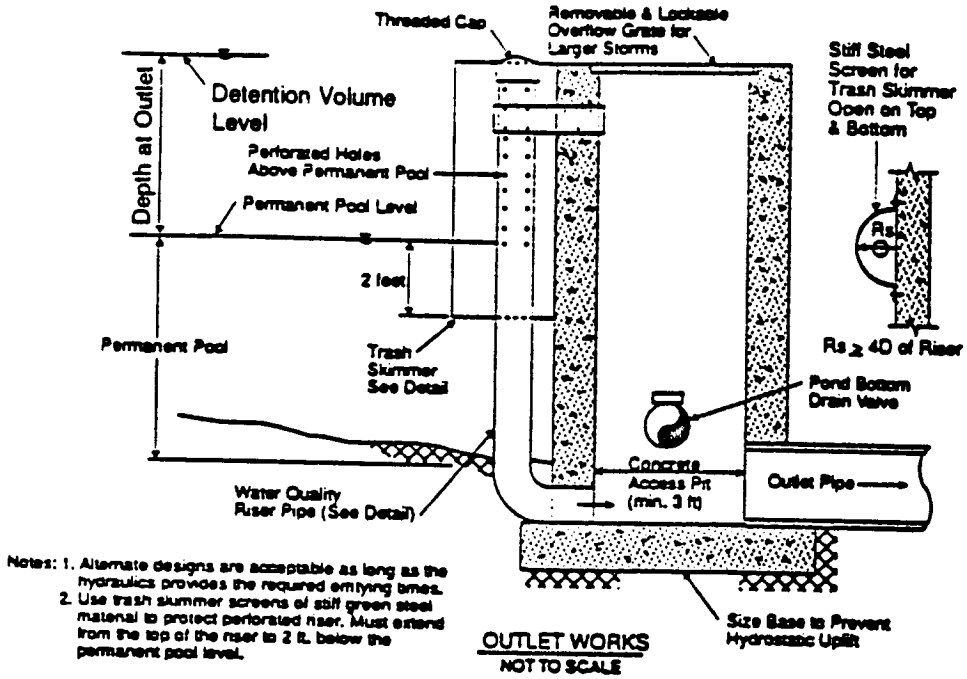
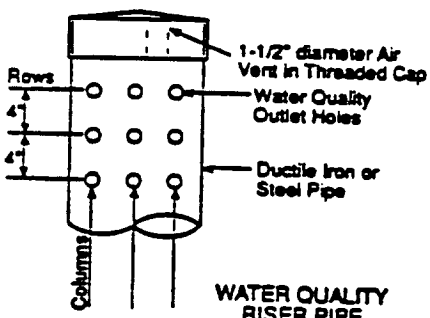


Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emptying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft. below the permanent pool level.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" Dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

(Used By Permission, UDFCD, 1992)

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, inches			
	1/4"	1/2"	3/4"	1"
4	8	8	–	–
6	12	12	8	–
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area (in. 2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

FIGURE 2D. WATER QUALITY OUTLET FOR A WET POND

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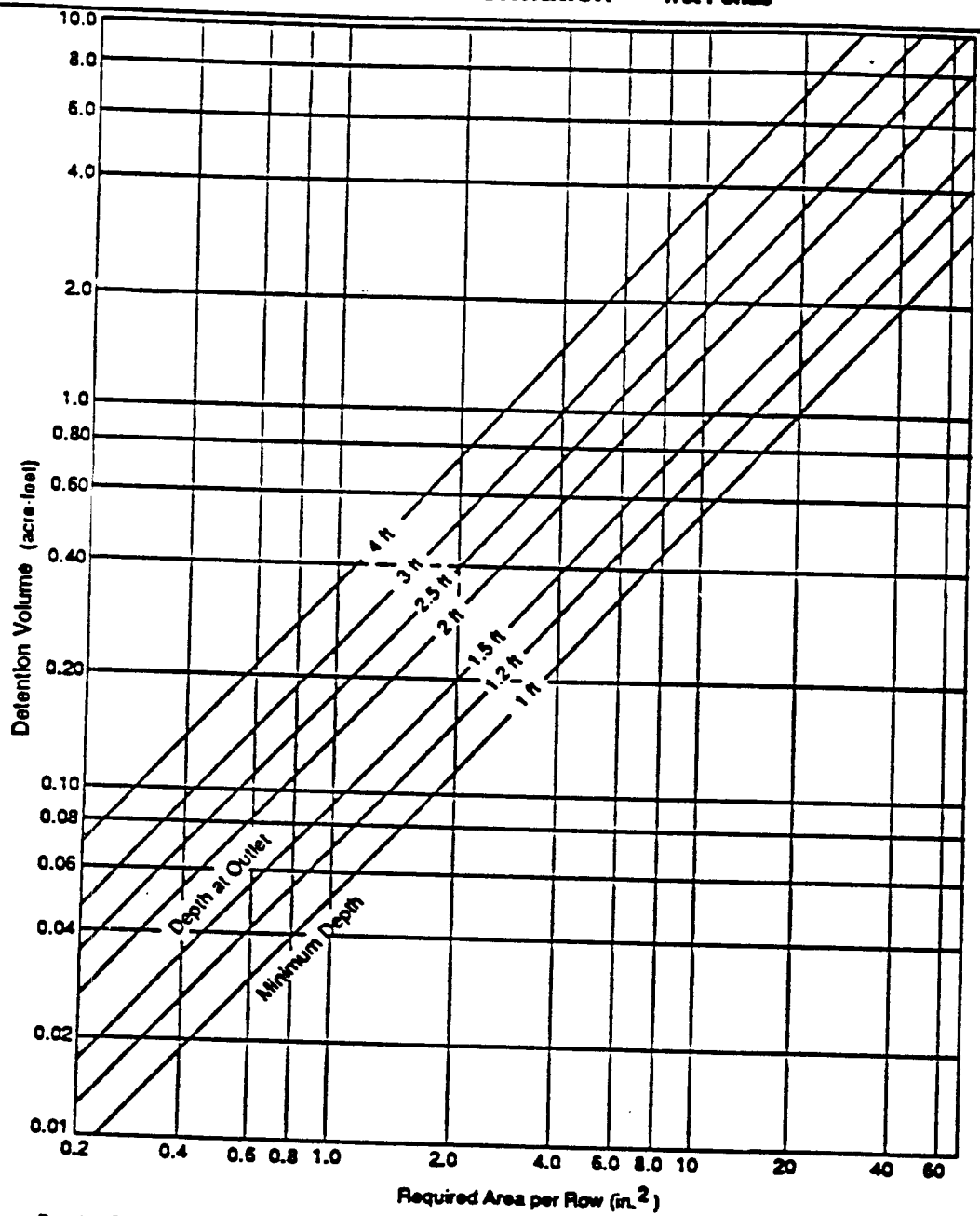

Source: *Douglas County Storm Drainage and Technical Criteria*, 1986. (Used By Permission, UDFCD, 1992)

FIGURE 2E. WATER QUALITY OUTLET SIZING: WET POND WITH A 12-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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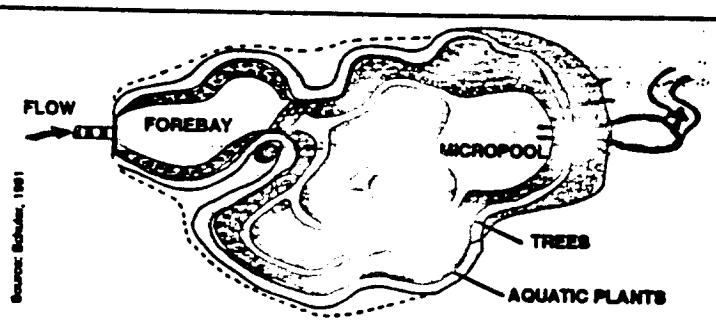
BMP: CONSTRUCTED WETLANDS



Source: Schueler, 1991

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

EXPERIENCE IN CALIFORNIA

Research facility constructed in Fremont in 1983 by the Association of Bay Area Governments. Several communities (Davis, Orange County) have regional detention ponds that are essentially constructed wetlands.

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation and wildlife.

LIMITATIONS

- Concern for mosquitoes.
- Cannot be placed on steep unstable slopes.
- Need base flow to maintain water level.
- Not feasible in densely developed areas.
- Wet season coincident with minimal plant growth.
- Nutrient release may occur during winter.
- Overgrowth can lead to reduced hydraulic capacity.
- Regulatory agencies may limit water quality to constructed wetlands.
- May be regulated under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.

DESIGN AND SIZING CONSIDERATIONS

- Suitable soils for wetland vegetation.
- Surface area equal to at least 1% and preferably 2% of the tributary watershed.
- Forebay.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Involve qualified wetland ecologist to design and install wetland vegetation.
- Establishing wetland vegetation may be difficult.

MAINTENANCE REQUIREMENTS

- Remove foreign debris and sediment build-up.
- Areas of bank erosion should be repaired.
- Remove nuisance species.
- Control mosquitoes.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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BMP: CONSTRUCTED WETLANDS (Continue)

COST CONSIDERATIONS

- Wetlands being shallower than wet ponds may result in larger area requirements.
- Costs for providing supplemental water may be prohibitive.

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Additional Information — Constructed Wetlands

General Information

Although natural wetlands are being used to treat storm water, regulatory agencies do not favor this use, except as a final "polishing" step after treatment by one or more of the treatment control BMPs presented in this chapter. Constructed wetlands, in contrast, are built specifically for treating storm water runoff. They are not wetlands created as mitigation for the loss of natural wetlands. Consequently, there is no intention to replicate the complete array of ecological functions of a wetland (e.g., the presence of wildlife), although it can be done. A constructed wetland is generally one of the more aesthetic than the treatment systems.

The simplest form of a constructed wetland includes a rectangular basin with a forebay and wetland vegetation area. The deeper forebay (3 to 6 feet) traps floatables and the larger settleable solids, facilitating maintenance as well as protecting the wetland vegetation. Alternatively, a detention pond may be placed before the wetland, to remove settleable solids and to protect the wetland from extreme increases in water elevation. The wetland vegetation is placed in a shallow pool that extends laterally across the basin. Construction of low flow channels through emergent vegetation can cause storm water to short circuit through channels rather than through the wetland vegetation.

Placing rooted wetland species through the majority of the facility adds to the cost, in comparison to a wet pond. However, it is believed by many practitioners that the vegetation improves performance. Placing the vegetation across the facility improves settling of particulates and uptake of dissolved contaminants. As the constructed wetland is shallower than a wet pond, there may be better contact between the water and soil which may be the primary remover of dissolved phosphorus and metals.

The vegetation reduces the effect of wind which can cause significant short-circuiting in a wet pond. Water loss in a wetland may not be greater and possibly less than a wet pond. Evapotranspiration from the plants will be greater in a wetland but evaporation from the water surface may be less because the dense vegetation eliminates the effect of the wind. The net result may be a slower rate of water loss. Conceivably a constructed wetland could be made smaller than a wet pond, given the benefits of the vegetation. But experience is too limited to identify how the size might be altered from what is calculated for a wet pond.

Relying on volunteer plants to cover the vegetated area will delay complete coverage for several years and may allow the invasion of undesirable species or dominance by one or two species such as cattails which tend to flourish in disturbed conditions. Complexity is promoted by varying water depth through the vegetated area rather than keeping the depth uniform. Preferred species to maximize the removal of dissolved metals are Salicornia pacifica (cadmium, copper and lead), Justicia americana (copper), Potamogeton crispus (cadmium), Phragmites communis (zinc), Carex stricta (zinc), and Scirpus lacustris (zinc) (Silverman, 1982).

There is some question as to the incremental benefit of wetland vegetation in California, inasmuch as most of the wet season occurs when the vegetation is dormant. The minimum desirable temperature for cattails, sedges, and bulrushes is 10°C, 14°C, and 16°C, respectively (USEPA, 1988). For most of California, mean temperatures during the winter months are 5 to 10°C; along the south coast they range from 10°C to 15°C. The primary removal mechanisms for dissolved phosphorus and metals are adsorption by the soil and use by non-rooted vegetation. Rooted vegetation obtains nutrients from the soils, not from the water, unless the vegetation is placed in gravel. In contrast non-rooted vegetation removes nutrients and metals from the water (Guntenspergen, et al., 1991). It can be expected that soil adsorption will continue during the winter to some extent. Removal of metals and nutrients by non-rooted vegetation may not occur, or will at least be significantly reduced because of the lack of growth. In contrast, loss will occur from vegetation die-off or dormancy. The net effect over a 12 month period may be that a constructed wetland is no more effective than a wet pond, particularly with regard to the removal of dissolved phosphorus and metals.

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The above concern is partially confirmed by research at the experimental wetland/wet pond in Fremont (Meiorin, 1991). The author states that the "uptake of nutrients ... was low because most storms occurred in winter when plant growth was reduced by ambient temperatures, short day lengths and low light levels". Despite the use of the word "low", phosphorus removal during the winter months was about 50% which is not noticeably better than removal in a wet pond. The removal of nitrogen was negative. Resuspension of plant material and detritus also occurred during the winter.

Despite the concerns, the wetland bottom soils are possibly a more significant mechanism for removing phosphorus and metals. However, the experience with constructed wetlands treating wastewater seems to indicate phosphorus removal occurs in the first two to three years but then removal rates decrease dramatically and have become negative in some cases (Faulkner and Richardson, 1991). This result appears to be due to saturation of the soil and the plants reaching maximum density. However, metals removal may continue. Nitrogen removal does not degrade over time because it is a bacteriological process. This process is very temperature dependent and therefore would be expected to be lower in the winter.

Using gravel as the substrate may be a suitable approach in small facilities. Because the gravel is lacking in nutrients certain emergent species will take their nutrients from the water (Thut, 1988). See Reddy and Smith (1988). Harvesting may also be more practical with this approach.

Of particular concern in many areas of California will be mosquitoes. Thick stands of emergent vegetation provide an ideal breeding habitat. If Gambusia (mosquito fish) are introduced into the facility the design must include a deep pool area where the fish can reside during the dry season. The forebay can serve this function.

Design

In the most comprehensive review to date of wetlands treating storm water, Stecker et al. (1992) found considerable variation in the performance of 26 facilities, both natural and constructed. All were located on large watersheds with mixed land uses, not industrial sites. There appeared to be no relationship between performance and the size (surface area) of the wetland. The surface area of the ten constructed wetlands varied from 0.3% to 12.6% of the tributary area. The removals of suspended solids and phosphorus ranged from 50 to 95% and 37 to 92%, respectively, for nine of the 10 facilities. The smallest facility removed 85% of the suspended solids and 37% of the phosphorus. The authors were unable to relate the variability of performance to any factor of design or operation. Constructed wetlands performed somewhat better than natural wetlands. The only conclusion that might be safely drawn from this study is that a surface area greater than about 1 or 2% of the tributary watershed is not justified, given the uncertainty of any improvement in performance with the increase in size. Lacking, however, are data on the percentage of each watershed that is impervious.

The facility can be sized using the same procedure outlined for Wet Ponds, TC2. However, inasmuch as a wetland is shallower than a wet pond, sizing the wetland for the same V_b/V_r as a wet pond requires considerably more surface area. Given the likely advantages of a constructed wetland over a wet pond, some may consider this to be an unreasonable penalty. It is therefore recommended that surface area of the constructed wetland not exceed that which would be determined for a wet pond.

Additional design considerations include:

- Have 25% to 50% (forebay and afterbay) 3 to 6 feet deep, and remaining area 6 in. to 24 in. deep or as appropriate for the wetland species selected. This geometry should provide satisfactory conditions for wetland wildlife (Adams et al., 1983).
- Side slopes of at least 4:1 to a water depth of 2 feet except on very small facilities where retaining walls may be used to conserve space. If retaining walls are used, the area must be fenced for safety.
- Access for maintenance vehicles to the forebay, the outlet, and around the perimeter.

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- Freeboard of at least 1 foot.
- With earthen contained facilities, install an antiseep collar on the outlet pipe.
- The soils must be suitable for wetland vegetation. If necessary organic soils (18 to 24 in.) must be imported to the site.
- The soil must have an affinity for phosphorus. Soils with aluminum and iron are best. Soils saturated with phosphorus or a metal specie may cause the concentrations of these contaminants to increase in the overlying water.
- Minimize short-circuiting by placing energy dissipators at the inlet, and by having a high length to width ratio.

Short circuiting must be minimized by using a generally rectangular configuration with a length to width ratio of a least 3:1 and by placing the inlet and outlet at opposite ends. The inlet and outlet can be placed at the same end if baffling (islands) is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the wetland to have an irregular shape, the pond area and volume should be increased to compensate for the dead spaces. Energy dissipators and entrance baffles will spread the water laterally across the facility.

- Minimize water loss by infiltration through the wetland bottom.
- Supplemental water may be needed to avoid loss of rooted vegetation during the dry period.

To maintain the wet pool to the maximum extent possible excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner. Wetland vegetation species have evolved to handle the stress of seasonal variations in water availability. However, during the dry season there must be sufficient water to avoid complete desiccation of plant roots. Consequently, constructed wetlands are infeasible in areas where there is a lack of either a baseflow or near-surface ground water during the dry season. Supplemental water such as pumped ground water and treated process wastewater may have to be used.

- A wetland ecologist should prepare the planting design and specifications, and oversee the planting.

Constructed wetlands may not need antivortex and trash rack devices on their outlets like a wet pond because of the rooted vegetation. See TC2, Wet Ponds regarding inlet design. Design concepts for outlet devices are discussed in TC5 Extended Detention Ponds. See Josselyn (1982) regarding wetland plant considerations. Establishing wetland vegetation initially may be difficult and require multiple plantings.

Maintenance

- Check at least annually and after each extreme storm event.
- Remove accumulated foreign debris.
- Repair areas of slope erosion.
- Employ mosquito countermeasures as required by local authorities.
- Clean deposits from the forebay when a loss of capacity is significant, probably every 3 to 5 years depending on the land use (see TC2, Wet Ponds), or when the concentrations of toxicants in the sediments are reaching a level of concern.

There is some question as to whether annual harvesting of rooted vegetation is either practical or effective at reducing seasonal losses of nutrients and prolonging the life of the facility (USEPA, 1988). The benefits of harvesting may depend upon the wetland specie (Suzuki, T. et al., 1991). Placing rooted vegetation in gravel beds rather than soil may make harvesting practical. If harvesting is to be done, it should occur twice per season, in the early summer when nutrient content in the plant material is at its peak, and in the fall before plant dormancy. Given the significant role of the bottom soil in removing metals and phosphorus its replacement may be required, although, probably not more frequently than once every few decades. Cleaning the forebay more frequently is important as noted above.

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Additional Information — Constructed Wetlands

Another consideration is the regulatory implications of removing accumulated material from constructed wetlands. Do such actions require a 404 or other permit? At present, constructed wetlands are excluded from this requirement (Ritchie, 1992).

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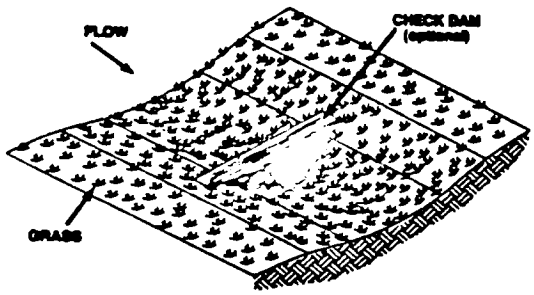
BMP: BIOFILTERS



DESCRIPTION

Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

EXPERIENCE IN CALIFORNIA

No biofilters specifically designed to treat storm water have been located. However, instances of "biofilter by happenstance" exist in northern communities (Davis, Sacramento, Turlock, Fresno) where storm water is discharged to a grassed area prior to an inlet or an infiltration area.

SELECTION CRITERIA

- Comparable performance to wet ponds and constructed wetlands.
- Limited to treating a few acres.
- Availability of water during dry season.

LIMITATIONS

- Poor performance has occurred but this appears to be due to poor design.
- May be limited to areas where summer irrigation is feasible.
- Can be difficult to maintain sheet flow in strips.
- Can be difficult to avoid channelization in swales.
- Cannot be placed on steep slope.
- Area required may make infeasible on industrial sites.
- Proper maintenance required to maintain health and density of vegetation.

DESIGN AND SIZING CONSIDERATIONS

- The surface area is defined by Figure 4A.
- The minimum width for a swale is determined by Mannings Equation.
- Minimum length of a strip is 10 feet.
- The longitudinal slope must not exceed 5%.
- Use a flow spreader and energy dissipator at the entrance of a swale.
- Good soils are important to achieve good vegetation cover.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure soils are suitable for healthy vegetation.
- Level cross-section and even longitudinal slope for swales.
- Achieve sheet flow with strips.

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ◒ Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Additional Information — Biofilters

A biofilter swale is a vegetated channel that looks similar to, but is wider than, a ditch that is sized only to transport flow. The biofilter swale must be wider to maintain low flow velocities and to keep the depth of the water below the height of the vegetation up to a particular design event. A filter strip is placed along the edge of the pavement (its full length if possible). The pavement grade must be such as to achieve sheet flow to the maximum extent practical along the strip.

Vegetated biofilters are suitable only for small catchment areas of a few acres, for reasons provided below. Swales are particularly suitable for small residential developments. It may be possible to integrate treatment swales with greenways within large residential developments but each swale should meet the design guidelines presented in this handbook. Strips are most suitable for parking lots in commercial and mutifamily developments. Swales may not function well in residential developments which have open space that remains in native vegetation. Soil eroded from these open spaces may clog the biofilter. Placing a Type 2 catch basin at the upper end of a swale may provide adequate pretreatment. To be effective, the diameter of the catch basin and the depth of the sump below the invert of the outlet should each be at least four (4) times the diameter of the outlet (Lager, et al., 1977).

The performance of biofilters is probably somewhat less than wet ponds and constructed wetlands because the latter provide treatment both during and between storms. Some researchers have observed poor performance, recommending their use only in combination with other treatment control BMPs. However, most field research on swale performance has been conducted on grassed roadside ditches. A swale must be wider than a traditional roadside ditch, to avoid excessive flow velocities which topples the grass and causes channelization. It appears that biofilters can remove particulate pollutants at rates similar to wet ponds and constructed wetlands. The removal of dissolved pollutants may also be similar to wet ponds but less than constructed wetlands. Some researchers have found effective removal of dissolved metals and nutrients whereas others have not.

The swale bottom must be as level as possible; energy dissipation and a flow spreader should be placed at the entrance to minimize channelization. The pavement must be as level as possible along its boundary with a biofilter strip. The pavement edge should be left clear; that is, no curbs. Parking stall blocks must be open to pass the flow as unhindered as possible. Use of curb cuts in curbs is not a satisfactory approach. The cuts channelize the water and can clog with debris. The performance of strips may be compromised by the failure to achieve sheet flow at the interface between the paved area and the strip.

Turf grass is the preferred vegetation. Figure 4B shows recommendations for seven species of turf grass and one ground cover plant for various areas of California (Youngner, et al., 1962). More recent information in this regard is also shown in Figure 4C (CCAE, 1984). Turf grass will require summer irrigation to remain active. Although it has not been tried it may be possible to allow the grass to become dormant during the summer since the biofilter is only in service during the wet season. The biofilter could be irrigated beginning in October to bring it to a healthy condition prior to the first storms. Ground cover species suitable for a non-irrigation situation may work but, it also has not been tried. The soil must be of a fertility and porosity that allows for healthy vegetation. A porous soil also promotes infiltration. See the references that follow for Agricultural Extensive publications on efficient water use by turf grasses.

If erosion of the swale is of concern because of the difficulty of maintaining a good grass cover, consider the use of concrete grids (see Infiltration Systems) or similar material. Another concept is to use check dams to divide the swale into a series of terraces, reducing the longitudinal slope to perhaps 1%, thereby reducing flow velocities.

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Additional Information — Biofilters

Design

Several methods have been proposed to size biofilters (Horner, 1988; FHWA, 1989; IEP, 1991; Tollner, et al., 1976). However, information on the relationship between biofilter area and performance is lacking for urban conditions. Figure 4A uses the method of Horner (1988) with the 2-year storm as the design event, a slope of 3%, and a grass height of 4 inches. A biofilter is sized to treat all storms up to a particular design event. The design event can be relatively small because the aggregate of all small events represents the majority of pollutant runoff. Research in western Washington (Metro, 1992) found that a biofilter sized according to this technique removed 80 percent of the suspended solids and attached pollutants and 50% of the soluble zinc. It was not able to remove dissolved phosphorus or copper.

Figure 4A is meant for guidance only and should be used with caution in areas where precipitation varies greatly because of terrain.

The design engineer must determine the width of a swale using Manning's Equation and the 2-year rainfall intensity (California, 1976) appropriate to the site. An "n" of 0.20 is recommended (Metro, 1992). The design engineer must also calculate the peak flow of the 100-year event to determine the depth of a swale. Since a width using an "n" of 0.20 is generally wider than what is required of a grass lined channel, channel stability should not be of concern. It is generally not necessary to have a bypass for the extreme events because the minimum width specification combined with the relatively gentle slope avoids excessive velocities. If erosion at extreme events is of concern, consider the above concepts to minimize erosion.

The design engineer can make the swale wider than determined in the above step, with a corresponding shortening of the swale length to obtain the same surface area. However, there is a practical limitation on how wide the swale can be and still be able to spread the flow across the swale width. Splitting the flow into multiple inlets and/or placing a flow spreader near the storm inlet should be incorporated into the design. A concept that may work is to place a level 2"x 12" timber across the width of the swale perhaps 10 feet from the pipe outlet. Place gravel between the outlet and the timber, to within 2 inches or so of the top of the timber. Place large rock immediately near the outlet to dissipate the flow energy; the rock also may help distribute the flow. The timber will function like a weir. Flow spreaders have seen limited application and their effect on performance has not been evaluated.

The problem of spreading the flow across the width of the swale may limit its use to tributary catchments of only a few acres. The minimum width based on using Manning's Equation results in widths of 3 to 12 feet per acre of impervious tributary surface, depending on the location and longitudinal slope.

A minimum length of 10 feet is recommended for biofilter strips. Length here is defined as the measurement in the direction of flow from the adjoining pavement. Lengths of 20 to 50 feet have been recommended by most practitioners perhaps because of the concern that sheet flow cannot be maintained. Wherever room permits a length greater than 10 feet should be used. The short length is recommended in this handbook because space is at a premium at most existing industrial sites: 10 feet should work satisfactory if good sheet flow is maintained and no obstructions such as curbs are placed along the pavement edge.

The type of strip discussed here is not to be confused with the natural vegetated buffer strip used in residential developments to separate the housing from a stream or wetland. As the later type follows the natural contour flow channelization is more likely and lengths of 75 to 150 feet are recommended.

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Additional Information — Biofilters

The length of pavement prior to the strip should not exceed a few hundred feet to avoid channelization of large aggregates of runoff along the pavement before it reaches the pavement edge. To avoid channelization, care must be taken during construction to make sure that the cross-section of the biofilter is level and that its longitudinal slope is even. Channelization will reduce the effective area of the biofilter used for treatment and may erode the grass because of excessive velocities.

Maintenance

The facility should be checked annually for signs of erosion, vegetation loss, and channelization of the flow. The grass should be mowed when it reaches a height of 6 inches. Allowing the grass to grow taller may cause it to thin and become less effective. The clippings should be removed.

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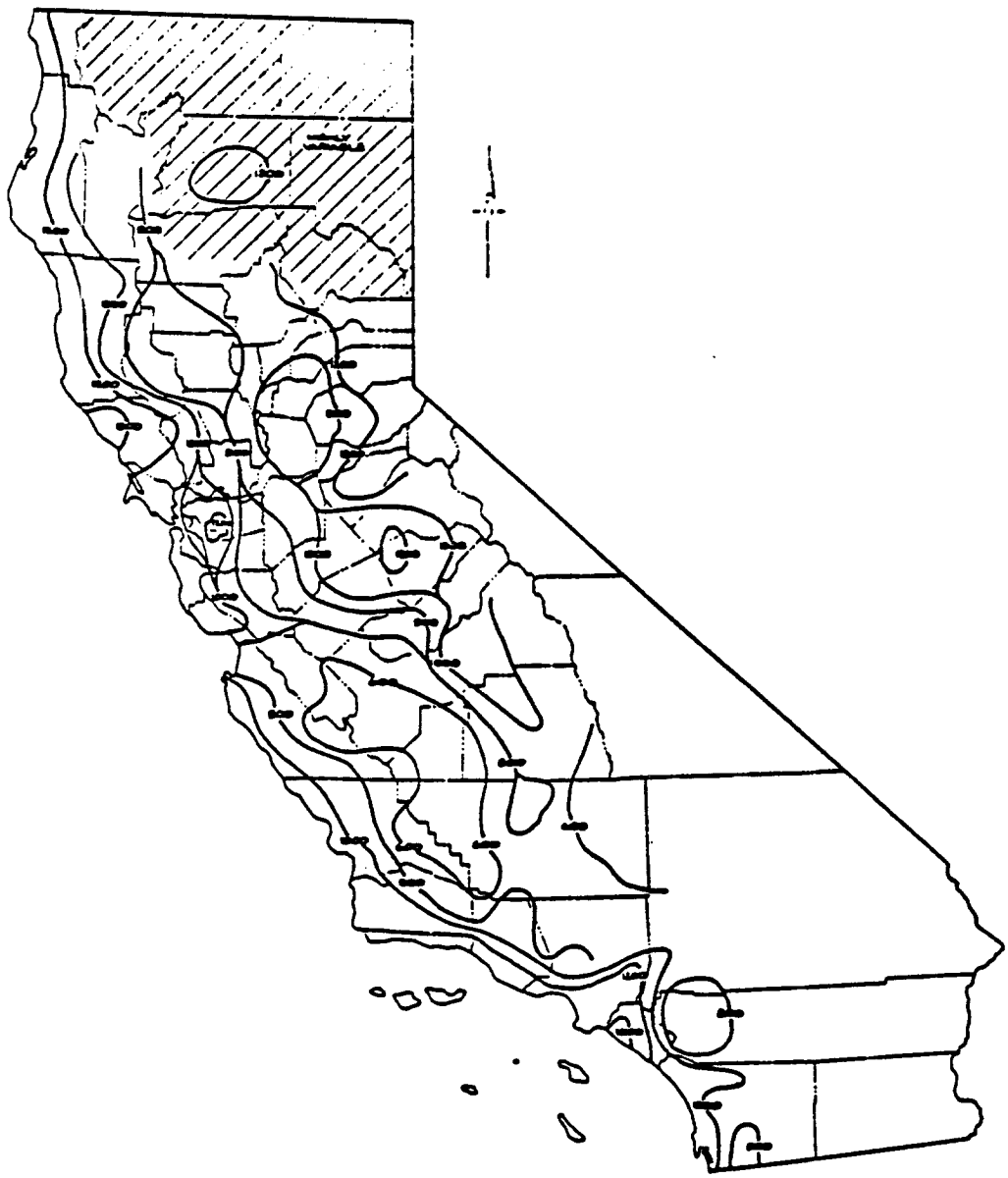

FIGURE 4A. SIZING GUIDELINE FOR BIOFILTERS (SQ. FT./IMPERVIOUS ACRE)

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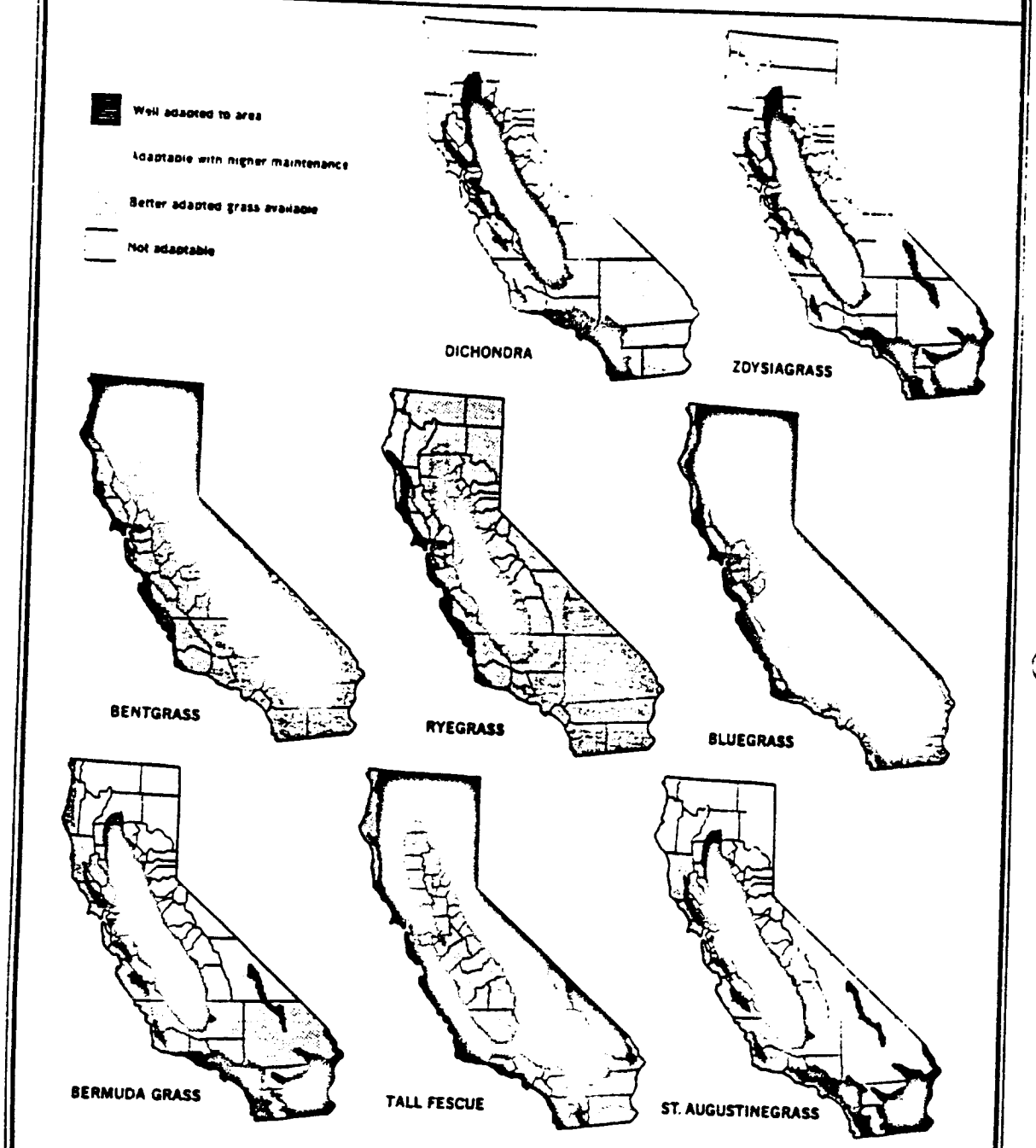

FIGURE 4B. STATE OF CALIFORNIA SHOWING MOST SUITABLE TURF GRASS SPECIES

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Additional Information — Biofilters

COLD TOLERANCE (winter color persistance)

High
- Creeping bentgrass
- Kentucky bluegrass
- Red fescue
- Colonial bentgrass
- Highland bentgrass
- Perennial ryegrass
- Tall fescue
- Weeping alkaligrass
- Dichondra
- Zoysiagrass
- Common bermudagrass
- Hybrid bermudagrass
- Kikuyugrass
- Seashore paspalum
- St. Augustinegrass

Low

HEAT TOLERANCE

High
- Zoysiagrass
- Hybrid bermudagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Dichondra
- Creeping bentgrass
- Kentucky bluegrass
- Highland bentgrass
- Perennial ryegrass
- Colonial bentgrass
- Weeping alkaligrass
- Red fescue

Low

MOWING HEIGHT ADAPTATION

High cut
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Weeping alkaligrass
- St. Augustinegrass
- Common bermudagrass
- Dichondra
- Kikuyugrass
- Colonial bentgrass
- Highland bentgrass
- Zoysiagrass
- Seashore paspalum
- Hybrid bermudagrass
- Creeping bentgrass

Low Cut

DROUGHT TOLERANCE

High
- Hybrid bermudagrass
- Zoysiagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Highland bentgrass
- Creeping bentgrass
- Colonial bentgrass
- Weeping alkaligrass
- Dichondra

Low

MAINTENANCE COST AND EFFORT

High
- Creeping bentgrass
- Dichondra
- Hybrid bermudagrass
- Kentucky bluegrass
- Colonial bentgrass
- Seashore paspalum
- Perennial ryegrass
- St. Augustinegrass
- Highland bentgrass
- Zoysiagrass
- Tall fescue
- Common bermudagrass
- Kikuyugrass

Low

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FIGURE 4C. ADDITIONAL INFORMATION ON THE SUITABILITY OF TURF GRASS SPECIES

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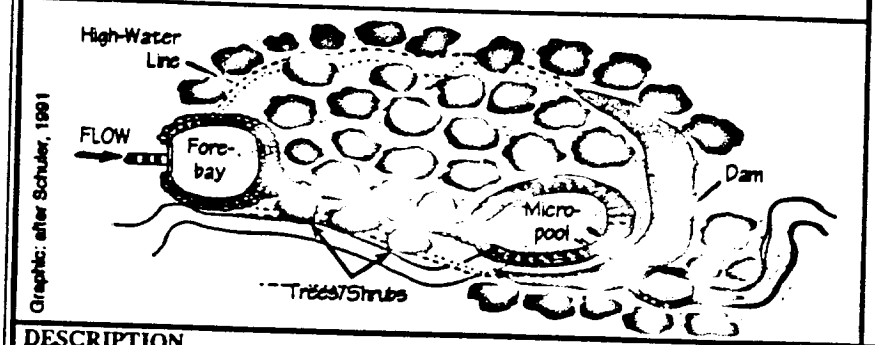
BMP: EXTENDED DETENTION BASINS



Considerations

- Soils
- **Area Required**
- Slope
- Water Availability
- Aesthetics
- **Hydraulic Head**
- Environmental Side Effects

DESCRIPTION

Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

EXPERIENCE IN CALIFORNIA

There are no known extended detention basins in California. Hydraulic detention basins may function like extended detention basins if the former has been sized to control the pre-development 2-year event. More liberal standards do not provide sufficient detention time.

SELECTION CRITERIA

- Objective is to remove only particulate pollutants.
- Use where lack of water prevents the use of wet ponds, wetlands or biofilters.
- Use where wet ponds or wetlands would cause unacceptable mosquito conditions.

LIMITATIONS

- May be less reliable than other treatment control BMPs.
- Inability to vegetate banks and bottom may result in erosion and resuspension.
- Limitation of the orifice diameter may preclude use in small watersheds.
- Requires differential elevation between inlet and outlet.
- Pending their volume and depth basin designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Basin volume is sized to capture a particular fraction of the runoff.
- Drawdown time of 24 to 40 hours.
- Shallow basin with large surface area performs better than deep basin with same volume.
- Place energy dissipators at the entrance to minimize bottom erosion and resuspension.
- Vegetate side slopes and bottom to the maximum extent practical.
- If side erosion is particularly severe, consider paving or soil stabilization.
- If floatables are a problem, protect outlet with trash rack or other device.
- Provide bypass or pass through capabilities for 100 year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure the outlet is installed as designed.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ◒ Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Best Management Practices

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BMP: EXTENDED DETENTION BASINS (Continue)

MAINTENANCE REQUIREMENTS

- Check outlet regularly for clogging.
- Check banks and bottom of surface basin for erosion and correct as necessary.
- Remove sediment when accumulation reaches 6-inches, or if resuspension is observed.

COST CONSIDERATIONS

- Generally less expensive than wet ponds and wetlands, but more expensive than biofilters.
- Erosion of unprotected areas in residential developments increases maintenance costs.

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Additional Information — Extended Detention Basins

General

Extended detention ponds and vaults may be particularly appropriate to California where dry weather base flow cannot be used to maintain water levels, as is required for wet ponds and constructed wetlands. These systems are suitable for essentially any size tributary area from an individual commercial development to a large residential area. Surface ponds are less expensive to construct, but underground vaults may be appropriate in commercial developments. Use of concrete retaining walls will reduce the space required by a pond. The basic elements of an extended detention basin are illustrated in Figure 5A. The configuration shown in Figure 5A is most appropriate for large sites.

Extended detention provides a lower removal efficiency than wet ponds and constructed wetlands: the facilities are smaller thereby reducing their effectiveness with particulate pollutants, and they do not have the ability to remove dissolved contaminants. Also, extended detention facilities may be less reliable than constructed wetlands or wet ponds because of the lack of a permanent water pool (See Figure 5A). But if desired, a shallow pool of 1 to 3 feet could be included in the design but this is more of an aesthetic consideration. If irrigation water is available, a thick grass turf on the bottom of the facility may provide some removal of dissolved contaminants, like a vegetated biofilter. See TC4 Biofilters for recommendations on turf grass and groundcover species.

Where irrigation water is not available, there may be concerns about erosion and resuspension of particulate pollutants in surface ponds. This, however, has not been a significant problem in Austin, Texas where sand filters are preceded by dry settling ponds (Hartigan, pers. comm.). However, the design must incorporate several features to minimize the potential for this problem. Drought tolerant vegetation may work but has not been evaluated. Nonvegetative materials may help such as concrete or plastic grids, small riprap, erosion matting, or paving. A paved forebay may facilitate maintenance thereby reducing the material available for resuspension.

The recommended drawdown time of 24 to 40 hours for a full pond is based on very limited laboratory data. A few extended detention ponds have been monitored and generally provide a removal efficiency of 60 to 80% with a drawdown time of about 24 hours. Forty hours is recommended in order to settle out the finer clay particles in California sediment that typically adsorb toxic pollutants.

Design

Determine the volume of the basin using the appropriate figure from Appendix D. The procedure is as follows: (1) select the appropriate figure for your area; (2) determine for the catchment the percentage of impervious area directly connected to the storm drain system; (3) choose a capture goal, and read the required unit volume required for the basin; and (4) multiply this unit volume times the total acreage of the catchment and convert to cubic feet. This volume is also referred to as water quality capture volume shown in Figure 5A. Total impervious acres may be used in lieu of directly connected impervious acres if it is easier to determine the former, although this will result in a larger facility. If the jurisdiction has the runoff coefficient for the watershed but not the impervious acreage, multiply the total acreage of the watershed times the runoff coefficient to obtain an estimate of impervious acreage. Although these variations are not equivalent, they are reasonable given the uncertainty of the methodology and expected basin performance.

What should be the capture goal? To achieve an equivalent pollutant capture percentage as a wet pond, 85 to 95 percent of the runoff must be captured and detained. But capture volumes over 85 percent are not cost effective as the capture cases in Appendix D show. Therefore it is recommended that a capture volume of 85 percent be used for determining the detention basin size required. Because of the possibility of resuspension of materials during extreme storms consideration should be given to placing the basin off line, that is, it should have a bypass for the extreme events. Bypassing larger events will also allow the bedload carried by the storm and is necessary for beach replenishment to move downstream.

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A drawdown time of 40 hours is recommended in order to settle out the finer clay particles as stated above; however, 24 hours can be used if it can be demonstrated that this rate will remove 80% of the solids. The analysis of runoff using the hydrologic model STORM and California precipitation data found that increasing the drawdown time from 24 to 40 hours increased the size of the basin by only about 10% to 20% depending on the location (see Appendix D).

Proper hydraulic design of the outlet is critical to achieving good performance of the detention basin. The two most common outlet problems that occur are: 1) the capacity of the outlet is too great resulting in partial filling of the basin and less than designed for drawdown time and 2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, two alternative outlet types are recommended for use: 1) V-notch wier, and 2) perforated riser. The V-notch wier will not clog, but it is also difficult to maintain small release rates at low heads. The perforated riser if properly designed and gravel packed gives much better control and is recommended over the V-notch wier.

Two different approaches can be used to control the outflow. One is to use a single orifice outlet with or without the protection of a riser pipe. The other is to use the perforated riser itself for discharge control. Both approaches are presented below.

Flow Control Using a Single Orifice

The outlet control orifice should be sized using the following equation (GKY, 1989).

$$a = \frac{2A(H-H_o)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7\times10^{-5})A(H-H_o)^{0.5}}{CT} \qquad (1)$$

where:
- a = area of orifice (ft^2)
- A = average surface area of the pond (ft^2)
- c = orifice coefficient
- T = drawdown time of full pond (hrs.)
- g = gravity (32.2 $ft./sec^2$)
- H = elevation when the pond is full (ft)
- H_o = final elevation when pond is empty (ft)

With a drawdown time of 40 hours the equation becomes:

$$a = \frac{(1.75\times10^{-6})A(H-H_o)^{0.5}}{C} \qquad (2)$$

Assuming an average release rate at one half the pond depth, a common approach in several design manuals, leads to considerable error. If the pond has a significant variation of surface area with depth, do not use Equation (2); consult GKY (1989).

Care must be taken in the selection of "c": 0.60 is most often recommended and used. However, based on actual tests GKY (1989) recommends the following:

c = 0.66 for thin materials, that is, the thickness is equal to or less than orifice diameter

c = 0.80 when the material is thicker than the orifice diameter

Drilling the orifice into an outlet structure that is made of concrete can result in considerable impact on the coefficient, as does the beveling of the edge. The experiments by GKY (1989) were with sharp edged orifices.

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Equation (1) defines the orifice area where a single orifice outlet is used to regulate the detention basin outflow. However, a recent survey of extended detention facilities (Galli, pers. comm.) found the drawdown time of small storms that do not fill the facility to be too short to provide effective treatment. The facilities surveyed were designed for a drawdown time of 24 hours. A 40 hour drawdown may provide sufficient time for the smaller storms. But it may be prudent to take additional steps to be certain that the small storms, which represent the majority of pollution, are effectively treated. One approach would be to check the design analysis to determine if the facility takes at least 24 hours to drain when half full. If not, either modify the design to achieve this objective, or install a two orifice outlet. The lower outlet is sized to drain a half-full facility in 24 hours. The second orifice is placed at the mid-water elevation and is sized in combination with the lower orifice to drain the entire facility in 40 hours. Another approach is to install the outlet about one foot above the bottom of the pond (essentially enlarging the micropool area). This lower area will dry up between storms and will capture much of the volume of small storms and improving pollutant removal.

Three alternative outlet structures are suggested (Figure 5B). The concrete block structure is appropriate for large ponds. The riser pipe is suggested for small to large ponds. Placing the outlet control in the berm or in a manhole located downstream of the facility is most suitable for small ponds.

Recommendations regarding the design of a riser pipe are shown in Table 5A for Austin (1988). Table 5A provides guidance on the location of holes. To prevent clogging of this orifice and the bottom orifices of the riser pipe, wrap the bottom three rows of orifices with geotextile fabric and a cone of one to three inch rock. The holes in the riser pipe should not be modified to achieve a 40 hour drawdown time. Rather, the control orifice should be placed downstream. For small facilities, place the control orifice in a manhole between the pond and the filter as shown in Figure 5B. Use a "T-pipe" (Figure 5B) to submerge the orifice.

TABLE 5A PERFORATED OUTLET RISER PIPE ORIFICES (Austin, 1988)

RISER PIPE DIAMETER	VERTICAL SPACING BETWEEN ROWS (center to center)	NUMBER OF PERFORMATIONS	PERFORATION DIAMETER
6 in.	2.5 in.	9 per row	1 in.
8 in.	2.5 in.	12	1 in.
10 in.	2.5 in.	16	1 in.

Clogging of the bottom holes has been observed in riser pipes in the mid-Atlantic states (MWCOG, 1992) suggesting that the diameter of the riser holes should not be less than 3/4 to 1" (MWCOG, 1992) although a minimum diameter of 2" is now being considered (Galli, pers comm.). However, most of the facilities surveyed had risers without the gravel cone and the outlet holes were modified to provide drawdown control. Modifying the holes in the riser to control the outlet rate reduces the diameter of the holes and increases the risk of clogging. However, gravel packing the riser pipe as shown in Figure 5B.2 and 5C.1 will minimize this risk. Submerging the control orifice as shown in Figure 5B.3 will allow the use of a smaller orifice diameter. One orifice with a diameter of 1/2 inch, or 1 inch to be conservative, allows the use of extended detention for very small catchments. Detention facilities in western Washington use this concept and have not experienced clogging problems.

Flow Control Using the Perforated Riser

For outlet control using the perforated riser as the outflow control, it is recommended that the procedure developed by the Denver Urban Drainage and Flood Control District be used (UDFCD, 1992) as illustrated in Figures 5C and 5D. Figure 5D uses a valve for C_d of 0.65. This design incorporates flow control for the small storms in the perforated riser but also, provides an overflow outlet for large storms. If properly designed, the facility can be used for both water quality and

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drainage control by: 1) sizing the perforated riser as indicated for water quality control; 2) sizing the outlet pipe to control peak outflow rate from the 2 year storm; and 3) using a spillway in the pond berm to control the discharge from larger storms up to the 100 year storm.

Other Design Considerations

- Do not locate on fill sites or on or near steep slopes if is expected that much of the water will exit through the bottom, or modify the bottom to prevent excessive infiltration.
- Energy dissipation at the inlet to minimize erosion
- Vegetate the slopes and bottom for the same reason
- Freeboard of 1 foot
- Side slopes of at least 2:1 unless vertical retaining walls are used
- Incorporate bypass or overflow for large events
- Provide dedicated access to the basin bottom (minimum 4:1) for maintenance vehicles
- With a riser structure, include an anti-vortex device and a debris barrier.

Maintenance

Conduct inspections semiannually and after each significant storm. Remove floatables and correct erosion problems in the pond slopes and bottom. Pay particular attention to the outlet control orifice(s) for signs of clogging. If the orifice is located in a Type 2 catch basin, remove sediments if they are within 18 in. of the orifice plate. Often extended detention basin serve multiple used, e.g. baseball field, resulting in higher maintenance costs.

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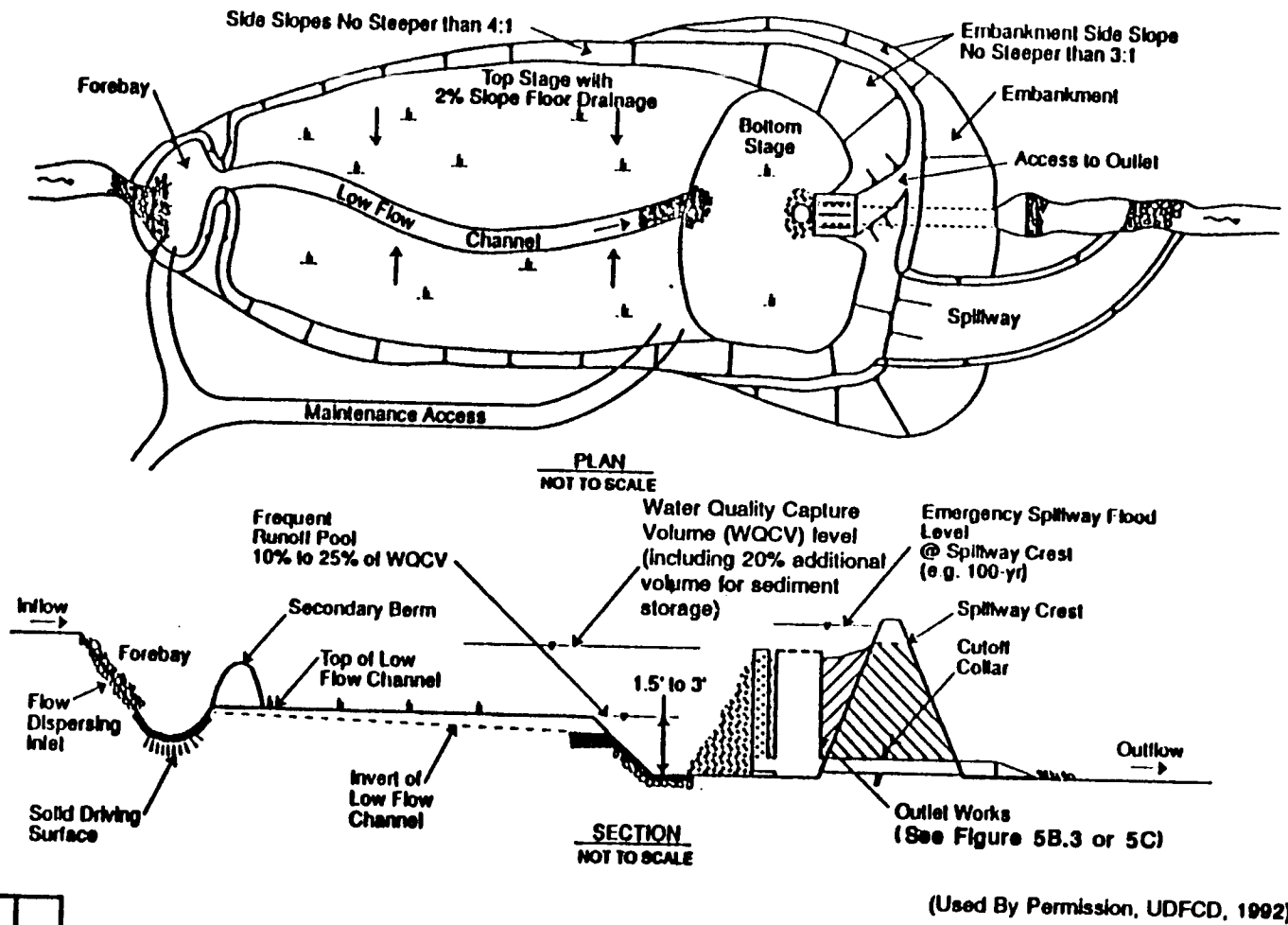

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FIGURE 5A. PLAN AND SECTION OF AN EXTENDED DETENTION BASIN

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FIGURE 5B.1 CONCRETE STRUCTURE

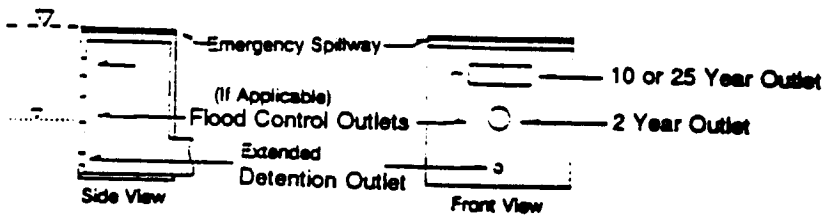

FIGURE 5B.2 RISER PIPE

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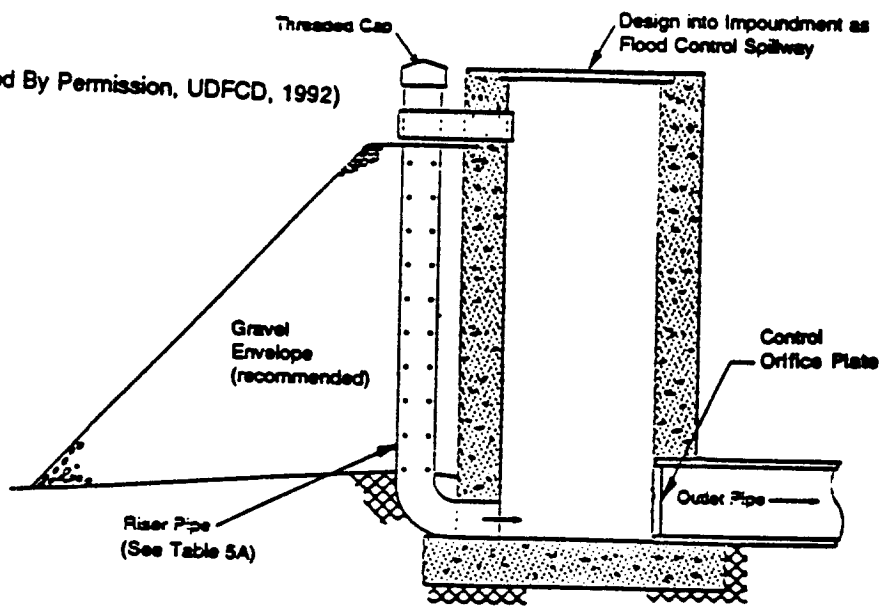

FIGURE 5B.3 CONTROL MANHOLE

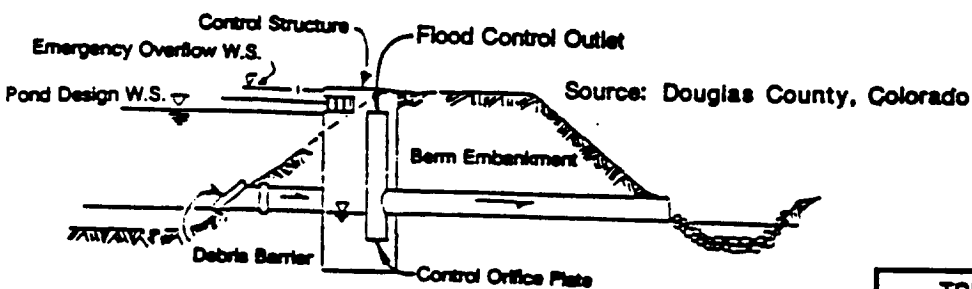

FIGURE 5B. OUTLET CONFIGURATIONS USING SINGLE ORIFICE FOR FLOW CONTROL

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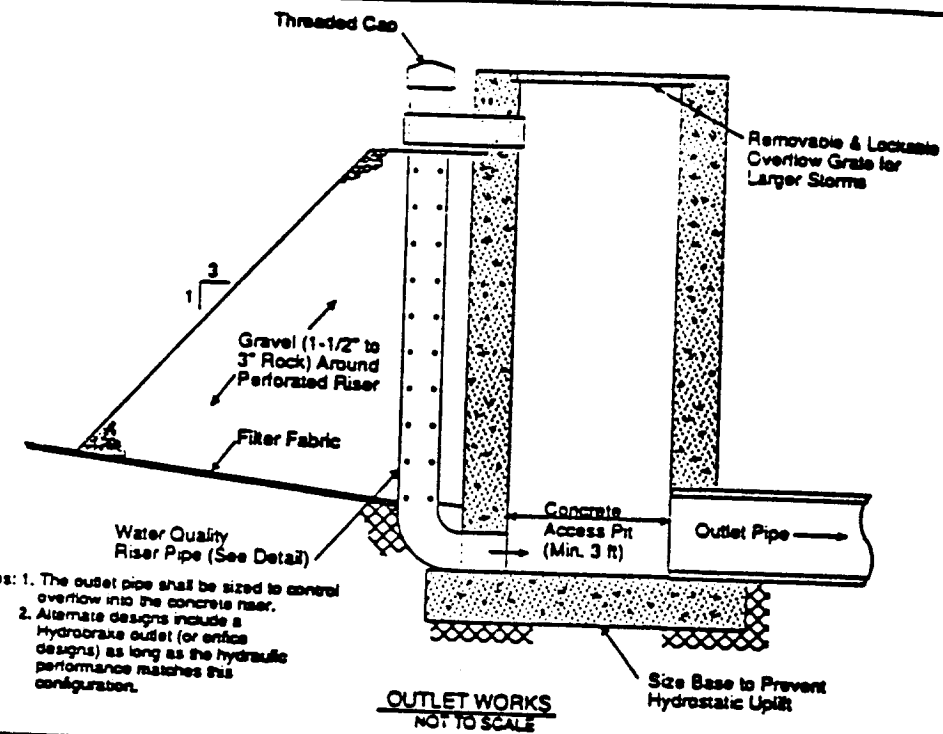
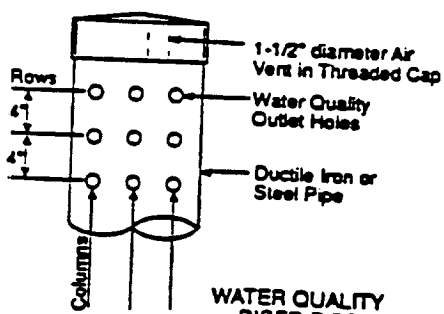


Notes: 1. The outlet pipe shall be sized to control overflow into the concrete riser.
2. Alternate designs include a Hydrobrake outlet (or orifice designs) as long as the hydraulic performance matches this configuration.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, in.			
	1/4"	1/2"	3/4"	1"
4	8	8	–	–
6	12	12	9	–
8	16	16	12	8
10	20	20	14	10
12	24	24	16	12

Hole Diameter (in.)	Area of Hole (in.2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

(Used By Permission, UDFCD, 1992)

FIGURE 5C. OUTLET CONFIGURATION USING PERFORATED RISER FOR FLOW CONTROL

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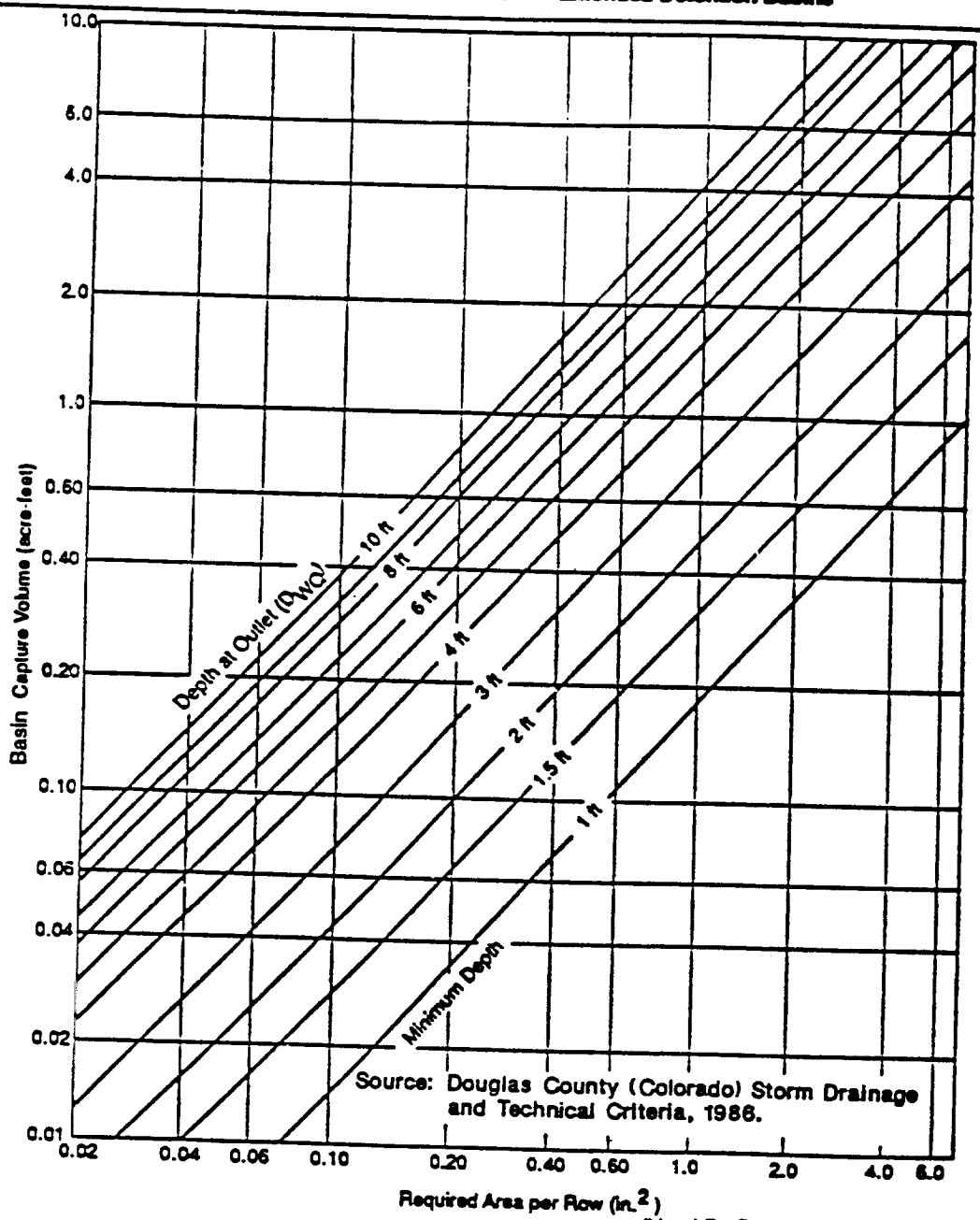

Source: Douglas County (Colorado) Storm Drainage and Technical Criteria, 1986.

(Used By Permission, UDFCD, 1992)

FIGURE 5D. WATER QUALITY OUTLET SIZING: EXTENDED DETENTION BASIN WITH A 40-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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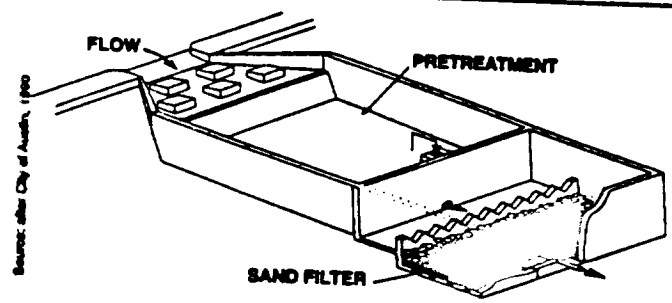
BMP: MEDIA FILTRATION



Source: after City of Austin, 1990

DESCRIPTION

Consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

EXPERIENCE IN CALIFORNIA

- A tenant at the Port of Long Beach recently installed a sand filter. The City of Los Angeles will soon install several experimental filters.

SELECTION CRITERIA

- Objective is to remove only sediment (particulate pollutants).
- Use where unavailability of water prevents the use of wet ponds, wetlands, or biofilters.
- Can be placed underground.
- Suitable for individual developments and small tributary areas up to about 100 acres.
- May require less space than other treatment control BMPs.

LIMITATIONS

- Filter may require more frequent maintenance than most of the other BMPs.
- Head loss.
- Dissolved pollutants are not captured by sand.
- Severe clogging potential if exposed soil surfaces exist upstream.

DESIGN AND SIZING CONSIDERATIONS

- Settling basin smaller than wet or extended detention basin.
- Spread flow across filter.
- Place filter offline to protect from extreme events.
- Minimize erosion in settling basin.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be certain filter sand is clean and the outlet device from the basin to the filter is level.

MAINTENANCE REQUIREMENTS

- Clean filter surface about twice annually; or more often if watershed is excessively erosive.

COST CONSIDERATIONS

- Filtration system may use less space than other systems.
- Smaller media improves performance but increases maintenance costs.

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Additional Information — Media Filtration

Sand filters may be particularly suitable for industrial sites because the settling basin can be located underground. A sand filter consists of two units: settling basin and the filter. Pretreatment is essential to avoid rapid clogging of the filter. Peat/sand mixture has been used: peat having the ability to remove dissolved contaminants. However, there have been clogging problems (Tomasak, et al., 1987) but this may be due to using the wrong type of peat (Galli, 1990). Limited research indicates that compost made from leaves is very effective at removing dissolved phosphorus and metals, and oil and grease (Stewart, 1989). A new concept is placement of a filter device in a catch basin insert (McPherson, 1992) which may be very well suited for industrial sites.

Field research in the City of Austin, Texas (Austin, 1990) indicates the sand filter has a removal efficiency of suspended solids that is similar to wet ponds and extended detention: 70 to 90%. The observed removal of metals was 20 to 80%, depending on the metal, 20 to 30% for nitrogen, and 50 to 60% for phosphorus. These rates are also similar to wet ponds, which is not expected as a filter does not remove dissolved contaminants. Sand with a diameter smaller than used in Austin would likely improve performance but has not been tried.

The sand filter should be an ideal system for the Central Valley and Southern California. It does not rely on vegetation, and has proven itself in the City of Austin. The sand filter is suitable for tributary areas of a less than an acre to about 50 acres.

Care should be taken if the tributary is prone to erosion, such as development in which open space is left unprotected. Experience in Austin indicates that exposed soils during construction "upstream" from the filter can result in penetration of fines into the filter media, resulting in a need to replace the entire filter bed. The system should have a bypass for extreme events.

Alternative configurations

The most experience to date is with surface facilities shown conceptually in Figure 6A. It can be used on catchments up to perhaps 50 acres. Its origin is Austin, Texas where there are now several hundred facilities. The "Austin" filter uses an extended detention basin with a drawdown time of 24 hours. Two other systems are most suitable for small catchments of a few acres. An underground "linear" filter (Figure 6B) is used in Delaware (Shaver, 1991). The filter accepts sheet flow from adjacent pavement. It, therefore, may be ideal for industrial applications. Another underground design (Figure 6C) developed in Washington D.C. (Truong, 1989) is also ideal for developments. It accepts concentrated flow. Both of these underground systems use a wet vault (or water quality inlet, see TC7) as the pretreatment device. The fourth concept is (Figure 6D) is an insert placed in existing catch basins. It should only be used where maintenance staff are available to check the filter frequently and where local flooding will not occur if the filter clogs.

Determining the volume of the pretreatment unit

To size the pretreatment basin refer to the sizing methods for extended detention (TC5). With the sand filter the pretreatment basin need not be as efficient as a full size system. The pretreatment system, however, should be large enough to provide a removal efficiency that avoids rapid clogging of the filter. As yet, there is no clear answer on this question. For now it is suggested that the volume of a wet vault be such as to achieve a removal efficiency of 50 to 60%.

The volume of an pretreatment unit can be decreased by reducing the drawdown time, which results in a lower but acceptable removal efficiency. The facility volume can be determined from TC5 Extended Detention using a drawdown time of 24 hours.

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Additional Information — Media Filtration

Determining the surface area of the filter

The following equation is derived from Austin (1988) for a maximum (full pretreatment basin) filtration time of 24 hours:

$$\text{Filter area (ft}^2) = 3630 S_u AH/K(D+H) \qquad (1)$$

where:
- S_u = unit storage (inches-acre) from Appendix D
- A = area in acres draining to facility
- H = depth (ft) of the sand filter
- D = average water depth (ft) over the filter taken to be one-half the difference between the top of the filter and the maximum water surface elevation
- K = filter coefficient recommended as 3.5 (Austin)

Equation (1) is appropriate for the filter media size recommended by the City of Austin, diameter of 0.02 to 0.04 inches. The filter area must be increased if a smaller media is used (see Austin, Texas (1988)).

Configuring a surface sand filter (City of Austin concept)

Additional design criteria for the settling basin (Austin, 1988):

- For the outlet use a perforated riser pipe, as described in TC5, Extended Detention
- Size the outlet orifice for a 24 hour drawdown
- Energy dissipator at the inlet to the settling basin
- Trash rack at outlets to the filter
- Vegetate slopes to the extent possible (see Vegetated Biofilters)
- Access ramp (4:1 or less) for maintenance vehicles
- One foot of freeboard
- Length to width ratio of at least 3:1 and preferably 5:1
- Sediment trap at inlet to reduce resuspension. One concept is shown in Figure 6E.

Additional design criteria for the filter:

- Use a flow spreader (Figure 6A).
- Use either of two alternative sand bed designs (Figure 6F).
- Use clean sand 0.02 to 0.04 inch diameter.
- Some have placed geofabric on sand surface to facilitate maintenance.
- Underdrains (Figure 6A).
  - Schedule 40 PVC.
  - 4 inch diameter.
  - 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
  - maximum 10 foot spacing between laterals.
  - minimum grade of 1/8" per foot.

Configuring the linear filter

Take the volume for the pretreatment unit and the filter area identified above and configure into a structure similar to that shown in Figure 6B. The structural design in Figure 6B assumes traffic loads over the filter. The structure can be less robust if it is located along the edge of the pavement, away from traffic. Other recommendations (Shaver, 1991):

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- Depth of sand 18"
- Diameter of the outlet pipe should be 6" or less; use multiple outlets if necessary

The filter must be positioned relative to the pavement in a manner that evenly distributes the flow as it enters the sedimentation chamber. Pavement design and construction is therefore critical.

Configuring the wet vault filter

Similarly the volume of the wet vault and filter area are configured into a rectangular unit similar to that shown in Figure 6C. Other considerations for the wet vault include:

- A length to width ratio of at least 3:1 to minimize short-circuiting
- Baffles to reduce entrance velocities and to retain floatables
- Access ports to facilitate maintenance
- Depth of the wet pool of at least 3 feet but not more than 10 feet

Catch basin insert

The catch basin insert filter may be ideal for industrial sites as it can be placed in existing catch basins, and therefore may avoid the need for an "end-of-pipe" facility. The system is illustrated in Figure 6D. It consists of a series of trays. The top tray is a sediment trap. Filter material is placed in the lower trays. Of several materials examined, the most suitable appears to be household fiberglass insulation. Limited tests indicate over 90% removal of metals and oil (McPherson, 1992). As the insert requires frequent attention it should only be used where a maintenance person is located on-site. The insert has a bypass along one side should the filter material clog and is hydraulically designed so as to not compromise the primary purpose of a catch basin, to get storm water into the drain system. The concept shown in Figure 6D is proprietary (Enviro-drain, 1992).

Maintenance

Inspect semiannually, and after major storms. Sediment should be removed from the settling basin when 4 inches accumulates and from the filter when 1/2 inch accumulates, or when there is still water in the basin or over the filter 40 hours after the storm. Remove floatables. Experience in Austin indicates the filter surface must be cleaned about twice each year by raking off the dried sediment. Failure to clean the filter regularly may result in the need to replace the entire media because of penetration of fines into the filter. It is more cost effective over the long term to clean the filter regularly as recommended. If there are open space areas in the tributary that are erosive or if construction is occurring, more frequent cleaning will be necessary. It may be necessary to replace the filter media after construction activity has ceased and the soils are stabilized.

Consult Austin (1988), Truong (1989), and Shaver (1991) for additional design and maintenance criteria.

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Galli, J., 1990, "Peat-Sand Filters: A Proposed Stormwater Management Practice for Urbanized Areas", Metropolitan Washington Council of Governments.

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Additional Information — Media Filtration

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Tomasak, M.D., G.E. Johnson, and P.J. Mulloy, 1987, "Operational Problems with a Soil Filtration System for Treating Stormwater", Minnesota Pollution Control Agency.

Truong, H. V., 1989, "The Sand Filter Quality Structure", District of Columbia Government.

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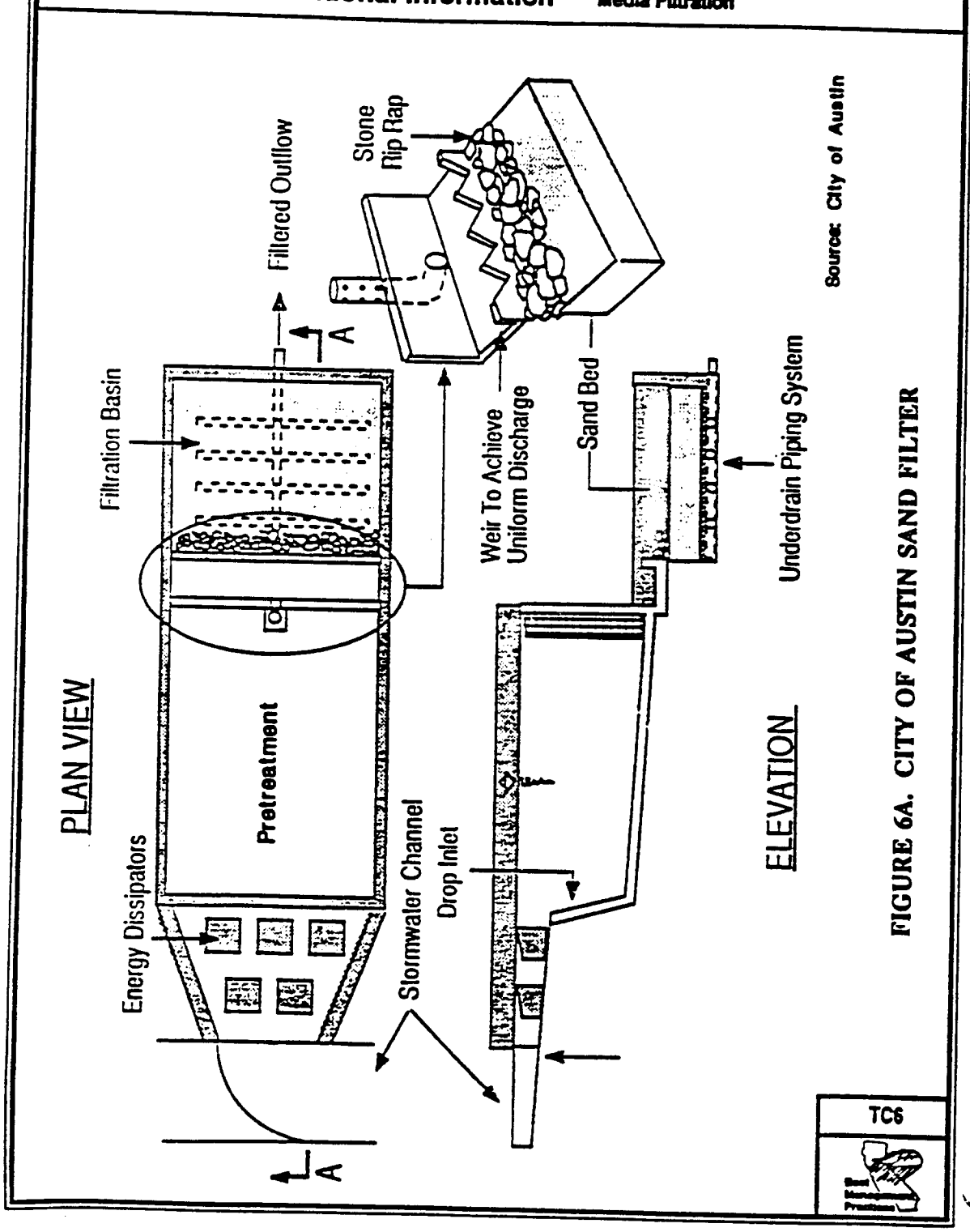

FIGURE 6A. CITY OF AUSTIN SAND FILTER

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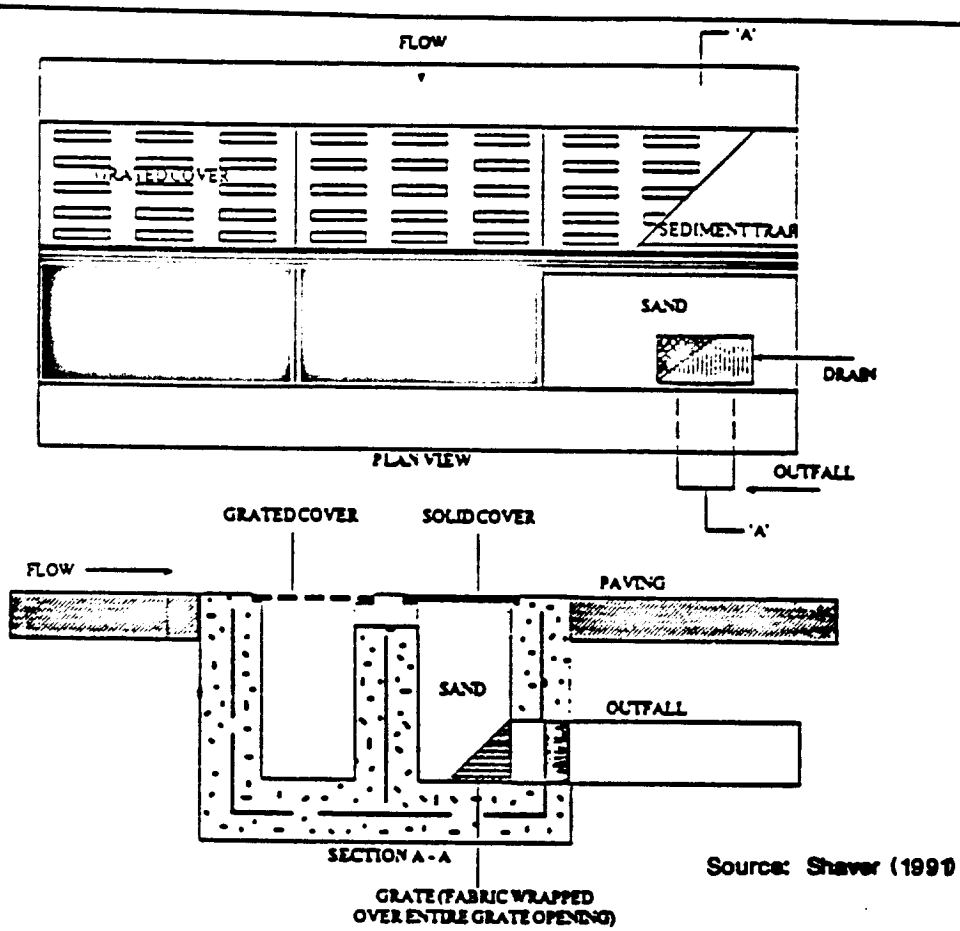
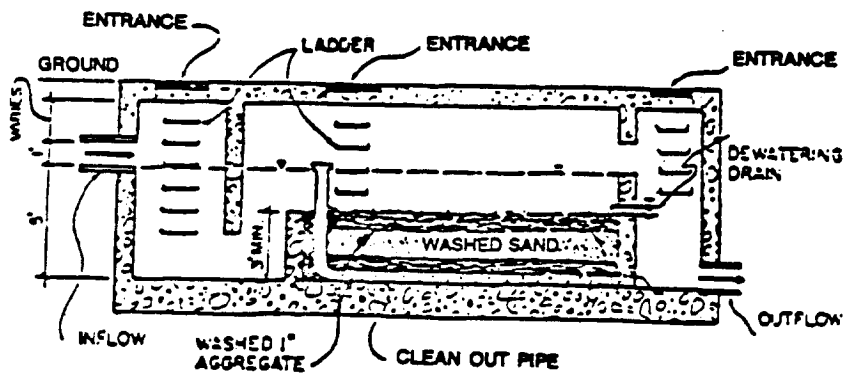


Source: Shaver (1991)

FIGURE 6B. LINEAL SAND FILTER



Source: District of Columbia

FIGURE 6C. VAULT SAND FILTER

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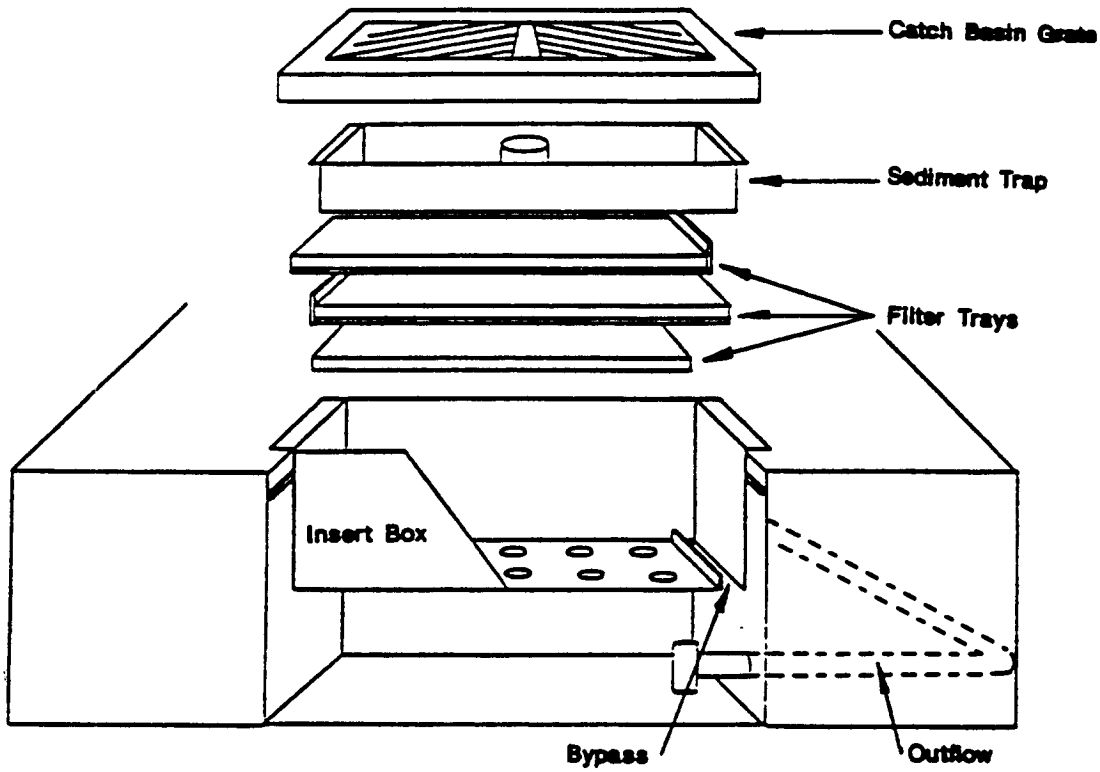

Source: McPherson (1992)

FIGURE 6D. CATCH BASIN FILTER

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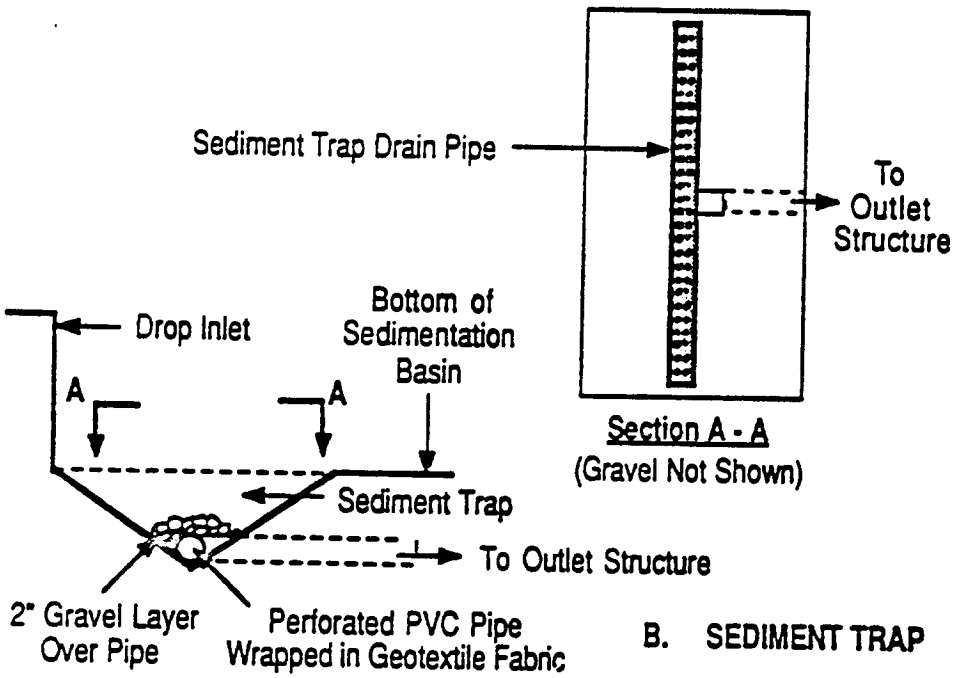

Source: City of Austin

FIGURE 6E. EXAMPLE RISER PIPE AND SEDIMENT TRAP DETAILS

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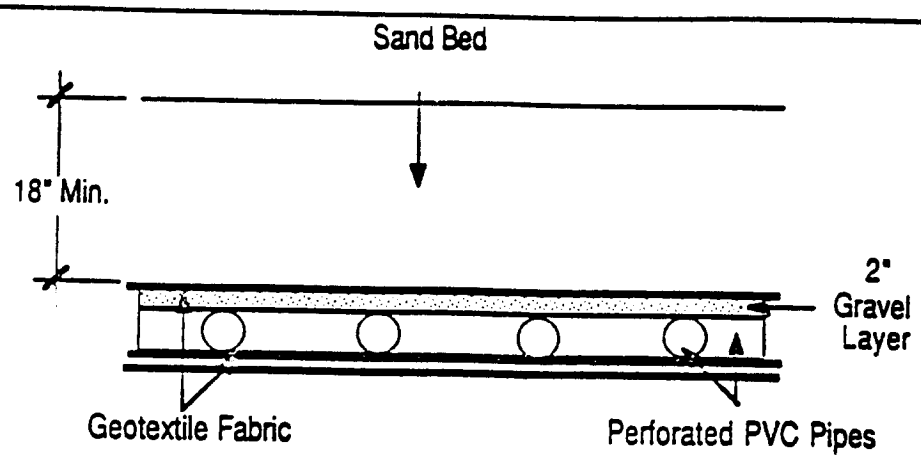
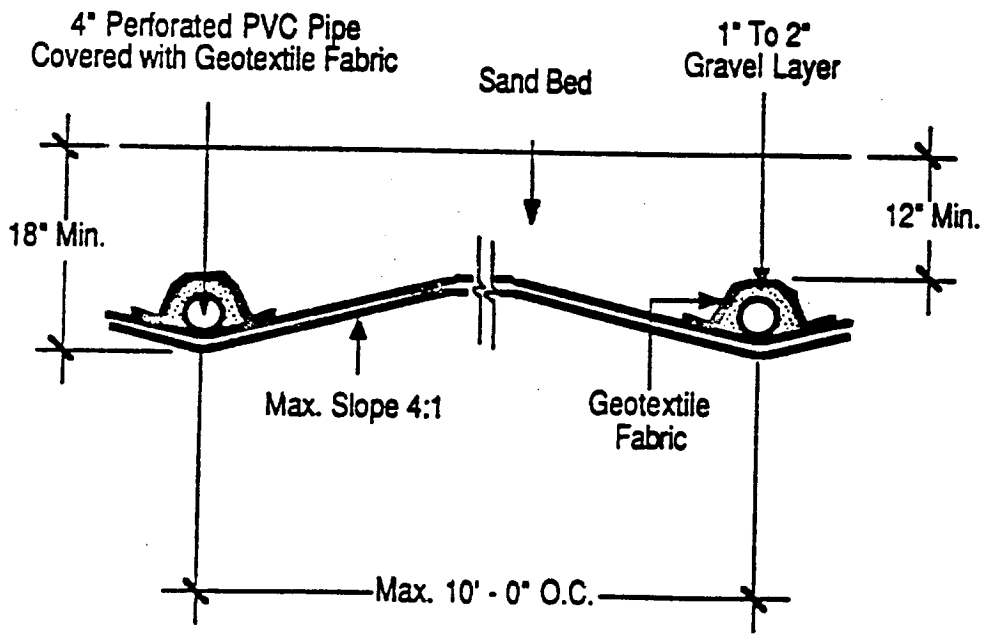


A. SAND BED PROFILE (WITH GRAVEL LAYER)



B. SAND BED PROFILE (TRENCH DESIGN)

Adapted from City of Austin (1989)

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FIGURE 6F. SAND BED FILTRATION CONFIGURATIONS

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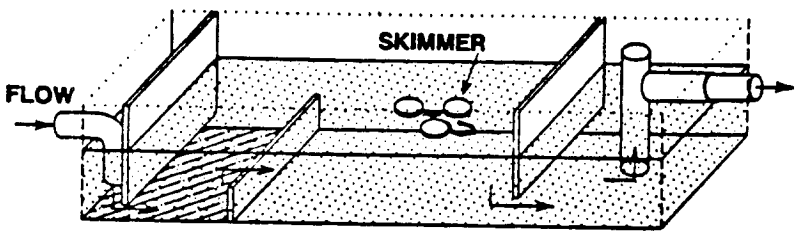
BMP: OIL/WATER SEPARATORS AND WATER QUALITY INLETS



Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids. Two general types of oil/water separators are used: conventional gravity separator and the coalescing plate interceptor (CPI).

EXPERIENCE IN CALIFORNIA

Oil/water separators are in use throughout California at industrial sites. Oil/water separators are used at all bulk petroleum storage and refinery facilities. A few jurisdictions require new commercial developments to install separators under certain situations that are environmentally sensitive.

SELECTION CRITERIA

Applicable to situations where the concentration of oil and grease related compounds will be abnormally high and source control cannot provide effective control. The general types of businesses where this situation is likely are truck, car, and equipment maintenance and washing businesses, as well as a business that performs maintenance on its own equipment and vehicles. Public facilities where separators may be required include marine ports, airfields, fleet vehicle maintenance and washing, facilities, and mass transit park-and-ride lots. Conventional separators are capable of removing oil droplets with diameters equal to or greater than 150 microns. A CPI separator should be used if smaller droplets must be removed.

LIMITATIONS

- Little data on oil characteristics in storm water leads to considerable uncertainty about performance.
- Air quality permit (conditional authorization) permit-by-rule from DTSC may be required.

DESIGN AND SIZING CONSIDERATIONS

- Sizing related to anticipated influent oil concentration, water temperature and velocity, and the effluent goal. To maintain reasonable separator size, it should be designed to bypass flows in excess of first flush.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- None identified.

MAINTENANCE REQUIREMENTS

- Clean frequently of accumulated oil, grease, and floating debris.

COST CONSIDERATIONS

- Coalescing plate material is costly but requires less space than the conventional separator.

Targeted Constituents

- ◒ Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Best Management Practices

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Additional Information — Oil/Water Separators and Water Quality Inlets

General Information

Oil/water separators will be needed for a few types of industrial sites where activities result in abnormal amounts of petroleum products lost to exposed pavement, either by accidental small spills or normal dripping from the vehicle undercarriage. This will most likely be related to vehicle and mobile equipment maintenance activities. Separators may also be advisable where an area is heavily used by mobile equipment such as loading wharfs at marine ports. Limited data indicates oil/water separators can reduce the oil/grease concentration below 10 mg/l (Lettenmaier, et al. 1985).

Wet ponds, constructed wetlands, and biofilters will remove petroleum products but their reliability is uncertain where high concentrations of petroleum products may occur frequently. Also, BMPs that rely on vegetation may be damaged or become unsightly if high concentrations of oil and grease occur frequently.

The sizing of separators is based upon the rise rate velocity of oil droplet and rate of runoff. However, with the exception of storm water from oil refineries there are no data describing the characteristics of petroleum products in urban storm water that are relevant to design: either oil density and droplet size to calculate rise rate or direct measurement of rise rates. Further, it is known (Silverman, 1982) that a significant percentage of the petroleum products are attached to the fine suspended solids and therefore are removed by settling not flotation. Consequently, the performance of oil/water separators is uncertain.

The basic configurations of the two types of separators are illustrated in Figure 7A. With small installations, a conventional gravity separator has the general appearance of a septic tank, but is much longer in relationship to its width. Larger facilities have the appearance of a municipal wastewater primary sedimentation tank. The CPI separator contains closely spaced plates which enhances the removal efficiency. In effect, to obtain the same effluent quality a CPI separator requires considerably less space than a conventional separator. The angle of the plates to the horizontal ranges from 0° (horizontal) to 60°, although 45° to 60° is the most common. The perpendicular distance between the plates typically ranges from 0.75 to 1 inch. The storm water will either flow across or down through the plates, depending on the plate configuration.

A related system is the water quality inlet illustrated in Figure 7B. It is essentially a conventional gravity separator but without the appropriate geometric configuration (see Design discussion below). Another name for this systems is a wet vault. Water quality inlets have been found to be generally ineffective (Shepp, et al., 1992) because the recommended size (200 to 400 ft^3/acre of tributary) is too small. To be effective, a water quality inlet must have the surface area and volume that is similar to that of conventional separators. They may exhibit odor problems during the summer because of the lack of bacterial degradation of accumulated organic matter and the lack of reaeration of the wet pool. Facilities in Washington D.C. have been observed to have odor but, it has been noticeable only when the system is opened for inspection.

Design of Conventional Separators

The sizing of a separator is based upon the calculation of the rise rate of the oil droplets using the following equation (modified from API, 1990):

$$V_p = 1.79\,(d_p - d_c)d^2 \times 10^{-8}/n \qquad (1)$$

where:
- V_p = rise rate (ft/second)
- n = absolute viscosity of the water (poises)
- d_p = density of the oil (gm/cc)
- d_c = density of the water (gm/cc)
- d = diameter of the droplet to be removed (microns)

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A water temperature must be assumed to select the appropriate values for water density and viscosity from Table 7A. The engineer should use the expected temperature of the storm water during the December-January period. There are no data on the density of petroleum products in urban storm water but it can be expected to lie between 0.85 and 0.95. To select the droplet diameter the engineer must identify an efficiency goal based on an understanding of the distribution of droplet sizes in storm water. However, there is no information on the size distribution of oil droplets in urban storm water. Figure 7C is a size and volume distribution for storm water from a petroleum products storage facility (Branion, undated). The engineer must also select a design influent concentration, which carries considerable uncertainty because it will vary widely within and between storms.

To illustrate Equation 1: if the effluent goal is 10 mg/l and the design influent concentration is 50 mg/l, a removal efficiency of 80% is required. From Figure 7C: this efficiency can be achieved by removing all droplets with diameters 120 microns or larger. Using a water temperature of 10°C gives a water density of 0.998. Using an oil density of 0.898, the rise rate for a 90 micron droplet is 0.0011 feet per second.

It is generally believed that conventional separators are not effective at removing droplets smaller than of 150 microns (API, 1990). Theoretically, a conventional separator can be sized to remove a smaller droplet but the facility may be so large as to make the CPI separator more cost-effective.

Sizing conventional separator (modified from API, 1990).

$$D = (Q/2V)^{0.5} \qquad (2)$$

where: D = depth, which should be between 3 and 8 feet
Q = design flow rate (cfs)
V = allowable horizontal velocity which is equal to 15 times the design oil rise rate but not greater than 0.05 feet per second

If the depth exceeds 8 feet, design parallel units dividing the design flow rate by the number of units needed to reach the maximum recommended depth of 8 feet. Equation (2) is simplified from equations in API (1990) based on a recommended width to depth ratio of 2. The constant in Equation (2) can be changed accordingly if a different ratio is assumed. Some engineers may wish to increase the facility size to account for flow turbulence. See API (1990) for the design procedure.

Then:

- Calculate length, $L = VD/V_p$
- Compute width, $W = Q/(VD)$. This should be 2 to 3 times the depth, but not to exceed 20 feet
- Baffle height to depth ratio of 0.85 for top baffles and 0.15 for bottom baffles
- Locate the distribution baffle at 0.10L from the entrance
- Add one foot for freeboard
- Install a bypass for flows in excess of the design flow

Determining the design flow, Q, requires identification of the design storm. The separator is expected to operate effectively at all flow rates equal to or less than the peak runoff rate of the design storm. The design storm need not be an extreme event, as is typically used in the sizing of flood control facilities. If sized to handle a storm frequency between the 3-month to 1-year event, the facility will effectively treat the vast majority of storm water that occurs over time. All events equal to or less than the 6-month event represents about 90% of the precipitation over time; designing for a 2-year

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event only increases the amount of runoff treated by about 5% (increase from 90% to 95% of rainfall treated). For the design storm selected, calculate the peak runoff rate using the rational method.

Application of the Conventional Oil/Water Separator

Assume that a conventional oil/water separator is to be used to treat runoff from a 1/2 acre parking lot. Assume further it is to be sized to treat runoff from a rainfall rate of 0.50 inches/hr (which translates to a runoff rate of 0.50 cfs/acre when the area is 100 percent impervious.

Using the example above, the computed Vp is 0.0011 ft/sec. Using Equation 2, V = 15 x 0.0011 = 0.0165 ft/sec which is less than 0.05 ft/sec; thus,

$$D = (Q/2V)0.05 = (1/2 \times 0.05/(2 \times 0.0165)) \times 0.05$$
$$D = 3.8 \text{ ft.}$$

$$L = VD/Vp = 0.0165 \times 3.8/0.0011$$
$$L = 57 \text{ ft.}$$

$$W = Q/(VD) = 0.25/(0.0165 \times 3.8)$$
$$W = 4.0 \text{ ft, since W is less than } 2 \times D\text{, increase width to } W = 3.8 \times 2 = 7.6 \text{ ft.}$$

Thus, a conventional oil/water separator sized to capture runoff from a 0.5 in/hr rainfall on a 1/2 acre parking lot would be:

D = 3.8 ft
W = 7.6 ft
L = 57 ft

Sizing CPI separator

Manufacturers can provide packaged separator units for flows up to several cubic feet per second. For larger flows, the engineer must size the plate pack and design the vault. Given the great variability of separator technology among manufacturers with respect to plate size, spacing, and inclination, it is recommended that the design engineer consult vendors for a plate package that will meet the engineer's criteria. Manufacturer's typically identify the capacity of various standard units. However, the engineer's design criteria must be comparable to that used by the manufacturer in rating its units.

The engineer can size the facility using the following procedure. First identify the expected plate angle, H (as degrees), and calculate the total plate area required, $A(ft^2)$.

$$A = Q/V_p \text{Cosine} H \qquad (3)$$

CPI separators are not 100% hydraulically efficient; ranging from 0.35 to 0.95 depending on the plate design (Aquatrend, undated). If the engineer wishes to incorporate this factor, divide the result from Equation 3 by the selected efficiency.

- Select spacing, S, between the plates, usually 0.75 to 1.5 inch.
- Identify reasonable plate width, W, and length, L.
- Number of plates, N = A/WL.
- Calculate plate volume, $P_V(ft^3)$.

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$$P_V = \frac{(NS + L\,\text{Cosine}H)(WL\,\text{Sine}H)}{12} \qquad (4)$$

- Add a foot beneath the plates for sediment storage.
- Add 6" to 12" above the plates for water clearance so that the oil accumulates above the plates.
- Add one foot for freeboard.
- Add a forebay for floatables and distribution of flow if more than one plate unit is needed.
- Add after bay for collection of the effluent from the plate pack area.
- For larger units include device to remove and store oil from the water surface.

Horizontal plates require the least plate volume to achieve a particular removal efficiency. However, settleable solids will accumulate on the plates complicating maintenance procedures. The plates may be damaged by the weight when removed for cleaning. The plates should be placed at an angle of 45° to 60° so that settleable solids slide to the facility bottom. Experience shows that even with slanted plates some solids will "stick" to the plates because of the oil and grease. Placing the plates closer together reduces the plate volume. However, if debris is expected such as twigs, plastics, and paper, select a larger plate separation distance. Or install ahead of the plates a trash rack and/or screens with a diameter somewhat smaller than the plate spacing.

Recognizing that an oil/water separator also removes settleable solids, it can also be considered a wet vault (TC2). The engineer can use Figure 2B (See TC2) to estimate the efficiency of both the conventional and CPI separators. As Figure 2B does not include the effect of plate technology, a CPI separator should perform considerably better than indicated in Figure 2B for the same V_b/V_r ratio.

See API (1990) for further design concepts for both the conventional and CPI separators.

Maintenance

Check monthly during the wet season and clean several times a year. Always clean in October before the start of the wet season. Properly dispose the oil.

REFERENCES

American Petroleum Institute (API), 1990, "Design and Operation of Oil-Water Separators", Publication 421.

Aquatrend, undated, "Design Manual: Innova Sep Particle Separation System", Shawnee Mission, Kansas.

Branion, R., undated, "Principles for the Separation of Oil Drops from Water in Gravity Type Separators", Department of Chemical Engineering, University of British Columbia.

Lettenmaier, D. and J. Richey, 1985, "Operational Assessment of a Coalescing Plate Oil/Water Separator", Municipality of Metropolitan Seattle.

Metropolitan Washington Council of Governments (MWCOG), March, 1992, "A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone".

Silverman, G, 1982, "Wetlands for Oil and Grease Control", Tech Memo. 87, Association of Bay Area Governments.

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TABLE 7A. WATER VISCOSITIES & DENSITIES

Temperature °C	Temperature °F	Absolute Viscosity (Poises)	Absolute Viscosity (slugs/ft.sec.)	Density (gm/cc)	Density of pure water in air (lbs/ft^3)
0	32.0	0.017921	0.00120424	0.999	62.351
1	33.8	0.017343	0.00116338	0.999	62.355
2	35.6	0.016728	0.00112407	0.999	62.358
3	37.4	0.016191	0.00108799	0.999	62.360
4	39.2	0.015674	0.00105324	1.000	62.360
5	41.0	0.015188	0.00102059	0.999	62.360
6	42.8	0.014728	0.00098968	0.999	62.359
7	44.6	0.014284	0.00095984	0.999	62.357
8	46.4	0.013860	0.00093135	0.999	62.354
9	48.2	0.013462	0.00090460	0.999	62.350
10	50.0	0.013077	0.00087873	0.999	62.345
11	51.8	0.012713	0.00085427	0.999	62.339
12	53.6	0.012363	0.00084870	0.999	62.333
13	55.4	0.012028	0.00080824	0.999	62.326
14	57.2	0.011709	0.00078681	0.999	62.317
15	59.0	0.011404	0.00076631	0.999	62.309
16	60.8	0.011111	0.00074662	0.999	62.299
17	62.6	0.010828	0.00072761	0.999	62.289
18	64.4	0.010559	0.00070953	0.999	62.278
19	66.2	0.010299	0.00069206	0.999	62.266
20	68.0	0.010050	0.00067533	0.998	62.254

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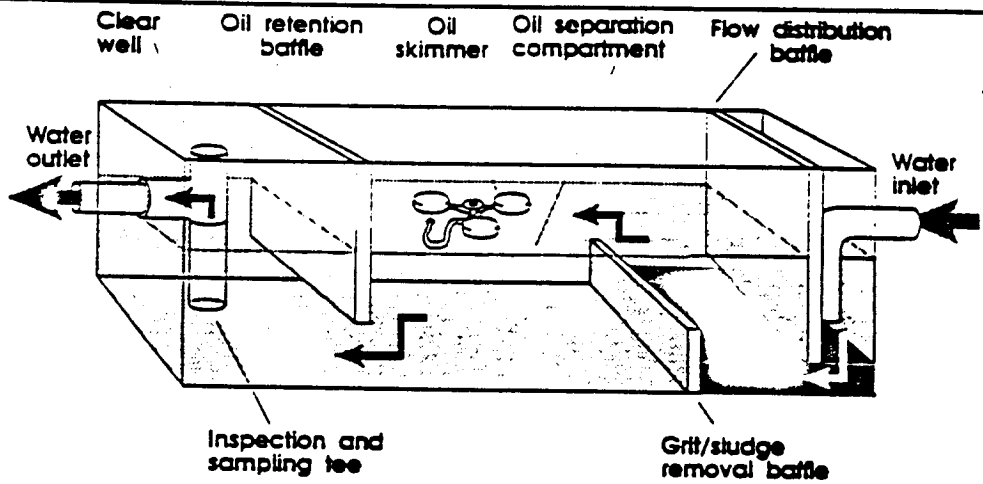
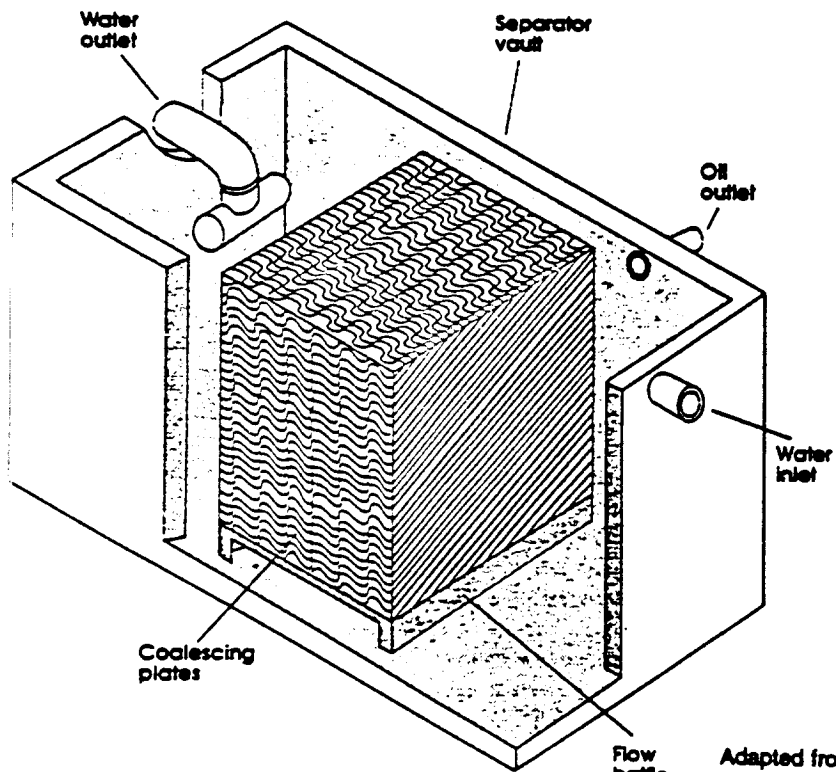
Additional Information — Oil/Water Separators and Water Quality Inlets



CONVENTIONAL SEPARATOR

Adapted from Romano, 1990



COALESCING PLATE SEPARATOR

Adapted from Romano, 1990

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FIGURE 7A. CONVENTIONAL AND COALESCING PLATE SEPARATORS

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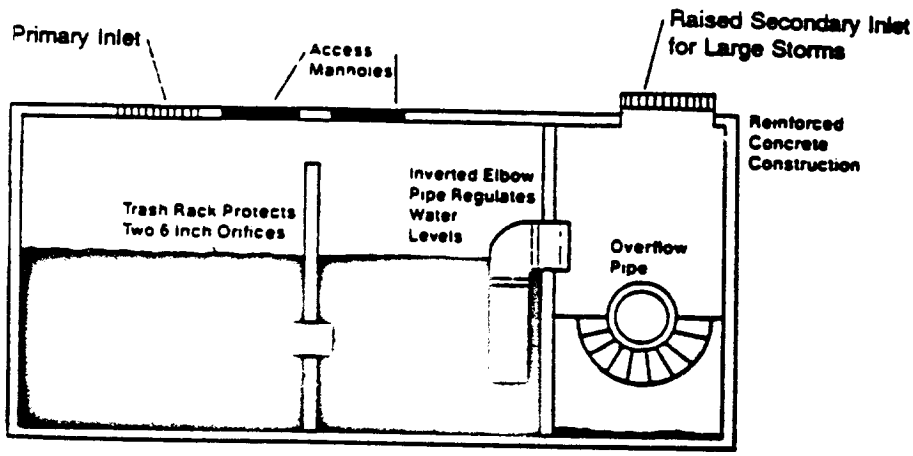

Adapted from Schueler, 1987

NOTE:
1. Size as conventional separator.
2. Design outlet orifice in elbow to limit outflow to the design rate for the unit.

FIGURE 7B. WATER QUALITY INLET

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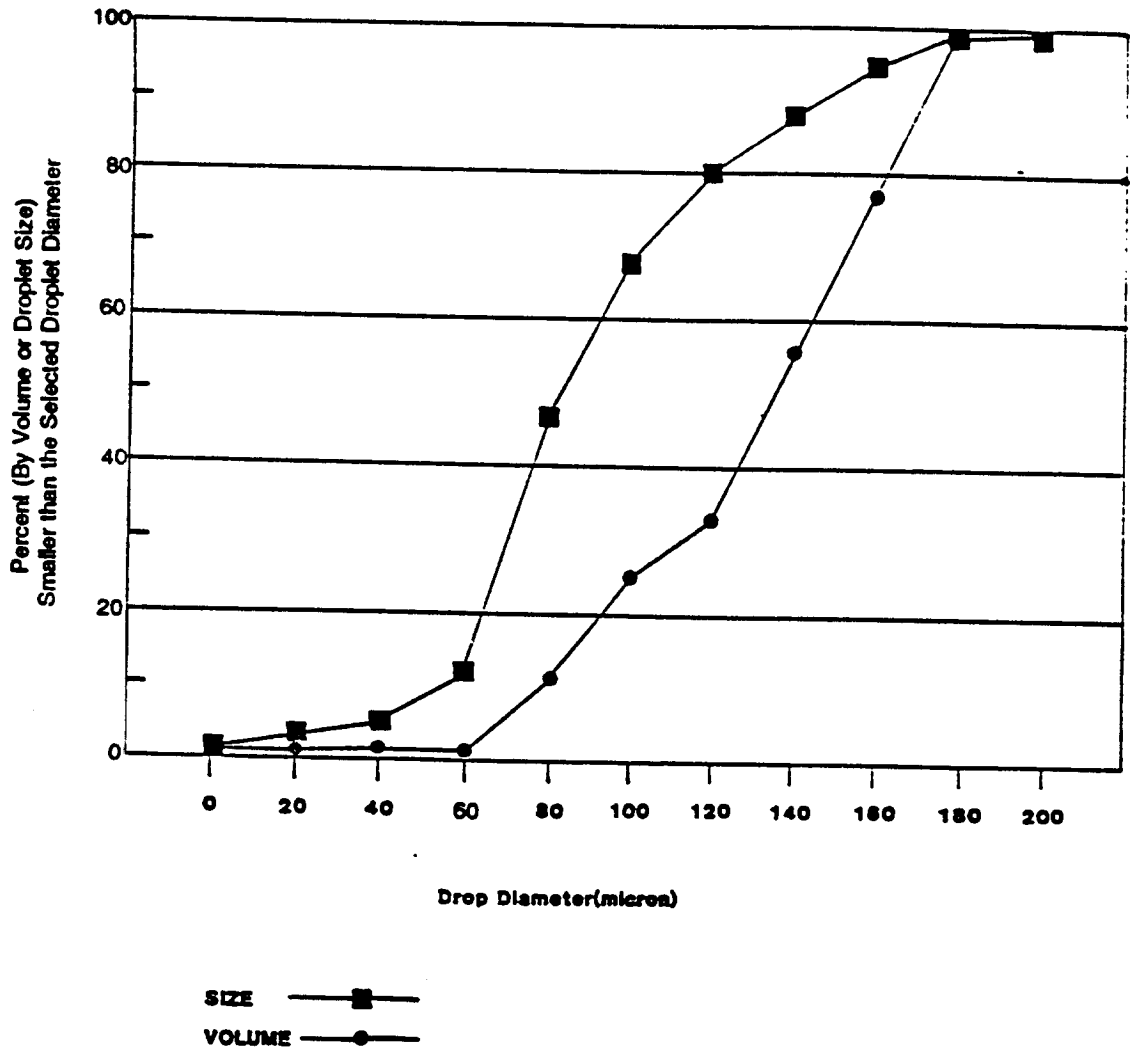

Source: Branion (undated)

FIGURE 7C. SIZE AND VOLUME DISTRIBUTION

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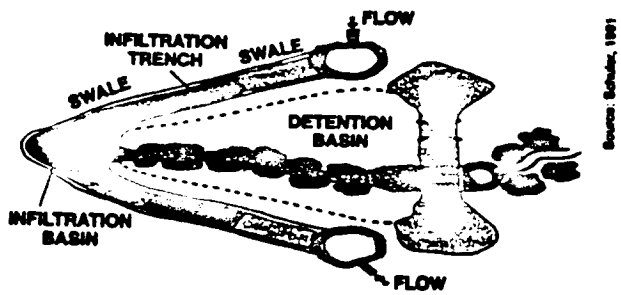
BMP: MULTIPLE-SYSTEMS



DESCRIPTION

A multiple treatment system uses two or more of the preceding BMPs in series. A few multiple systems have already been described: settling basin combined with a sand filter; settling basin or biofilter combined with an infiltration basin or trench; extended detention zone on a wet pond.

EXPERIENCE IN CALIFORNIA

- The research wetlands at Fremont, California are a combination of wet ponds, wetlands, and grass biofilters.

SELECTION CRITERIA

- Need to protect a downstream treatment system
- Enhanced reliability
- Optimum use of the site

LIMITATIONS

- Available space

DESIGN AND SIZING CONSIDERATIONS

- Refer to individual treatment control BMPs

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Refer to individual treatment control BMPs

MAINTENANCE REQUIREMENTS

- Refer to individual treatment control BMPs

COST CONSIDERATIONS

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ● O&M Costs
- ● Maintenance
- ○ Training

● High ○ Low

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Additional Information — Multiple-Systems

Multiple systems may occur in series or by stacking vertically. Multiple systems that have been tried or that appear to be feasible are presented below.

Stacked systems

- Extended detention above wet pond: used extensively in the mid-Atlantic states. Recommended by several practioners because of the uncertainty about the performance of wet ponds.
- Wet pond above sand filter: has been tried in Florida and Massachusetts and found wanting due to the clogging of the sand filter by settleable solids.

Series systems

- Extended detention basin - sand filter: standard system in Austin, Texas. Settling basin is needed to avoid excessive maintenance on the sand filter.
- Detention basin - sand filter - wetland: Large system operating in Florida.
- Wet pond - wetland: where an unusually high loading of sediment is expected, a full size wet pond, rather than just a forebay in the wetland, may be desirable to minimize the amount of sediment reaching the wetland where it would be more costly to remove.
- Biofilter - wet pond: Used frequently in the Pacific Northwest, again to enhance reliability.
- Biofilter - infiltration trench: treatment of the storm water before it enters an infiltration system.
- Oil/water separator - wetland or biofilter: oil/water separator used to protect the vegetated treatment system where high concentrations of oil may frequently occur.

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Chapter 6

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6. MEASURING BMP PERFORMANCE

INTRODUCTION

This chapter describes methods for measuring the performance of Best Management Practices (BMPs). These methods include both conventional as well as non-conventional monitoring. In general, conventional monitoring is more appropriate for treatment controls (Chapter 5), while source controls (Chapter 4) often require non-conventional methods. After a brief discussion of conventional monitoring requirements, the focus of the chapter will be on non-conventional methods for measuring performance.

MONITORING REQUIREMENTS

Monitoring is required by several sections in the Part 2 storm water permit application requirements. In addition, all the NPDES permits issued to date to municipalities have included monitoring. The regulatory required monitoring include:

- Source identification: Inventory the location of major outfalls not previously reported and the location and description of facilities that discharge storm water associated with industrial activity [40 CFR 122.26 (d)(2)(ii)].

- Characterization data: During the first year, collection and analysis of storm water discharges from 5-10 outfalls for three storms occurring at least one month apart [40 CFR 122.26 (d)(2)(iii)(A)]. For the long-term, the monitoring program must describe the data collection needs for the term of the NPDES permit [40 CFR 122.26(d)(2)(iii)(D)].

- Proposed management program: A description of a program to monitor pollutants from landfills, hazardous waste treatment, storage, and disposal TSD facilities [40 CFR 122.26 (d)(2)(iv)(A)(5)]. A description of a program to monitor and control pollutants from landfills, TSD facilities, and industrial facilities [40 CFR 122.26 (d)(2)(iv)(C)].

It is beyond the scope of this handbook to adequately describe the techniques required to meet the above requirements, however, USEPA has published extensive guidance on conventional storm water sampling (USEPA, 1992a and b) which may be used. The guidance is applicable to SWRCB issued NPDES storm water permits. Information is provided for both municipal and industrial facilities for use in Storm Water Management Programs (SWMP) and Storm Water Pollution Prevention Plans (SWPPP). The USEPA document presents information on: who should sample; where and when to sample; types and techniques of sampling; sampling fundamentals; analytical considerations; flexibility in sampling; and health and safety. Additional information on monitoring industrial activities at municipal facilities is provided in Chapter 6, Monitoring, of the Industrial BMP Handbook. Chapter 6, Monitoring, of the Construction BMP Handbook provides information on monitoring municipal construction projects.

NON-CONVENTIONAL MONITORING

Although conventional monitoring is preferred because it provides a direct measure of the receiving water body, measuring BMP performance based on these data can be difficult because of:

- The inherent variability (spatial and temporal) in rainfall and runoff characteristics;

- The lack of baseline data on the types, sources, and concentrations of pollutants in the storm sewer system;

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- The receiving water integrates many impacts (e.g., atmospheric deposition, groundwater, storm water, illegal discharges, permitted discharges) making it very difficult to establish cause and effect relationships; and

- The difficulty in predicting and measuring the effectiveness of controls, especially source controls.

Unless these sources of uncertainty can be controlled or reduced to insignificance, data from conventional monitoring can be expensive to generate and yield little information on program effectiveness.

In contrast, there are non-conventional measures of effectiveness that will provide more direct information on specific BMPs. These methods typically provide data on pollutant reductions (pounds of pollutant reduced in the waste stream per unit [e.g., dollar, capita, time period, area]) as opposed to water quality (runoff or receiving water) data gathered by conventional monitoring. Although these methods do not measure receiving water directly, they do eliminate many of the variables and uncertainties associated with monitoring. Listed below are several methods that may be used to establish both baseline and subsequent information to measure BMP effectiveness.

It should be noted, however, that the methods are suggested and that some municipalities may opt to conduct an alternative monitoring program. The important aspect to keep in mind is that the information collected will help in refining and improving the overall storm water management program.

- Public surveys - Source controls place a strong emphasis on public education and participation. Effective implementation depends on a clear sense of the public's awareness of the problem, the most effective means for increasing their understanding, and their willingness to participate in the solutions. Public surveys are an excellent tool for gathering the following information:

  - Levels of environmental awareness,
  - Perceived pollution sources,
  - Disposal practices,
  - Willingness/Support for new services/programs,
  - Sources of information, and
  - Neighborhood differences.

Both a baseline as well as progress surveys should be conducted to track the effectiveness of the program and to provide information for program modifications.

- Products (New Ordinances/Programs) - The implementation of new programs and ordinances (not just plans) is often the first indication that the new SWMP is having an effect. Although the establishment of new programs and ordinances does not mean that the SWMP is effective, it does mean that within the municipality, the problems have been identified, decision makers have been educated and are supportive, goals have been set, budgets have been modified, and resources (staff and equipment) have been allocated. All these steps lay the necessary groundwork for an effective program.

- Level of participation - Level of participation by the general public and businesses can provide a direct measure of effectiveness. Performance can be measured by number of pounds of pollutant reduced for BMPs such as: household hazardous waste collection (SC31) and used oil recycling (SC32). Or effectiveness may be inferred by level of participation in, for example, storm drain stencilling (SC30). Participation indicates an understanding of the problem and a willingness of the participant to share in the solution.

- Record Keeping/Program Tracking - This is the municipal employee equivalent of the level of participation method for the general public and businesses. This is an important aspect of many of the source controls, particularly the following:

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- Safer alternatives (SC11) - Amount of hazardous materials purchased.
- Material storage control (SC20) - Accurate inventories of hazardous materials stored.
- Storm drain stencilling (SC30) - Number of drains stencilled by municipal employees.
- Illegal dumping (SC50) - Number, location, type, and size of incidents.
- Illegal connections (SC60-62) - Number, location, type, and size of connections.
- Street cleaning (SC70) - Number of curb-miles swept and amount of waste collected.
- Catch basin cleaning (SC71) - Number of catch basins cleaned and amount of waste collected.
- Detention/Infiltration device maintenance (SC76) - Number of devices cleaned and amount of waste collected.

USING MONITORING DATA

All of the above methods may be used to document the municipality's efforts and to provide information for:

- Program planning;
- Cost-effectiveness determinations for program evaluation and modification;
- Reporting requirements; and
- Establishing that pollutants are being reduced to the "maximum extent practicable" as required by the regulations.

REFERENCES

United States Environmental Protection Agency (1992a), "NPDES Storm Water Sampling Guidance Document," EPA 833-B-92-001, July.

United States Environmental Protection Agency (1992b), "Guidance Manual for the Preparation of Part 2 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems", EPA 833-B-92-002, November.

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APPENDIX A

SOURCE CONTROL BMPs EXAMPLE

Appendix A

Source Control BMP Example

Introduction

This Appendix is provided as a step-by-step planning example on how to select potential source control BMPs for inclusion in a municipal Storm Water Management Program (SWMP). It describes how to conduct Step 4: Select Near-Term BMPs, of the six-step decision-making process introduced in Chapter 2 and assumes that program goals and priorities, and existing conditions (Steps 1-3) have been identified. This example illustrates how source control BMPs listed in Chapter 4 may be selected using Worksheet #1 in Chapter 3 to match the required elements of a SWMP as summarized in Table 3.1.

Selection Process

The selection criteria and the scoring system introduced in Chapter 3 are similar to other selection processes developed around California and represents the state-of-the-art. On the other hand, BMP selection, particularly of source controls, is by no means a science. Therefore, we encourage you to use this selection process, but feel free to modify either the criteria and/or the scoring to suit your community. Modification of the following selection process attributes may be considered:

- **Criteria** - You may want to redefine some of the criteria, or add/subtract criteria.
- **Scores** - Likewise, you may want to modify the scoring to a simple +, 0, and -, or 1, 2, and 3.
- **Weighting** - In addition, you may want to group the criteria into tiers reflecting their relative importance to your SWMP goals. By multiplying the scores of the highest tier by some factor (e.g., x2) the first tier scores could be weighted more heavily than the others to reflect this importance.
- **Fatal flaw** - Scoring the BMPs should provide for some fatal flaw (e.g, the BMP is illegal or its implementation is completely unacceptable to the public) which would make implementation impossible. Scoring a fatal flaw as a 0 is one way of highlighting the flaw. Any BMP scoring a 0 against a criterion would be eliminated from consideration, regardless of its overall ranking.

Example

In the following example, municipality Anytown, CA is developing a Storm Water Management Program which includes an element for Residential/Commercial Activities. By following the steps below, Anytown, CA uses Worksheet #1 to rank the BMPs according to their ability to meet the selection criteria. The partially filled out worksheets provided in this Appendix show the initial results of this hypothetical ranking.

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1. The selection process involves the use of the following portions of the Municipal Handbook:

   - Table 3.1 "Application of BMPs to SWMP elements" (p. 3-2),
   - Discussion of selection criteria (pp. 3-5 through 3-7),
   - Worksheet #1 (p. 3-12), and
   - Source Control BMPs (Chapter 4).

2. A review of Table 3.1 shows that for Residential/Commercial Activities, the storm water regulations require the SWMP to have an element addressing Roadway and Drainage Facility Maintenance. The program activity and element are listed at the top of Worksheet #1.

3. Looking across the Roadway and Drainage Facility Maintenance row in Table 3.1, there are two categories of source control BMPs that apply, Material Use Controls and Street/Storm Drain Maintenance.

4. Starting with the Material Use Controls category, Page 4-1 shows that this category includes two types of BMPs, Housekeeping Practices, and Safer Alternative Products. These are listed on Worksheet #1.

5. A review of the BMP fact sheets indicates several BMPs are described within each fact sheet. These are also listed on Worksheet #1.

6. Using the discussion of selection criteria (pp. 3-5 through 3-7), the BMPs are ranked against the selection criteria using the scale of 1-5.

7. For the first BMP, Distribute public education materials, the following scores are recorded:

   Meets regulatory requirements = 3. Public education meets the intent of the storm water regulations.

   Effectiveness of pollutant removal = 2. Effectiveness of source control is high, however, insufficient data exist to support claim.

   Public acceptance = 5. Anytown believes that the public education materials will help the public understand the problem and as a result its citizens will support and participate in program implementation.

   Implementable = 5. Existing department and staff may be used and public education materials are available from other municipalities and agencies to serve as models or to purchase for use as is.

   Institutional constraints = 4. To provide a consistent message to the public, Anytown must coordinate its public education program with the County which already has in place a hazardous waste disposal program. The County has indicated that it will cooperate fully with Anytown to ensure the public education material is consistent with the County's program.

   Costs = 5. Given the availability of materials to serve as models or to use directly, production should be relatively inexpensive.

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8. Addition of the criteria scores across each row produces a total score which may be compared to the other totals.

9. The process is continued for each of the source control BMP categories checked in Table 3.1

As a result of this evaluation, Anytown, CA implemented all the BMPs in the Housekeeping Practices and Safer Alternative Products categories, as well as the maintenance BMPs in the Street/Storm Drain Maintenance category. However, the scores for the other Street/Storm Drain Maintenance BMPs indicated that further study was necessary before their implementation could be proposed. Anytown, CA also found that storm drain flushing was not allowed by the local sewer agency, so this fatal flaw removed this BMP from further consideration.

Few Points to Remember

- Have several people or one of your storm water committees, conduct the selection independently to get a broad perspective on the relative merits of each BMP and to help reach a consensus.
- Keep the selection system as simple as possible and use best professional judgment to interpret and to conduct a reality check on the total scores.
- Differences of a few points in the total score are probably not significant.
- The final rankings may be used to plan and prioritize your SWMP. For example, those BMPs with the highest scores may be implemented in the first year of the NPDES permit, while low scoring BMPs may need more time to develop, relegating their implementation to the fifth year or to further study.
- The exercise of working through this selection will provide the necessary data to promote the program to other departments, political leaders, regulatory agencies, and the public.

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Required Elements of SWMP	SOURCE CONTROL BMPS CHAPTER 4							
	Planning Management	Material Use Control	Material Exposure Controls	Material Disposal & Recycling	Spill Prevention & Cleanup	Illegal Dumping Controls	Illicit Connection Controls	Street/ Storm Drain Maintenance
FOR RESIDENTIAL/ COMMERCIAL ACTIVITIES:								
Roadway and drainage facility maintenance		X						X
BMP planning for new development and redevelopment projects	X							X
Retrofitting existing or proposed flood control projects with BMPs	(See Page 3-9, Chapter 3)							
Municipal waste handling and disposal operations		X	X	X	X	X		
Pesticide, herbicide, and fertilizer use controls		X	X	X	X	X		
FOR IMPROPER DISCHARGE ACTIVITIES:								
Prevention, detection, and removal of illegal connections to storm drains							X	
Spill prevention, containment, and response		X	X	X	X	X		
Promote proper use and disposal of toxic materials		X	X	X	X	X		
Reduce storm water contamination by leaking/ overflowing separate sanitary sewers					X	X		
FOR INDUSTRIAL ACTIVITIES:								
Inspection and control prioritization and procedures		X	X	X	X	X	X	X
Monitoring of significant industrial discharges						X	X	
FOR CONSTRUCTION AND LAND DEVELOPMENT ACTIVITIES:								
Water quality and BMP assessments during planning	X	X	X	X	X	X		X
Site inspection and enforcement procedures	X	X	X	X	X	X		X
Training for developers and contractors	X							

TABLE 3.1 APPLICATION OF BMPs TO SWMP PROGRAM ELEMENTS

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WORKKSHEET 1
SOURCE CONTROL BMP

PROGRAM ACTIVITIES: ***Residential / Commercial***

PROGRAM ELEMENT: ***Roadway and Drainage Facility Maintenance***

BMPs	Meets Regulatory Requirements (1 - 5)	Effectiveness of Pollutant Removal (1 - 5)	Public Acceptance (1 - 5)	Implementable (1 - 5)	Institutional Constraints (1 - 5)	Costs (1 - 5)	Total (30 MAX.)
MATERIAL USE CONTROL							
Housekeeping Practices							
• *Distribute Public Education Material*	3	2	5	5	4	5	24
• *Train City Employees Regarding Chemical Use*	3	3	5	4	4	5	24
Safer Alternative Products							
• *Use Organic Soil Amendments*	3	5	5	3	5	2	23
• *Train City Employees Regarding IPM*	3	3	5	4	4	5	24
• *Substitute IPM for Pesticides*	3	5	5	2	5	5	25

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WORKKSHEET 1
SOURCE CONTROL BMP

PROGRAM ACTIVITIES: ***Residential / Commercial***

PROGRAM ELEMENT: ***Roadway and Drainage Facility Maintenance***

BMPs	Meets Regulatory Requirements (1 - 5)	Effectiveness of Pollutant Removal (1 - 5)	Public Acceptance (1 - 5)	Implementable (1 - 5)	Institutional Constraints (1 - 5)	Costs (1 - 5)	Total (30 MAX.)
STREET/STORM DRAIN MAINTENANCE							
Street Cleaning							
• *Replace Mechanical Sweepers with Vacuum*	*3*	*3*	*5*	*3*	*3*	*1*	*18*
• *Increase Frequency Two Times a Week*	*3*	*2*	*5*	*3*	*4*	*2*	*19*
• *Maintain Equipment*	*3*	*2*	*5*	*5*	*5*	*4*	*24*
• *Maintain Operation Log*	*3*	*1*	*5*	*5*	*5*	*5*	*24*
Storm Drain Flushing							
• *Flushing*	*3*	*4*	*4*	*2*	*0*	*4*	*17**

* *NOT ALLOWED BY LOCAL SEWER AUTHORITY.*

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APPENDIX B

TREATMENT CONTROL BMPs EXAMPLE

Appendix B

Treatment Control BMP Example

This Appendix is provided as a step-by-step planning example on how to screen potential treatment control BMPs using the six-step planning process described in Chapter 2, the Treatment Control BMP evaluation process presented in Chapter 3, and specific criteria about the BMPs given in Chapter 5.

- **Step 1 - Define Goals**

  Establish your Storm Water Management Plan (SWMP) goals - initial site planning should include listing and prioritizing the goals of your plan including water quality protection, flood control, wetlands management, aquifer recharge, storm water conservation/reuse, public recreation, and operation/maintenance. Performance standards to achieve the goals should also be established. This approach was outlined in Chapter 2. In terms of water quality protection, performance standards could include:

  - 80 percent capture of average annual runoff from the site;
  - No increase from the existing Event Mean Concentrations (EMCs) or annual/seasonal pollutant load for key pollutants;
  - Minimum increases in EMCs or annual/seasonal pollutant loads; or
  - Decreases in EMCs or annual/seasonal pollutant loads.

  The selected performance standard should be one which can be demonstrated to be the Maximum Extent Practicable (MEP) level of control based on physical and financial constraints as well as community interests and regulatory requirements.

  The example BMP comparison problem is for a potential 1,000-acre development near Fresno, California. The development is proposed to be 800 acres of medium density residential and 200 acres of commercial land use. An 80 percent capture of runoff will be the target performance standard for this example.

- **Step 2 - Assess Existing Conditions**

  Identify the BMP needs by considering the receiving water(s), beneficial uses of the receiving water(s), potential water quality concerns about use impairment, critical pollutants for the water(s), and likely pollutants generated from the proposed site. For example, toxic metals loadings would be a potential concern for the beneficial use of a fishery. Therefore, control of metals loadings could be a concern for discharges to these receiving waters depending on various factors.

  The identified receiving water is the San Joaquin River and metals are the critical pollutant to control for this example. Beneficial uses include industrial and agricultural water supply; water contact and non-contact recreation; aesthetic enjoyment; groundwater recharge; freshwater replenishment; and preservation/enhancement of fish, wildlife, and other aquatic resources. The residential and commercial land uses will generate some metals loadings.

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Many municipalities are in the process of collecting storm water samples representative of the quality of runoff from the predominant land uses within the municipality. While this data is being collected, the Nationwide Urban Runoff Program (NURP) database and findings can be used to identify types of pollutants expected and can be used as the basis for estimates of storm water pollutant loads (Final Report of the Nationwide Urban Runoff Program, EPA, 1983). Two of the NURP studies were done in California: one in Fresno and another in Coyote Creek near San Francisco. These and other local data sources could also be used. Reliable site-specific data should be used when possible.

Watershed characteristics important for selecting treatment control BMPs include soil permeability (SCS Hydrologic Group), depth to water table (soils report or SCS Soil Survey), depth to bedrock, recharge zones and unique geologic features (e.g., springs), land slopes, wetlands, floodplains/floodways, and available space for BMPs.

For this example, average annual rainfall is approximately 10.07 inches and the average storm is 0.44 inches (Handbook Figure 2C). Rainfall data and statistics can be obtained from the National Climatic Data Center (NCDC) in Asheville, North Carolina or from other local sources. The terrain for this example is relatively flat, and soils consist of SCS Hydrologic Groups A, B, and C, indicating moderate to good permeability. The present land use is open land, formerly pasture, with no on-site BMPs. Future land use will be comprised of 80 percent medium density residential (800 acres) and 20 percent commercial (200 acres). There is available space for BMPs, and there are no other site constraints.

- **Step 3 - Set Priorities and Identify Potential BMPs**

Use Handbook Figure 3-3 to identify the potential BMPs which fit within the site constraints and will provide the necessary benefits. Table 1 summarizes requirements versus benefits for typical treatment control BMPs. Based upon the site constraints and the project needs, any of the BMPs could be considered.

For this example, three different BMP scenarios were devised which met the site constraints and integrated well with the project site plan:

1. Post-development: Future land use with 100 percent BMP coverage by extended detention;

2. Post-development: Future land use (80 percent residential and 20 percent commercial) with 100 percent BMP coverage by swales; and

3. Post-development: Future land use with a mix of BMPs which include the following:

   - Residential
     - 40 percent swales
     - 30 percent infiltration basins
     - 30 percent without BMPs

   - Commercial
     - 50 percent extended detention
     - 50 percent wet ponds

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Table 1
Treatment Control BMP Prioritization Features
Requirements versus Benefits

MEDIA FILTRATION	INFILTRATION	BIOFILTERS (SWALES & FILTER STRIPS)	WET PONDS & WETLANDS	EXTENDED DETENTION
Requirements:				
Moderate available space	Basins: available space Trenches/permeable pavement: limited space available	Moderate to limited space available	Available space	Available space
Well-designed filter system	Water Table >3 ft below pond bottom	Water Table >3 ft below swale bottom	Water Table at or near pond normal pool level	
Frequent maintenance otherwise systems will clog	Permeable soils (SCS Group A or B)	Relatively permeable soils (SCS Group A or B), moderate slopes	Relatively impermeable soils (SCS Group D)	
Benefits:				
Peak discharge reduction for small storms	Peak discharge reduction for small storms	Peak discharge reduction for small storms	Peak discharge control	Peak discharge control
Pollutant load reduction off-line or on-line, high suspended solids removal	Volume discharge control	Volume discharge control	Load reduction for dissolved and suspended pollutants	Load reduction for suspended pollutants
Multiple-use park areas	Aquifer recharge	Aquifer recharge	Aesthetic permanent pool	Multiple-use park area
	Pollutant load removed from runoff off-line or on-line for dissolved and suspended pollutants by infiltration	Pollutant load reduction off-line or on-line by infiltration and sedimentation	Wildlife habitat	
	Multiple-use park areas		Multiple-use park areas	

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- **Step 4 - Select BMPs**

The most cost-effective BMP scenario is selected using Worksheet 2 in Chapter 3. The first step in setting up Worksheet 2 is to determine the average annual pollutant loading from the site prior to development (i.e, pasture with no BMPs), the annual pollutant load increase due to the development, and the average annual pollutant loading under each of the three BMP scenarios identified in Step 3. The purpose is to compare projected non-point source pollutant loads before and after development in order to identify the load reductions that could be achieved by placing different BMP options. The NURP data and/or other local studies could be used for pollutant load estimates, runoff estimates, or removal efficiencies.

For this example, pollutant loads were simulated using the Camp Dresser & McKee Inc. (CDM) Watershed Management Model (WMM). WMM is a spreadsheet-based tool for annual and/or seasonal load evaluations based on the methodology outlined in the Guidance Manual for the Preparation of Part 1 of the NPDES Permit Application for Discharges from Municipal Separate Storm Sewer Systems, EPA, 1991. EMCs and impervious values for WMM are shown in Table 2. These are based upon NURP data and CDM experience. For WMM, annual runoff volumes for the pervious/impervious areas in each land use category are calculated by multiplying the average annual rainfall volume by a runoff coefficient. A runoff coefficient of 0.9 is typically used for impervious areas (i.e., 90 percent of the rainfall is assumed to be converted to runoff from the impervious fraction of each land use). A pervious area runoff coefficient of 0.15 is typically used. The total average annual surface runoff from a given land use L is calculated by weighting the impervious and pervious area runoff factors for each land use category as follows:

$$R_L = [\, C_P + (C_I - C_P)\, IMP_L \,] * I \qquad \textit{Equation 1}$$

Where:
- R_L = total average annual surface runoff from land use L (in/yr)
- IMP_L = fractional imperviousness of land use L from Table 2
- I = long-term average annual precipitation (in/yr)
- C_P = pervious area runoff coefficient = 0.15
- C_I = impervious area runoff coefficient = 0.90.

The WMM generates nonpoint source pollution loads (expressed as lbs/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for land use L by the following equation:

$$M_L = EMC_L * R_L * K * A_L \qquad \textit{Equation 2}$$

Where:
- M_L = loading factor for land use L (lb/yr)
- EMC_L = event mean concentration of runoff from land use L (mg/L); EMC_L varies by land use and by pollutant
- R_L = total average annual surface runoff from land use L computed from Equation 1 (in/yr)
- K = 0.2266, a unit conversion constant
- A_L = area of land use L (acres).

The loads are then summed for a given area or scenario to produce summary results without BMPs. BMP efficiencies are then applied as fractional removal coefficients to reduce annual loads.

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Table 2

Event Mean Concentrations And Impervious Percentages Assigned For The Watershed Management Model

Land Use	Percent Impervious	Oxygen Demand & Sediment				Nutrients				Heavy Metals			
		BOD mg/L	COD mg/L	TSS mg/L	TDS mg/L	TP mg/L	SP mg/L	TKN mg/L	NO23 mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
Forest/Open	0.5%	8.0	51	216	100	0.23	0.06	1.36	0.73	0.00	0.00	0.00	0.00
Agriculture/Pasture	0.5%	8.0	51	216	100	0.23	0.06	1.36	0.73	0.00	0.00	0.00	0.00
Cropland	0.5%	8.0	51	216	100	0.23	0.06	1.36	0.73	0.00	0.00	0.00	0.00
Low Density Residential	10.0%	10.8	83	140	100	0.47	0.16	2.35	0.96	0.18	0.05	0.18	0.002
Medium Density Residential	30.0%	10.8	83	140	100	0.47	0.16	2.35	0.96	0.18	0.05	0.18	0.002
High Density Residential	50.0%	10.8	83	140	100	0.47	0.16	2.35	0.96	0.18	0.05	0.18	0.002
Commercial	90.0%	9.7	61	91	100	0.24	0.10	1.28	0.63	0.13	0.04	0.33	0.002
Office/Light Industrial	70.0%	9.7	61	91	100	0.24	0.10	1.28	0.63	0.13	0.04	0.33	0.002
Heavy Industrial	80.0%	9.7	61	91	100	0.24	0.10	1.28	0.63	0.13	0.04	0.33	0.002
Water	100.0%	3.0	22	26	100	0.03	0.01	0.60	0.60	0.00	0.00	0.11	0.000
Wetlands	0.5%	8.0	51	216	100	0.23	0.06	1.36	0.73	0.00	0.00	0.00	0.00
Major Highway	90.0%	9.7	103	142	100	0.44	0.17	1.78	0.83	0.53	0.05	0.37	0.002

Source: EPA, 1983 and CDM experience

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The BMPs in each scenario were sized based upon the guidelines in this handbook. For simplicity, it was assumed that the cost of flood control/drainage facilities would be the same in each scenario, even though economies of scale are usually achieved if flood control and storm water pollution control facilities are integrated. The following paragraphs discuss the BMP sizing procedure:

- Scenario 1: Extended Detention - Extended detention basins were sized graphically using the unit control volume curve for Fresno found in Appendix D. Figure B.1 shows how the total extended detention volume for the site is derived to achieve an annual percent capture of 80 percent of the average annual runoff.

- Scenario 2: Swales - Swales for the purpose of this example were sized as mini-infiltration basins with raised inlets used to pond water in the swales to increase infiltration in this flat area example. Consequently, the sizing criteria for the swales were based on the criteria outlined in Chapter 5 for infiltration. The curve in Figure B.1 shows the total volume of swales sized for retention/infiltration (i.e., 0.015 Ac-ft/Ac in the medium density residential area, and 0.032 Ac-ft/Ac in the commercial area). Swales were planned to be 1.0 ft deep, triangular in cross-section shape, and 10 feet wide at the top. Native, arid vegetation could be used in the swales for this example since they are planned to be more of an infiltration device rather than a flow-through device.

- Scenario 3: Mixed BMPs - The four types of BMPs which comprise this scenario are sized in the following manner:

  - Infiltration basins, swales, and extended detention basins are all sized using the unit control volume curves found in Appendix D. Figure B.2 shows a hand-worked example for this scenario.

  - Wet ponds - The permanent pool of the wet pond serving the commercial area in Scenario 3 was sized using Equation (1) in Chapter 5 BMP Treatment Control 2, namely:

$$V = 3\ (0.44\ \text{in})(100\ \text{Ac})(0.9)(1\ \text{ft}/12\ \text{in}) = 9.9\ \text{Ac.-Ft.}$$

BMP removal efficiencies will vary depending upon design. For this example, mid-range efficiencies were used based upon NURP findings and CDM experience as shown and noted in Table 3. These mid-range efficiencies are for an 80 percent runoff capture performance standard.

As discussed earlier, the WMM and the NURP EMC data for the twelve National Pollutant Discharge Elimination System (NPDES) storm water pollutants were used to generate:

- Average annual runoff estimates;

- Average annual pollutant loads for surface runoff with and without BMPs (no baseflow or point sources were simulated in this example); and

- The reductions of average annual pollutant loads as a percent and as a total load.

In addition, EMCs were estimated by dividing the average annual loads by the average annual runoff. Tables 4 through 7 provide numerical summaries of the respective scenarios. It should be noted that

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Figure B.1 - Scenario 1: Extended Detention Basin Sizing

Fresno

40 Hour Detention Storage Analysis

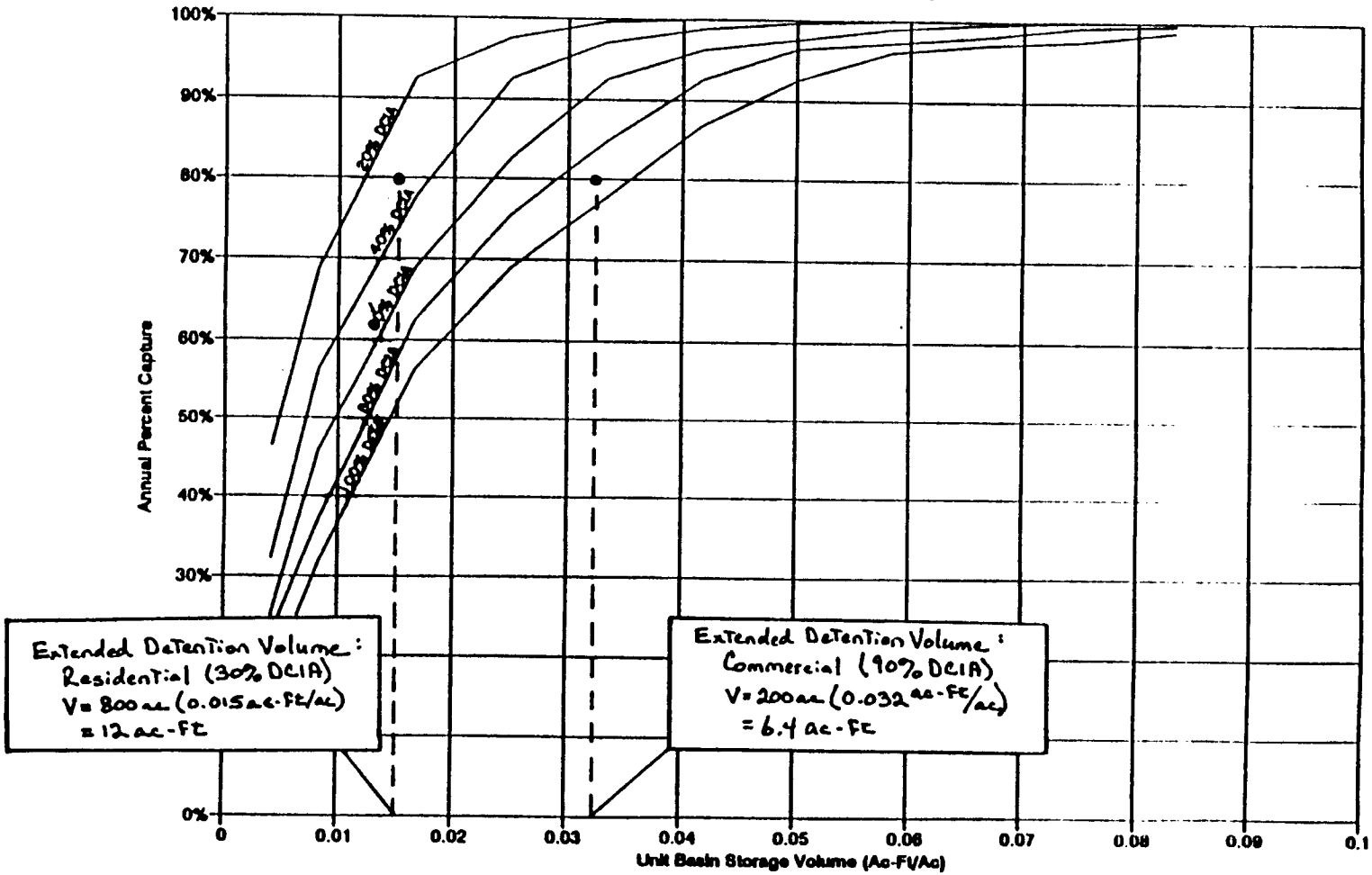

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Figure B.2 - Scenario 3: Mixed BMP Sizing (Swales, Infiltration, Extended Detention)

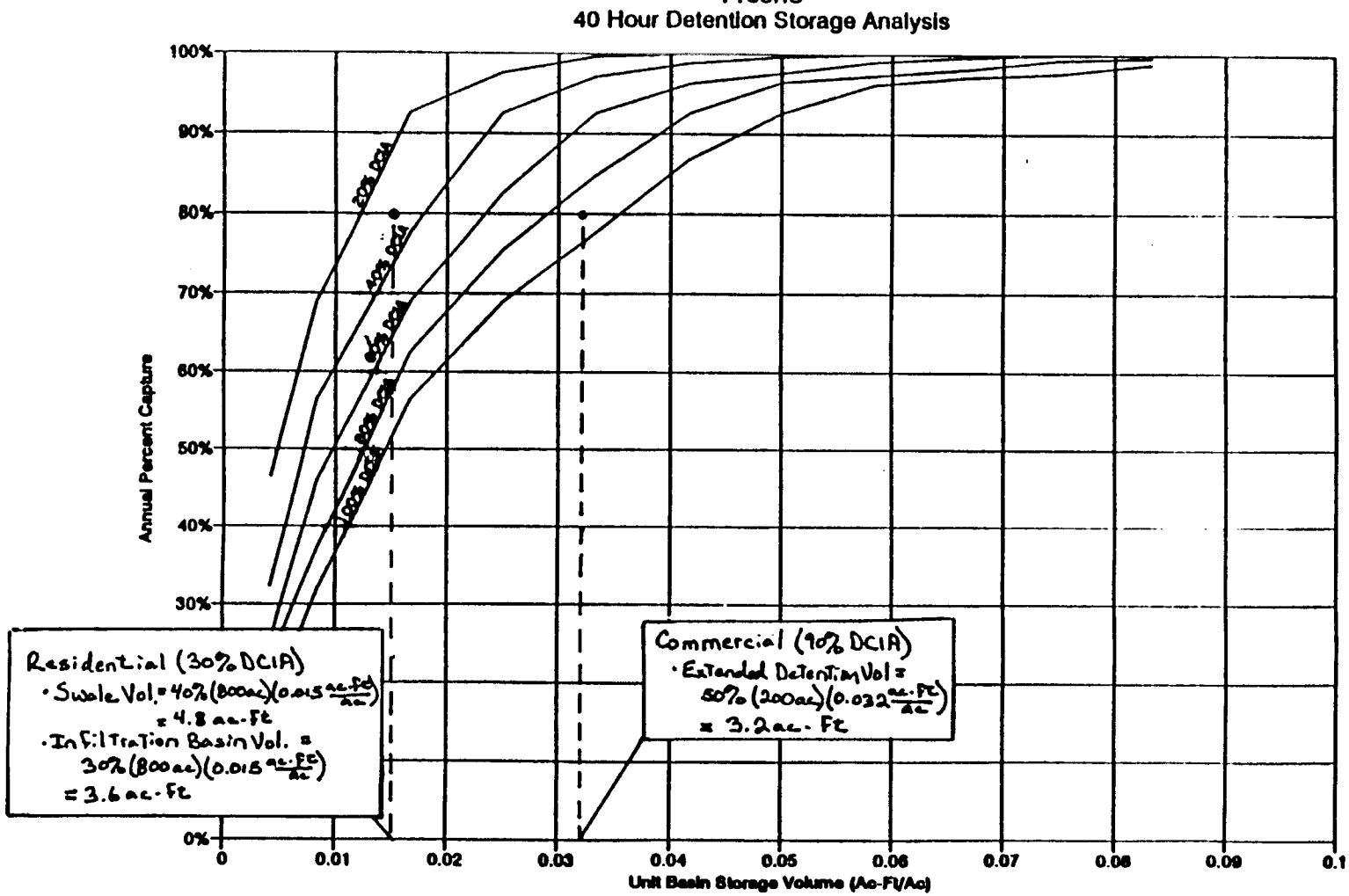

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Table 3
Average Annual Pollutant Removal Efficiencies for Treatment Control BMPs

Pollutant	Range of Pollutant Removal Efficiencies (Percent)			
	Infiltration	Extended Detention	Wet Ponds	Swales
BOD5	80% to 99%	20% to 30%	20% to 40%	20% to 40%
COD	80% to 99%	20% to 30%	20% to 40%	20% to 40%
TSS	80% to 99%	80% to 90%	80% to 90%	70% to 90%
TDS	80% to 99%	0%	20% to 40%*	0% to 20%
Total-P	80% to 99%	20% to 30%	40% to 50%	30% to 50%
Dissolved-P	80% to 99%	0%	60% to 70%	0% to 20%
NO2 + NO3	80% to 99%	10% to 20%	30% to 40%	30% to 50%
TKN	80% to 99%	30% to 40%	20% to 30%	30% to 50%
Cadmium	80% to 99%	70% to 80%	70% to 80%	50% to 80%
Copper	80% to 99%	50% to 60%	60% to 70%	40% to 60%
Lead	80% to 99%	70% to 80%	70% to 80%	60% to 90%
Zinc	80% to 99%	40% to 50%	40% to 50%	40% to 60%

NOTES:

1. Extended detention basin efficiencies assume that the storage capacity of the extended detention pool is adequately sized to achieve the design detention time of at least 80 percent of the annual runoff volume.

2. Wet pond efficiencies assume a permanent pool storage volume which achieves average hydraulic time of at least two weeks.

3. Infiltration removal rates assume that the BMP is adequately sized to capture at least 80 percent of the annual runoff volume from the BMP drainage area.

4. Swale efficiencies listed here are for swales which are also designed for infiltration and capture of 80 percent of the annual runoff volume.

* No data is available for TDS removal in wet ponds.

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TABLE 4
WATERSHED MANAGEMENT MODEL
NONPOINT SOURCE LOADING SUMMARY
AVERAGE ANNUAL NONPOINT SOURCE LOADS AND EMCs
PRESENT LAND USE – NO BMPs

Area	Constituent	(units)	Surface Loads/EMCs No BMPs	Surface Loads/EMCs With BMPs	Reduction Surface NPS Loads (%)	Load Reduction
1	Runoff	(in/yr)	1.5	1.5		
	BOD	(lbs/yr)	2,245	2,245	0.0%	0.0
	COD		14,238	14,238	0.0%	0.0
	TSS		60,641	60,641	0.0%	0.0
	TDS		28,067	28,067	0.0%	0.0
	Total–P		66	66	0.0%	0.0
	Dissolved–P		17	17	0.0%	0.0
	TKN		383	383	0.0%	0.0
	NO2 & NO3		206	206	0.0%	0.0
	Lead		0	0	0.0%	0.0
	Copper		0	0	0.0%	0.0
	Zinc		0	0	0.0%	0.0
	Cadmium		0	0	0.0%	0.0
2	Runoff	(in/yr)	1.5	1.5		
	BOD	(lbs/yr)	561	561	0.0%	0.0
	COD		3,560	3,560	0.0%	0.0
	TSS		15,160	15,160	0.0%	0.0
	TDS		7,017	7,017	0.0%	0.0
	Total–P		16	16	0.0%	0.0
	Dissolved–P		4	4	0.0%	0.0
	TKN		96	96	0.0%	0.0
	NO2 & NO3		52	52	0.0%	0.0
	Lead		0	0	0.0%	0.0
	Copper		0	0	0.0%	0.0
	Zinc		0	0	0.0%	0.0
	Cadmium		0	0	0.0%	0.0
TOTAL	Runoff	(in/yr)	1.5	1.5		
	BOD	(lbs/yr)	2,807	2,807	0.0%	0.0
	COD		17,798	17,798	0.0%	0.0
	TSS		75,801	75,801	0.0%	0.0
	TDS		35,084	35,084	0.0%	0.0
	Total–P		82	82	0.0%	0.0
	Dissolved–P		21	21	0.0%	0.0
	TKN		479	479	0.0%	0.0
	NO2 & NO3		258	258	0.0%	0.0
	Lead		0	0	0.0%	0.0
	Copper		0	0	0.0%	0.0
	Zinc		0	0	0.0%	0.0
	Cadmium		0	0	0.0%	0.0
EMCs	BOD	(mg/L)	8.0	8.0	0.0%	0.0
	COD		50.7	50.7	0.0%	0.0
	TSS		216.0	216.0	0.0%	0.0
	TDS		100.0	100.0	0.0%	0.0
	Total–P		0.2	0.2	0.0%	0.0
	Dissolved–P		0.1	0.1	0.0%	0.0
	TKN		1.4	1.4	0.0%	0.0
	NO2 & NO3		0.7	0.7	0.0%	0.0
	Lead		0.0	0.0	0.0%	0.0
	Copper		0.0	0.0	0.0%	0.0
	Zinc		0.0	0.0	0.0%	0.0
	Cadmium		0.0	0.0	0.0%	0.0

NOTES:

Area 1 : 800 ac of pasture land use, 4 ac of impervious area (0.5%).

Area 2 : 200 ac of pasture land use, 1 ac of impervious area (0.5%).

There is no BMP coverage for either land use.

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TABLE 5
WATERSHED MANAGEMENT MODEL
NONPOINT SOURCE LOADING SUMMARY
AVERAGE ANNUAL NONPOINT SOURCE LOADS AND EMCs
BMP SCENARIO 1

Area	Constituent	(units)	Surface Loads/EMCs No BMPs	Surface Loads/EMCs With BMPs	Reduction Surface NPS Loads (%)	Load Reduction
1	Runoff	(in/yr)	3.8	3.8		
	BOD	(lbs/yr)	7,399	5,179	-30.0%	(2,220)
	COD	|	57,033	39,923	-30.0%	(17,110)
	TSS	|	95,845	9,585	-90.0%	(86,261)
	TDS	|	68,457	68,457	0.0%	0
	Total-P	|	319	223	-30.0%	(96)
	Dissolved-P	|	108	108	0.0%	0
	TKN	|	1,610	966	-40.0%	(644)
	NO2 & NO3	|	655	524	-20.0%	(131)
	Lead	|	123	25	-80.0%	(99)
	Copper	|	32	13	-60.0%	(19)
	Zinc	|	121	60	-50.0%	(60)
	Cadmium	v	1	0	-80.0%	(1)
2	Runoff	(in/yr)	8.3	8.3		
	BOD	(lbs/yr)	3,666	2,566	-30.0%	(1,100)
	COD	|	23,036	16,125	-30.0%	(6,911)
	TSS	|	34,096	3,410	-90.0%	(30,687)
	TDS	|	37,651	37,651	0.0%	0
	Total-P	|	91	64	-30.0%	(27)
	Dissolved-P	|	37	37	0.0%	0
	TKN	|	483	290	-40.0%	(193)
	NO2 & NO3	|	239	191	-20.0%	(48)
	Lead	|	47	9	-80.0%	(38)
	Copper	|	14	6	-60.0%	(8)
	Zinc	|	125	62	-50.0%	(62)
	Cadmium	v	1	0	-80.0%	(1)
TOTAL	Runoff	(in/yr)	4.7	4.7		
	BOD	(lbs/yr)	11,065	7,745	-30.0%	(3,319)
	COD	|	80,069	56,048	-30.0%	(24,021)
	TSS	|	129,941	12,994	-90.0%	(116,947)
	TDS	|	106,108	106,108	0.0%	0
	Total-P	|	410	287	-30.0%	(123)
	Dissolved-P	|	145	145	0.0%	0
	TKN	|	2,094	1,256	-40.0%	(837)
	NO2 & NO3	|	894	715	-20.0%	(179)
	Lead	|	171	34	-80.0%	(136)
	Copper	|	46	18	-60.0%	(28)
	Zinc	|	245	123	-50.0%	(123)
	Cadmium	v	2	0	-80.0%	(2)
EMCs	BOD	(mg/L)	10.4	7.3	-30.0%	-3.1
	COD	|	75.5	52.8	-30.0%	-22.6
	TSS	|	122.5	12.2	-90.0%	-110.2
	TDS	|	100.0	100.0	0.0%	0.0
	Total-P	|	0.4	0.3	-30.0%	-0.1
	Dissolved-P	|	0.1	0.1	0.0%	0.0
	TKN	|	2.0	1.2	-40.0%	-0.8
	NO2 & NO3	|	0.8	0.7	-20.0%	-0.2
	Lead	|	0.2	0.0	-80.0%	-0.1
	Copper	|	0.0	0.0	-60.0%	-0.0
	Zinc	|	0.2	0.1	-50.0%	-0.1
	Cadmium	v	0.0	0.0	-80.0%	-0.0

NOTES:

Area 1: 800 ac of residential land use, 240 ac of impervious area (30%).

Area 2: 200 ac of commercial land use, 180 ac of impervious area (90%).

BMP coverage is 100% extended detention for both land uses.

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TABLE 6
WATERSHED MANAGEMENT MODEL
NONPOINT SOURCE LOADING SUMMARY
AVERAGE ANNUAL NONPOINT SOURCE LOADS AND EMCs
BMP SCENARIO 2

Area	Constituent	(units)	Surface Loads/EMCs No BMPs	Surface Loads/EMCs With BMPs	Reduction Surface NPS Loads (%)	Load Reduction
1	Runoff	(in/yr)	3.8	3.8		
	BOD	(lbs/yr)	7,399	5,179	-30.0%	(2,220)
	COD	|	57,033	39,923	-30.0%	(17,110)
	TSS	|	95,845	19,169	-80.0%	(76,676)
	TDS	|	68,457	61,611	-10.0%	(6,846)
	Total-P	|	319	191	-40.0%	(127)
	Dissolved-P	|	108	97	-10.0%	(11)
	TKN	|	1,610	966	-40.0%	(644)
	NO2 & NO3	|	655	393	-40.0%	(262)
	Lead	|	123	31	-75.0%	(92)
	Copper	|	32	16	-50.0%	(16)
	Zinc	|	121	60	-50.0%	(60)
	Cadmium	v	1	0	-65.0%	(1)
2	Runoff	(in/yr)	8.3	8.3		
	BOD	(lbs/yr)	3,666	2,566	-30.0%	(1,100)
	COD	|	23,036	16,125	-30.0%	(6,911)
	TSS	|	34,096	6,819	-80.0%	(27,277)
	TDS	|	37,651	33,886	-10.0%	(3,765)
	Total-P	|	91	55	-40.0%	(36)
	Dissolved-P	|	37	33	-10.0%	(4)
	TKN	|	483	290	-40.0%	(193)
	NO2 & NO3	|	239	143	-40.0%	(96)
	Lead	|	47	12	-75.0%	(36)
	Copper	|	14	7	-50.0%	(7)
	Zinc	|	125	62	-50.0%	(62)
	Cadmium	v	1	0	-65.0%	(0)
TOTAL	Runoff	(in/yr)	4.7	4.7		
	BOD	(lbs/yr)	11,065	7,745	-30.0%	(3,319)
	COD	|	80,069	56,048	-30.0%	(24,021)
	TSS	|	129,941	25,988	-80.0%	(103,953)
	TDS	|	106,108	95,497	-10.0%	(10,611)
	Total-P	|	410	246	-40.0%	(164)
	Dissolved-P	|	145	130	-10.0%	(14)
	TKN	|	2,094	1,256	-40.0%	(837)
	NO2 & NO3	|	894	536	-40.0%	(357)
	Lead	|	171	43	-75.0%	(128)
	Copper	|	46	23	-50.0%	(23)
	Zinc	|	246	123	-50.0%	(123)
	Cadmium	v	2	1	-65.0%	(1)
EMCs	BOD	(mg/L)	10.4	7.3	-30.0%	-3.1
	COD	|	75.5	52.8	-30.0%	-22.6
	TSS	|	122.5	24.5	-80.0%	-98.0
	TDS	|	100.0	90.0	-10.0%	-10.0
	Total-P	|	0.4	0.2	-40.0%	-0.2
	Dissolved-P	|	0.1	0.1	-10.0%	-0.0
	TKN	|	2.0	1.2	-40.0%	-0.8
	NO2 & NO3	|	0.8	0.5	-40.0%	-0.3
	Lead	|	0.2	0.0	-75.0%	-0.1
	Copper	|	0.0	0.0	-50.0%	-0.0
	Zinc	|	0.2	0.1	-50.0%	-0.1
	Cadmium	v	0.0	0.0	-65.0%	-0.0

NOTES:

Area 1: 800 ac of residential land use, 240 ac of impervious area (30%).

Area 2: 200 ac of commercial land use, 180 ac of impervious area (90%).

BMP coverage is 100% swales for both land uses.

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TABLE 7
WATERSHED MANAGEMENT MODEL
NONPOINT SOURCE LOADING SUMMARY
AVERAGE ANNUAL NONPOINT SOURCE LOADS AND EMCs
BMP SCENARIO 3

Area	Constituent	(units)	Surface Loads/EMCs No BMPs	Surface Loads/EMCs With BMPs	Reduction Surface NPS Loads (%)	Load Reduction
1	Runoff	(in/yr)	3.8	3.8		
	BOD	(lbs/yr)	7,399	4,513	-39.0%	(2,886)
	COD		57,033	34,790	-39.0%	(22,243)
	TSS		95,845	39,296	-59.0%	(56,549)
	TDS		68,457	47,235	-31.0%	(21,222)
	Total-P		319	182	-43.0%	(137)
	Dissolved-P		108	74	-31.0%	(33)
	TKN		1,610	918	-43.0%	(692)
	NO2 & NO3		655	373	-43.0%	(282)
	Lead		123	53	-57.0%	(70)
	Copper		32	17	-47.0%	(15)
	Zinc		121	64	-47.0%	(57)
	Cadmium	v	1	1	-53.0%	(1)
2	Runoff	(in/yr)	8.3	8.3		
	BOD	(lbs/yr)	3,666	2,566	-30.0%	(1,100)
	COD		23,036	16,125	-30.0%	(6,911)
	TSS		34,096	3,410	-90.0%	(30,687)
	TDS		37,651	30,121	-20.0%	(7,530)
	Total-P		91	55	-40.0%	(36)
	Dissolved-P		37	24	-35.0%	(13)
	TKN		483	314	-35.0%	(169)
	NO2 & NO3		239	179	-25.0%	(60)
	Lead		47	9	-80.0%	(38)
	Copper		14	5	-65.0%	(9)
	Zinc		125	62	-50.0%	(62)
	Cadmium	v	1	0	-80.0%	(1)
TOTAL	Runoff	(in/yr)	4.7	4.7		
	BOD	(lbs/yr)	11,065	7,079	-36.0%	(3,985)
	COD		80,069	50,915	-36.4%	(29,154)
	TSS		129,941	42,706	-67.1%	(87,235)
	TDS		108,108	77,356	-27.1%	(28,752)
	Total-P		410	236	-42.3%	(173)
	Dissolved-P		145	98	-32.0%	(46)
	TKN		2,094	1,232	-41.2%	(862)
	NO2 & NO3		894	552	-38.2%	(341)
	Lead		171	62	-63.4%	(108)
	Copper		46	22	-52.5%	(24)
	Zinc		245	126	-48.5%	(119)
	Cadmium	v	2	1	-62.6%	(1)
EMCs	BOD	(mg/L)	10.4	6.7	-36.0%	-3.8
	COD		75.5	48.0	-36.4%	-27.5
	TSS		122.5	40.2	-67.1%	-82.2
	TDS		100.0	72.9	-27.1%	-27.1
	Total-P		0.4	0.2	-42.3%	-0.2
	Dissolved-P		0.1	0.1	-32.0%	-0.0
	TKN		2.0	1.2	-41.2%	-0.8
	NO2 & NO3		0.6	0.5	-38.2%	-0.3
	Lead		0.2	0.1	-63.4%	-0.1
	Copper		0.0	0.0	-52.5%	-0.0
	Zinc		0.2	0.1	-48.5%	-0.1
	Cadmium	v	0.0	0.0	-62.6%	-0.0

NOTES:

Area 1: 800 ac of residential land use, 240 ac of impervious area (30%).

Area 2: 200 ac of commercial land use, 180 ac of impervious area (90%).

BMP coverage is a mixed combination for both land uses, including swales, infiltration, extended detention, and wet ponds.

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annual runoff and annual pollutant loads are higher under future land use conditions than under present land use conditions. Pollutant loads with BMPs in place are also greater than pollutant loads under present land use because BMP efficiencies are less than 100 percent.

- **Step 5 - Implementation: Regional versus On-site**

  Once the preferred BMPs are chosen, a decision should be made about the extent of on-site versus regional BMP deployment. This issue is generally administrative and offers capital operation and maintenance cost savings, but it also offers cost savings due to economies-of-scale. In general, regional BMPs (100 to 200 acre contributing areas) are more cost-effective and easier to maintain/operate than on-site BMPs (1 to 10 acre areas). Regional BMPs tend to be more reliable as well because the O&M is more likely to be conducted on a regular basis. In addition, larger-scale BMPs can often be worked into multiple-use applications (e.g. park) providing added benefits to the community. For this example, a regional approach was taken for detention and infiltration. The swales are semi-regional since they serve the entire contributory area; however, they would be located along roads and other paved areas to work as a combined treatment and conveyance system.

- **Step 6 - Estimate Cost-Effectiveness**

  From load reduction estimates for each BMP, cost estimates can be made to compare BMP effectiveness in dollars per pound of pollutant removed ($/Lb). This is calculated by dividing total annual cost ($/Yr) by total annual load removed (Lb/Yr). Then the optimal BMP is chosen for site implementation.

  For this example, costs for capital and operation/maintenance were estimated for each BMP to identify the total annual costs and the removal costs. A 20-year design period was used to annualize capital costs. All costs were in 1992 dollars and were based on the unit values in Table 8. It was assumed that land acquisition would be required for all BMPs (including swales) and only the costs of the water quality portion of the BMP were used for comparison (i.e., no flood control or other costs). With respect to swales, the swales were designed as mini-infiltration basins consequently no cost was incurred for irrigation. However, the land cost for the swales proved to be approximately 80 percent of the total cost. If the land containing the swales was located in a road right-of-way and sold to a lot owner with deed restrictions for protection (so they could not be filled in), then the land costs could be eliminated. This would make swales a very favorable BMP for this scenario. From these estimates, Worksheet 2 from Chapter 3 was filled out to compare BMP cost-effectiveness as shown in Tables 9 through 11 (one for each of the three BMP scenarios). The tables also list the volume of storage required for each BMP. The critical parameters were identified as metals discharged to the San Joaquin River. Therefore, the removal costs were based upon the total load of NPDES indicator metals removed (lead, copper, zinc, and cadmium) versus the total annual BMP costs.

  Once BMP effectiveness is known, it can be used in conjunction with the performance standard established in Step 1 (e.g., 80 percent capture of runoff) to choose the appropriate BMPs for implementation. The source control BMP approach in this handbook should be used in conjunction with this choice to maximize the water quality benefits for the most cost-effective investment. It can be seen that extended detention is the most cost-effective treatment control BMP for this development and set of site conditions based upon pollutant removal and cost. Therefore, the recommended plan for this hypothetical example is ten extended detention basins each serving approximately 100 acres of contributory area.

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TABLE 8

UNIT COST TABLE TREATMENT CONTROL BMPs EXAMPLE			
Item	**Units**	**Cost**	**Notes**
Concrete	yd^3	$350.00	Installed
Control Structures	per unit	$26,000.00	Installed in detention pond
Dry Excavation	yd^3	$5.00	Haul within 5 miles
Wet Excavation	yd^3	$15.00	Haul within 5 miles
Raised Inlets	per unit	$2,500.00	For swales
Sod	yd^2	$3.00	Installed
Seed & Mulch	yd^2	$0.30	Installed
Land	Ac	$30,000.00	Average value
Wetlands Planting	Ac	$5,000.00	Does not include survival maintenance
Contingency	per system	30.00%	
Engineering, Survey and Permitting	per system	15.00%	

Note: All costs in 1992 dollars.

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TABLE 9

WORKSHEET 2

TREATMENT CONTROL BMP

BMP SCENARIO 1 – EXTENDED DETENTION

Pollutants of Concern SAN JOAQUIN R.	BMP	(1) Area of Application (Ac)	(2) Annual Pollutant Removed (Lb/Yr)	(3) Annual Capital Costs ($/Yr)	(4) Annual O&M Cost ($/Yr)	(5) Annual Admin. Costs ($/Yr)	(6) Total Annual Costs ($/Yr)	(7) Removal Costs ($/Lb)
METALS	EXTENDED DETENTION (10 BASINS)	1,000	289	77,000	20,000	0	97,000	336
TOTALS	10 BASINS	1,000	289	77,000	20,000	0	97,000	336

Notes:

(1) Annual capital costs based on a 20-year design period.

(2) Annual administration costs are best determined by a given community once a city-wide program is established.

(3) Removal costs are in units of [$/Yr] / [Lb/Yr]= $/Lb.

(4) VOLUME REQUIRED = 18.4 Ac.Ft

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TABLE 10
WORKSHEET 2

TREATMENT CONTROL BMP

BMP SCENARIO 2 - SWALES

Pollutants of Concern SAN JOAQUIN R.	BMP	(1) Area of Application (Ac)	(2) Annual Pollutant Removed (Lb/Yr)	(3) Annual Capital Costs ($/Yr)	(4) Annual O&M Cost ($/Yr)	(5) Annual Admin. Costs ($/Yr)	(6) Total Annual Costs ($/Yr)	(7) Removal Costs ($/Lb)
METALS	SWALES (161,000')	1,000	275	98,000	16,000	0	114,000	415
TOTALS	161,000'	1,000	275	98,000	16,000	0	114,000	415

Notes:
(1) Annual capital costs based on a 20-year design period.
(2) Annual administration costs are best determined by a given community once a city-wide program is established.
(3) Removal costs are in units of [$/Yr] / [Lb/Yr]= $/Lb.
(4) VOLUME REQUIRED = 18.4 Ac. Ft

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TABLE 11

WORKSHEET 2

TREATMENT CONTROL BMP

BMP SCENARIO 3 - MIXED BMPs

Pollutants of Concern SAN JOAQUIN R.	BMP	(1) Area of Application (Ac)	(2) Annual Pollutant Removed (Lb/Yr)	(3) Annual Capital Costs ($/Yr)	(4) Annual O&M Cost ($/Yr)	(5) Annual Admin. Costs ($/Yr)	(6) Total Annual Costs ($/Yr)	(7) Removal Costs ($/Lb)
METALS	SWALES (42,000)	320		26,000	4,000	0	30,000	
METALS	INFILTRATION (2 BASINS)	240		15,000	4,000	0	19,000	
SUBTOTAL			143	41,000	8,000	0	49,000	343
METALS	NONE	240	0	0	0	0	0	0
METALS	EXTENDED DETENTION (1 BASIN)	100		12,000	2,000	0	14,000	
METALS	WET POND (1 BASIN)	100		28,000	6,000	0	34,000	
SUBTOTAL			110	40,000	8,000	0	48,000	436
TOTALS		1,000	253	81,000	16,000	0	97,000	383

Notes:

(1) Annual capital costs based on a 20-year design period.

(2) Annual administration costs are best determined by a given community once a city-wide program is established.

(3) Removal costs are in units of [$/Yr] / [Lb/Yr]= $/Lb.

(4) VOLUMES REQUIRED:

SWALES = 4.8 Ac. Ft

INFILTRATION = 3.6 Ac. Ft

EXTENDED DETENTION = 3.2 Ac. Ft

WET POND = 9.9 Ac. Ft

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APPENDIX C

EXAMPLE OF STORM WATER DISCHARGE ORDINANCE

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ORDINANCE NO. O-92-51

AN ORDINANCE ADDING CHAPTER 9 TO TITLE 3 OF THE ORDINANCE CODE OF THE COUNTY OF ALAMEDA RELATING TO STORM WATER MANAGEMENT AND DISCHARGE CONTROL

The Board of Supervisors of the County of Alameda ordains as follows:

SECTION I

Chapter 9 is added to Title 3 of the Ordinance Code of the County of Alameda to read:

CHAPTER 9

STORM WATER MANAGEMENT AND DISCHARGE CONTROL

Article 1

Title, Purpose and General Provisions

Section 3-350.0 Title. This chapter shall be known as the "County of Alameda Storm Water Management and Dischage Control Ordinance" and may be so cited.

Section 3-350.1 Purpose and Intent. The purpose of this chapter is to ensure the future health, safety, and general welfare of County of Alameda citizens by:

(a) eliminating non-storm water discharges to the municipal separate storm drain.

(b) controlling the discharge to municipal separate storm drains from spills, dumping or disposal of materials other than storm water.

(c) reducing pollutants in storm water discharges to the maximum extent practicable.

The intent of this chapter is to protect and enhance the water quality of our watercourses, water bodies, and wetlands in a manner pursuant to and consistent with the Clean Water Act.

3-350.2 Definitions.

(a) Any terms defined in the federal Clean Water Act and acts amendatory thereof or supplementary thereto, and/or defined in the regulations for the storm water discharge permitting program issued by the Environmental Protection Agency on November 16, 1990 (as may from time to time be amended) as used in this chapter shall have the same meaning as in that statute or regulations. Specifically, the definition of the following terms included in that statute or regulations are hereby incorporated by reference, as now applicable or as may hereafter be amended: discharge, illicit discharge, pollutant, and storm water. These terms presently are defined as follows:

(1) Discharge: (a) any addition of any pollutant to navigable waters from any point source, or (b) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft.

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(2) Illicit discharge: any discharge to the County storm drain system that is not composed entirely of storm water except discharges pursuant to a NPDES permit, discharges resulting from fire fighting activities, and discharges further exempted at section 3-351.0 of this chapter.

(3) Pollutant: dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharge into water.

(4) Storm Water: storm water runoff, snow melt runoff, and surface runoff and drainage.

(b) When used in this chapter, the following words shall have the meanings ascribed to them in this section:

(1) Director of Public Works: The Director of the Alameda County Public Works Agency.

(2) Authorized Enforcement Officer: Authorized enforcement officers shall be the Director of Public Works and those individuals designated by the Director of Public Works as authorized enforcement officers.

(3) Best Management Practices: ("BMPs"): schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to "waters of the United States." BMPs also include treatment requirements, operating procedures, design specifications, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

(4) County: the County of Alameda.

(5) County Storm Drain System: includes but is not limited to those facilities within the county by which storm water may be conveyed to the waters of the United States, including flood control channels, any roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains, which are not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR Section 122.2.

(6) Non-Storm Water Discharge: any discharge that is not entirely composed of storm water.

(7) Premises: any building, lot parcel, real estate, or land or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

(8) Facility: any non-residential Premises.

3-350.3 Responsibility for Administration. This Chapter shall be administered for the County by the Director of Public Works.

3-350.4 Construction and Application. This chapter shall be construed to assure consistency with the requirements of the federal Clean Water Act and acts amendatory thereof or supplementary thereto, applicable implementing regulations, and NPDES Permit No. CA0029831 and any amendment, revision or reissuance thereof.

3-350.5 Severability and Application. If any portion of this chapter is declared invalid, the remaining portions of this chapter are to be considered valid.

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3-350.6 Taking. The provisions of this chapter shall not operate to deprive any landowner of substantially all of the market value of his/her property or otherwise constitute an unconstitutional taking without compensation. If application of this chapter to a specific project would create a taking then pursuant to the chapter the County Board of Supervisors may allow additional land uses, but only to the extent necessary to avoid a taking. Such uses shall be consistent with and carry out the purposes of this chapter as stated in Section 3-350.1 above.

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Article 2

Discharge Regulations and Requirements

3-351.0 Discharge of Pollutants. The discharge of non-storm water discharges to the County storm drain system is prohibited. All discharges of material other than storm water discharges must be in compliance with a NPDES permit issued for the discharge (other than NPDES permit No. CA0029831).

(a) Exceptions to Discharge Prohibition. The following discharges are exempt from the prohibition set forth in Section 3-351.0 above.

(1) The prohibition of discharges shall not apply to any discharge regulated under a National Pollutant Discharge Elimination System (NPDES) permit issued to the discharger and administered by the State of California under the authority of the United States Environmental Protection Agency, provided that the discharger is in full compliance with all requirements of the permit and other applicable laws or regulations.

(2) Discharges from the following activities will not be considered a source of pollutants to waters of the United States when properly managed - water line flushing and other discharges from potable water sources, landscape irrigation and lawn watering, irrigation water, diverted stream flows, rising ground waters, infiltration to separate storm drains, uncontaminated pumped ground water, foundation and footing drains, water from crawl space pumps, air conditioning condensation, springs, individual residential car washings, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges or flows from fire fighting, accordingly are not subject to the prohibition of discharges.

3-351.1 Discharge in Violation of Permit. Any discharge that would result in or contribute to a violation of NPDES Permit No. CA0029831 (this permit is available for viewing at the Alameda County Public Works Agency building, 399 Elmhurst Street, Hayward, California) and any amendment, revision or reissuance thereof, either separately considered or when combined with other discharges, is prohibited. Liability for any such discharge shall be the responsibility of the person(s) causing or responsible for the discharge, and such persons shall defend, indemnify and hold harmless the County in any administrative or judicial enforcement action relating to such discharge.

3-351.2 Illicit Discharge and Illicit Connections. It is prohibited to establish, use, maintain, or continue illicit drainage connections to the County storm drain system, and to commence or continue any illicit discharges to the county storm drain system. This prohibition is expressly retroactive and applies to connections made in the past, regardless of whether made under a permit or other authorization or whether permissible under the law or practices applicable or prevailing at the time of the connection.

3-351.3 Reduction of Pollutants in Storm Water. Any person engaged in activities which will or may result in pollutants entering the County storm drain system shall undertake all practicable measures to reduce such pollutants. Examples of such activities include ownership and use of facilities which may be a source of pollutants such as parking lots, gasoline stations, industrial facilities, stores fronting streets, etc. The following minimum requirements shall apply.

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(a) Littering. No person shall throw, deposit, leave, maintain, keep, or permit to be thrown, deposited, placed, left or maintained, any refuse, rubbish, garbage, or other discarded or abandoned objects, articles, and accumulations, in or upon any street, alley, sidewalk, storm drain, inlet, catch basin, conduit or other drainage structures, business place, or upon any public or private plot of land in the County, so that the same might be or become a pollutant, except containers or in lawfully established waste disposal facilities.

The occupant or tenant, or in the absence of occupant or tenant, the owner, lessee, or proprietor of any real property in the County of Alameda in front of which there is a paved sidewalk shall maintain said sidewalk free of dirt or litter to the maximum extent practicable. Sweepings from said sidewalk shall not be swept or otherwise made or allowed to go into the gutter or roadway, but shall be disposed of in receptacles maintained on said real property as required for the disposal of garbage.

No person shall throw or deposit litter in any fountain, pond, lake, stream, or any other body of water in a park or elsewhere within the County.

(b) Standard for Parking Lots and Similar Structures. Persons owning or operating a paved parking lot, gas station pavement, paved private street or road, or similar structure, shall clean those structures as frequently and thoroughly as practicable in a manner that does not result in discharge of pollutants to the County storm drain system.

(c) Best Management Practices for New Developments and Redevelopments. The Director of Public Works may adopt regulations establishing controls on the volume and rate of storm water runoff from new developments and redevelopments as may be appropriate to minimize the discharge and transport of pollutants. The Director of Public Works may require of any construction contractor performing work in the unincorporated portion of Alameda County a Water Pollution Prevention Plan prior to Final Map approval, or issuance of a Building Permit whichever first occurs.

(d) Notification of Intent and Compliance with General Permits. Each industrial discharger, discharger associated with construction activity, or other discharger, described in any general storm water permit addressing such discharges, as may be adopted by the United States Environmental Protection Agency, the State Water Resources Control Board, or the California Regional Water Quality Control Board, San Francisco Bay Region, shall provide notice of intent, comply with, and undertake all other activities required by any general storm water permit applicable to such discharges.

Each discharger identified in an individual NPDES permit relating to storm water discharges shall comply with and undertake all activities required by such permit.

(e) Compliance with Best Management Practices. Where best management practices guidelines or requirements have been adopted by any federal, State of California, regional, and/or County Agency, for any activity, operation, or facility which may cause or contribute to storm water pollution or contamination, illicit discharges, and/or discharges of non-storm water to the storm water system, every person undertaking such activity or operation, or owning or operating such facility shall comply with such guidelines or requirements as may be identified by the Director of Public Works.

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Article 3

Inspection and Enforcement

3-352.0 Authority to Inspect. Whenever necessary to make an inspection to enforce any of the provisions of this Chapter, or whenever an authorized enforcement officer has reasonable cause to believe that there exists in any building or upon any premises any condition which constitutes a violation of the provisions of this Chapter, the officer may enter such building or premises at all reasonable times to inspect the same or perform any duty imposed upon the officer by this Chapter; provided that (i) if such building or premises be occupied, he or she shall first present proper credentials and request entry; and (ii) if such building or premises be unoccupied, he or she shall first make a reasonable effort to locate the owner or other persons having charge or control of the building or premises and request entry.

Any such request for entry shall state that the property owner or occupant has the right to refuse entry and that in the event such entry is refused, inspection may be made only upon issuance of a search warrant by a duly authorized magistrate. In the event the owner and/or occupant refuses entry after such request has been made, the officer is hereby empowered to seek assistance from any court of competent jurisdiction in obtaining such entry.

Routine or area inspections shall be based upon such reasonable selection processes as may be deemed necessary to carry out the objectives of this chapter, including but not limited to random sampling and/or sampling in areas with evidence of storm water contamination, illicit discharges, discharge of non-storm water to the storm water system, or similar factors.

(a) Authority to Sample and Establish Sampling Devices. With the consent of the owner or occupant or pursuant to a search warrant, any authorized enforcement officer may establish on any property such devices as are necessary to conduct sampling or metering operations. During all inspections as provided herein, the officer may take any samples deemed necessary to aid in the pursuit of the inquiry or in the recordation of the activities on-site.

(b) Notification of Spills. All persons in charge of a facility or responsible for emergency response for a facility have a personal responsibility to train facility personnel and maintain notification procedures to assure immediate notification is provided to the County of any suspected, confirmed or unconfirmed release of material, pollutants or waste creating a risk of discharge into the County storm drain system.

As soon as any person in charge of a facility or responsible for emergency response for a facility has knowledge of any suspected, confirmed or unconfirmed release of materials, pollutants or waste which may result in pollutants or non-storm water discharge entering the County storm drain system, such person shall take all necessary steps to ensure the discovery and containment and clean up of such release and shall notify the County of the occurrence by telephoning 510-670-5543 and confirming the notification by correspondence to Director of Public Works, 399 Elmhurst Street, Hayward, CA 94544, Attn: Spill Notification.

(c) Requirement to Test or Monitor. Any authorized enforcement officer may request that any person engaged in any activity and/or owning or operating any facility which may cause or contribute to storm water pollution or contamination, illicit discharges, and/or discharge of non-storm water to the storm water system, undertake such monitoring activities and/or analyses and furnish such reports as the officer may specify. The burden, including costs, of these activities, analyses and reports shall bear a reasonable relationship to the need for the monitoring, analyses and reports and the benefits to be obtained. The recipient of such request shall undertake and provide the monitoring, analyses and reports required.

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3-352.1 Violations Constituting Misdemeanors. Unless otherwise specified by chapter, the violation of any provision of this Chapter, or failure to comply with any of the mandatory requirements of this Chapter shall constitute a misdemeanor; except that notwithstanding any other provisions of this Chapter, any such violation constituting a misdemeanor under this Chapter may, at the discretion of the authorized enforcement officer may be charged and prosecuted as an infraction.

3-352.2 Penalty for Violation. Upon conviction of a misdemeanor, a person shall be subject to payment of a fine, or imprisonment, or both, not to exceed the limits set forth in California Government Code Section 36901.

Upon conviction of an infraction, a person shall be subject to payment of a fine, not to exceed the limits set forth in California Government Code Section 36900. After a third conviction for a violation of the same provision subsequent violations within a twelve (12) month period may be charged as a misdemeanor.

3-352.3 Continuing Violation. Unless otherwise provided, a person, firm, corporation or organization shall be deemed guilty of a separate offense for each and every day during any portion of which a violation of this Chapter is committed, continued or permitted by the person, firm, corporation or organization and shall be punishable accordingly as herein provided.

3-352.4 Concealment. Causing, permitting, aiding, abetting or concealing a violation of any provision of this Chapter shall constitute a violation of such provision.

3-352.5 Acts Potentially Resulting in Violation of Federal Clean Water Act and/or Porter-Cologne Act. Any person who violates any provision of this Chapter, any provision of any permit issued pursuant to this Chapter, or who discharges waste or wastewater which causes pollution, or who violates any cease and desist order, prohibition, or effluent limitation, may also be in violation of the federal Clean Water Act and/or Porter-Cologne Act and may be subject to the sanctions of those Acts including civil and criminal penalty. Any enforcement action authorized under this Article should also include notice to the violator of such potential liability.

3-352.6 Violations Deemed a Public Nuisance. In addition to the penalties hereinbefore provided, any condition caused or permitted to exist in violation of any of the provisions of this Chapter is a threat to the public health, safety and welfare, is declared and deemed a nuisance, may be summarily abated and/or restored by any authorized enforcement officer, and/or civil action to abate, enjoin or otherwise compel the cessation of such nuisance may be taken by County Counsel.

The cost of such abatement and restoration shall be borne by the owner of the property and the cost thereof shall be invoiced to the owner of the property. If the invoice is not paid within sixty (60) days, a lien shall be placed upon and against the property. If the lien is not satisfied within three (3) months, the property may be sold in satisfaction thereof in a like manner as other real property is sold under execution.

If any violation of this Chapter constitutes a seasonal and recurrent nuisance, the Director of Public Works shall so declare. Thereafter such seasonal and recurrent nuisance shall be abated every year without the necessity of any further hearing.

In any administrative or civil proceeding under this Chapter in which the County prevails, the County shall be awarded all costs of investigation, administrative overhead, out-of-pocket expenses, costs of administrative hearings, costs of suit and reasonable attorney fees.

3-352.7 California Code of Civil Procedure Section 1094.6. The provisions of Section 1094.6 of the California Code of Civil Procedure are applicable to judicial review of County decisions pursuant to this Chapter.

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3-352.8 Civil Actions. In addition to any other remedies provided in this section, any violation of this section may be enforced by civil action brought by the County. In any such action, the County may seek, and the Court shall grant, as appropriate, any or all of the following remedies:

(1) A temporary and/or permanent injunction.

(2) Assessment of the violator for the costs of any investigation, inspection, or monitoring survey which led to the establishment of the violation, and for the reasonable costs of preparing and bringing legal action under this subsection.

(3) Costs incurred in removing, correcting, or terminating the adverse effects resulting from the violation.

(4) Compensatory damages for loss or destruction to water quality, wildlife, fish and aquatic life. Assessments under this subsection shall be paid to the County to be used exclusively for costs associated with monitoring and establishing storm water discharge pollution control systems and/or implementing or enforcing the provisions of this chapter.

3-352.9 Administrative Enforcement Powers. In addition to the other enforcement powers and remedies established by this chapter, any authorized enforcement officer has the authority to utilize the following administrative remedies.

(a) Cease and Desist Orders. When an authorized enforcement officer finds that a discharge has taken place or is likely to take place in violation of this Chapter, the officer may issue an order to cease and desist such discharge, or practice, or operation likely to cause such discharge and direct that those persons not complying shall: 1) comply with the requirement, 2) comply with a time schedule for compliance, and/or 3) take appropriate remedial or preventive action to prevent the violation from recurring.

(b) Notice to Clean. Whenever an authorized enforcement officer finds any oil, earth dirt, grass, weeds, dead trees, tin cans, rubbish, refuse, waste or any other material of any kind, in or upon the sidewalk abutting or adjoining any parcel of land, or upon any parcel of land or grounds, which may result in an increase in pollutants entering the County storm drain system or a non-storm water discharge to the County storm drain system, he or she may give notice to remove such oil, earth, dirt, grass, weeds, dead trees, tin cans, rubbish, refuse, waste or other material, in any manner that he or she may reasonably provide. The recipient of such notice shall undertake the activities as described in the notice.

In the event the owner or operator of a facility fails to conduct the required activities as described in the notice, the authorized enforcement officer may cause such required activities as described in the notice and the cost thereof shall be invoiced to the owner of the property. If the invoice is not paid within sixty (60) days, a lien shall be placed upon and against the property. If the lien is not satisfied by the owner of the property within three (3) months, the property may be sold in satisfaction thereof in a like manner as other real property is sold under execution.

3-352.10 Authority to Arrest or Issue Citations. Authorized enforcement officers shall have and are hereby vested with the authority to arrest or cite and release any person who violates any Section of this Code in the manner provided by the California Penal Code for the arrest or release on citation of misdemeanors or infractions as prescribed by Chapter 5, 5c, and 5d of Title 3, Part 2 of the Penal Code (or as the same may be hereinafter amended).

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Such authorized enforcement officers or employees may issue a citation and notice to appear in the manner prescribed by Chapter 5c of Title 3, Part 2 of the Penal Code, including Section 853.6 (or as the same may hereafter be amended). It is the intent of the County Board of Supervisors that the immunities prescribed in Section 836.5 of the Penal Code be applicable to public officers or employees or employees acting in the course and scope of employment pursuant to this Chapter.

3-352.11 Remedies Not Exclusive. Remedies under this Article are in addition to and do not supersede or limit any and all other remedies, civil or criminal. The remedies provided for herein shall be cumulative and not exclusive.

3-352.12 Appeal. Any person, firm, corporation or organization required to perform monitoring, analyses, reporting and/or corrective activities by an authorized enforcement officer who is aggrieved by the decision of the authorized enforcement officer may appeal such decision to the Director of Public Works within 10 days following the effective date of the decision by writing to the Director of Public Works. Upon receipt of such request, the Director of Public Works shall request a report and recommendation from the authorized enforcement officer and shall set the matter for hearing at the earliest practical date. At said hearing, the Director of Public Works may hear additional evidence, and may reject, affirm or modify the authorized enforcement officer's decision. Said decision shall be final.

3-352.13 Disclaimer of Liability. The degree of protection required by this Chapter is considered reasonable for regulatory purposes and is based on scientific, engineering and other relevant technical considerations. The standards set forth herein are minimum standards and this Chapter does not imply that compliance will ensure that there will be no unauthorized discharge of pollutants into the waters of the United states. This Chapter shall not create liability on the part of the County, any officer or employee thereof for any damages that result from reliance on this Chapter or any administrative decision lawfully made thereunder.

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Article 4

Coordination with Other Programs

3-353.0 Coordination with Hazardous Materials Inventory and Response Program. The first revision of the business plan for any facility subject to the County's hazardous materials inventory and response program shall include a program for compliance with this Chapter, including the prohibitions on non-storm water discharges and illicit discharges, and the requirement to reduce storm water pollutants to the maximum extent practicable.

SECTION II

This chapter shall take effect and be in force thirty (30) days from and after the date of passage and before the expiration of fifteen (15) days after its passage it shall be published once with the names of the members voting for and against the same in The Inter-City Express, a newspaper published in the said County of Alameda.

Adopted by the Board of Supervisors of the County of Alameda, State of California, on the 11 day of August, 1992, by the following called vote:

AYES: Supervisors Campbell, Perata, Steele, Widener and President King - 5

NOES: Supervisors None

EXCUSED: Supervisors None

Mary V. King
President of the Board of Supervisors,
County of Alameda, State of California

APPROVED AS TO FORM:

County Counsel

ATTEST:

William Mehrwein
William Mehrwein, Clerk, of the Board of Supervisors, County of Alameda, State of California

I CERTIFY THAT THE FOREGOING IS A CORRECT COPY OF AN ORDINANCE ADOPTED BY THE BOARD OF SUPERVISORS, ALAMEDA COUNTY, CALIFORNIA AUG 11 1992
ATTEST: AUG 11 1992
WILLIAM MEHRWEIN
THE BOARD OF SUPERVISORS

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APPENDIX D

UNIT CONTROL VOLUMES

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APPENDIX D

Appendix D is used for sizing infiltration facilities (TC 1) and extended detention basins (TC 5). The sizing criteria was determined using the Storage, Treatment, Overflow, Runoff Model (STORM) as developed by the U.S. Corp of Engineers. STORM was applied to long-term, hourly rainfall data at fifteen (15) rain gauges across the State. Based on this analysis nine gauges were selected as being representative for sizing detention storage facilities (see Figure D.1). Zones were drawn to reflect these nine gauges taking into consideration rainfall data and topography. The sizing curves should apply to most areas within each zone. However, the zone boundaries are approximate and certain areas within each zone will be strongly influenced by topographic features.

Each sizing curve was developed using the following parameters:

- A drawdown time from the entire storage volume of 40 hours. This drawdown time allows quiescent conditions to establish in the basin, resulting in at least 80% sediment removal for most soils in California.
- Initial abstraction/depression storage on Impervious surface of 0.06 inch.
- Runoff coefficient of 0.9 for impervious surfaces and 0.15 for pervious surfaces.

Appendix D may be used in the following manner:

1. Identify the appropriate zone for your location from Figure D.1 and Table D.1 and then select the appropriate detention storage figure for your zone.
2. Determine for the catchment area the percentage of impervious area directly connected to the storm drain system. Directly connected impervious area (DCIA) is defined as the area covered by pavement, building, and other impervious surfaces which drain directly into the storm drain without first flowing across pervious areas (e.g. lawns).
3. Choose a capture goal, and read the required unit volume required for the basin. In selecting the capture goal consider the requirements of the local municipality or a point at the "knee of the curve". Once the capture goal has been established draw a horizontal line from the capture goal to the appropriate DCIA curve, then a vertical line to the unit storage volume.
4. Multiply the unit volume times the total acreage of the catchment basin and convert to acre-feet or cubic feet.

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GENERAL ZONES WITHIN CALIFORNIA FOR SELECTING DETENTION/INFILTRATION SIZING CURVES

ZONE	AREA	GAGE
1	Inland Empire: Western San Diego, Riverside, San Bernardino Counties	Riverside City Experimental Station (#7473)
2	Mojave Desert: Eastern San Diego, Riverside, San Bernardino, Los Angeles, Kern Counties	Thermal Airport - Federal Aviation Administration (#8892) and Fire Station 39 (#8893)
3	Southern Coastal: Los Angeles, Orange, Ventura Counties	Los Angeles International Airport - Weather Service Office (#5114)
4	Central and Northern Coastal: Santa Barbara, San Luis Obispo, Monterey, Santa Cruz, Santa Clara, San Mateo, San Francisco, Alameda, Contra Costa, Western Solano, Napa, Marin, Sonoma, Mendocino, Trinity and Humboldt Counties	Oakland Airport - Weather Service Office (#6335)
5	Southern Central Valley: Kern County	Bakersfield Airport - Weather Service Office (#442)
6	Mid-Central Valley: Kings, Western Fresno, Western Tulare, Western Madera, Merced, and Mariposa Counties	Fresno Airport - Weather Service Office (#3257)
7	North Central Valley: Stanislaus, San Joaquin, Sacramento, Eastern Solano, Yolo, Colusa, Lake, Glenn, Tehama, Butte, Western Nevada, and Yuba Counties	Sacramento - Weather Service Office (#7633)
8	Owens Valley: Mono and Inyo Counties	Bishop Airport - Weather Service Office (#822)
9	Sierra: Del Norte, Siskiyou, Modoc, Shasta, Lassen, Plumas, Sierra, Eastern Nevada, Placer, El Dorado, Amador, Calaveras, Tuolume, Mariposa, Eastern Madera, Eastern Fresno, and Eastern Tulare Counties	Truckee (#9043)

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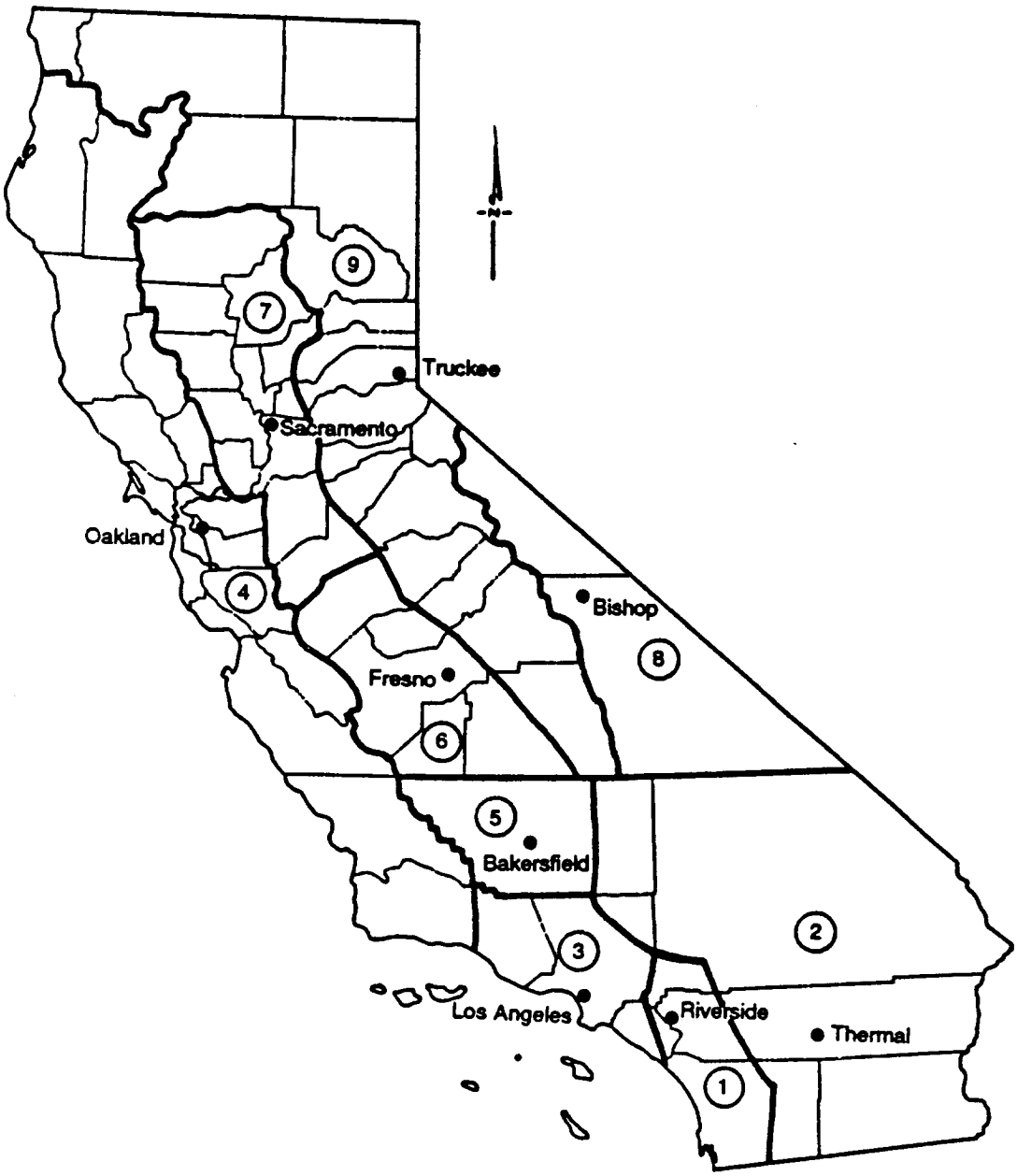

FIGURE D1. LOCATIONS OF RAIN GAGES USED FOR SIZING DETENTION/ INFILTRATION BASINS

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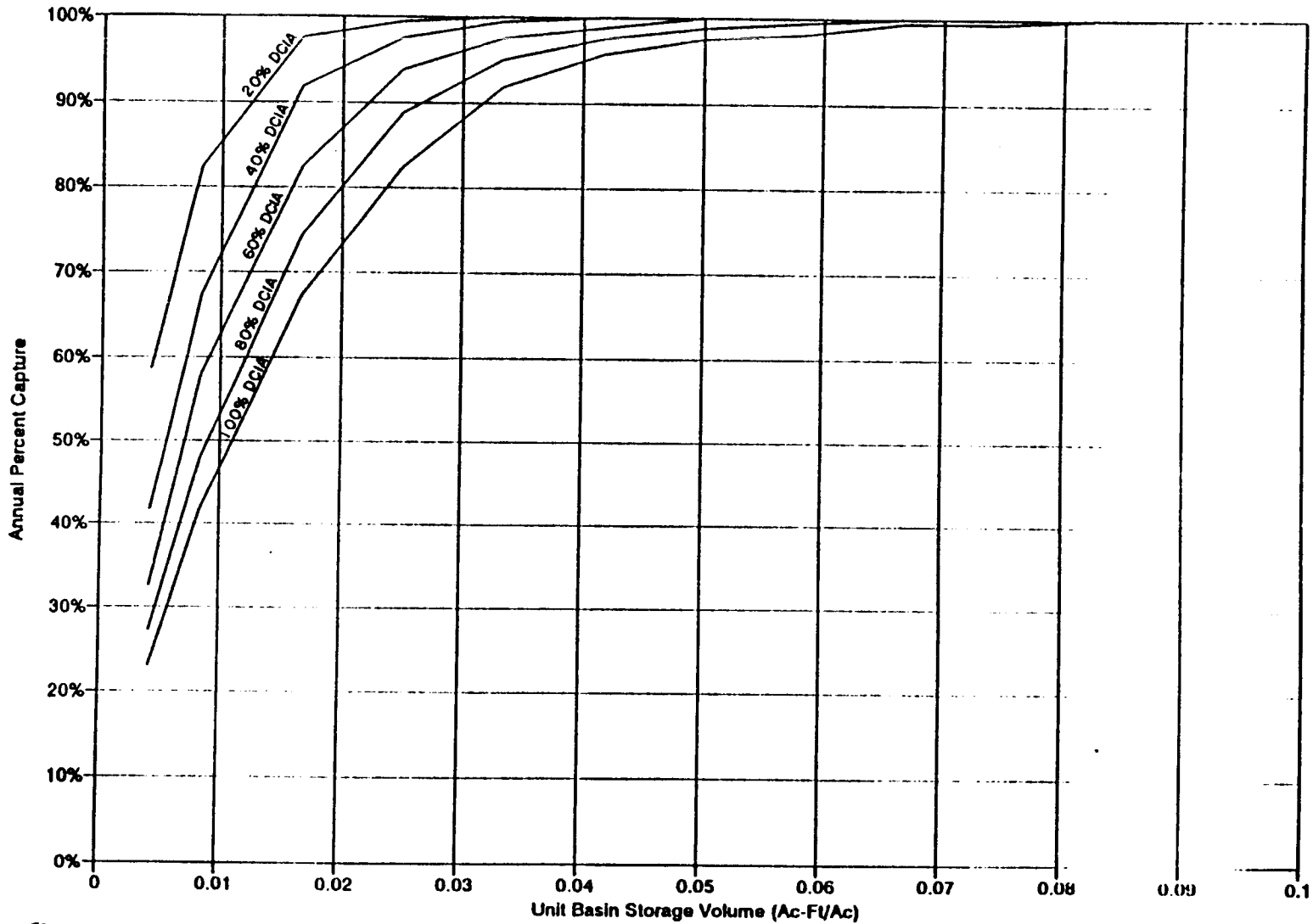
Bakersfield
40 Hour Detention Storage Analysis



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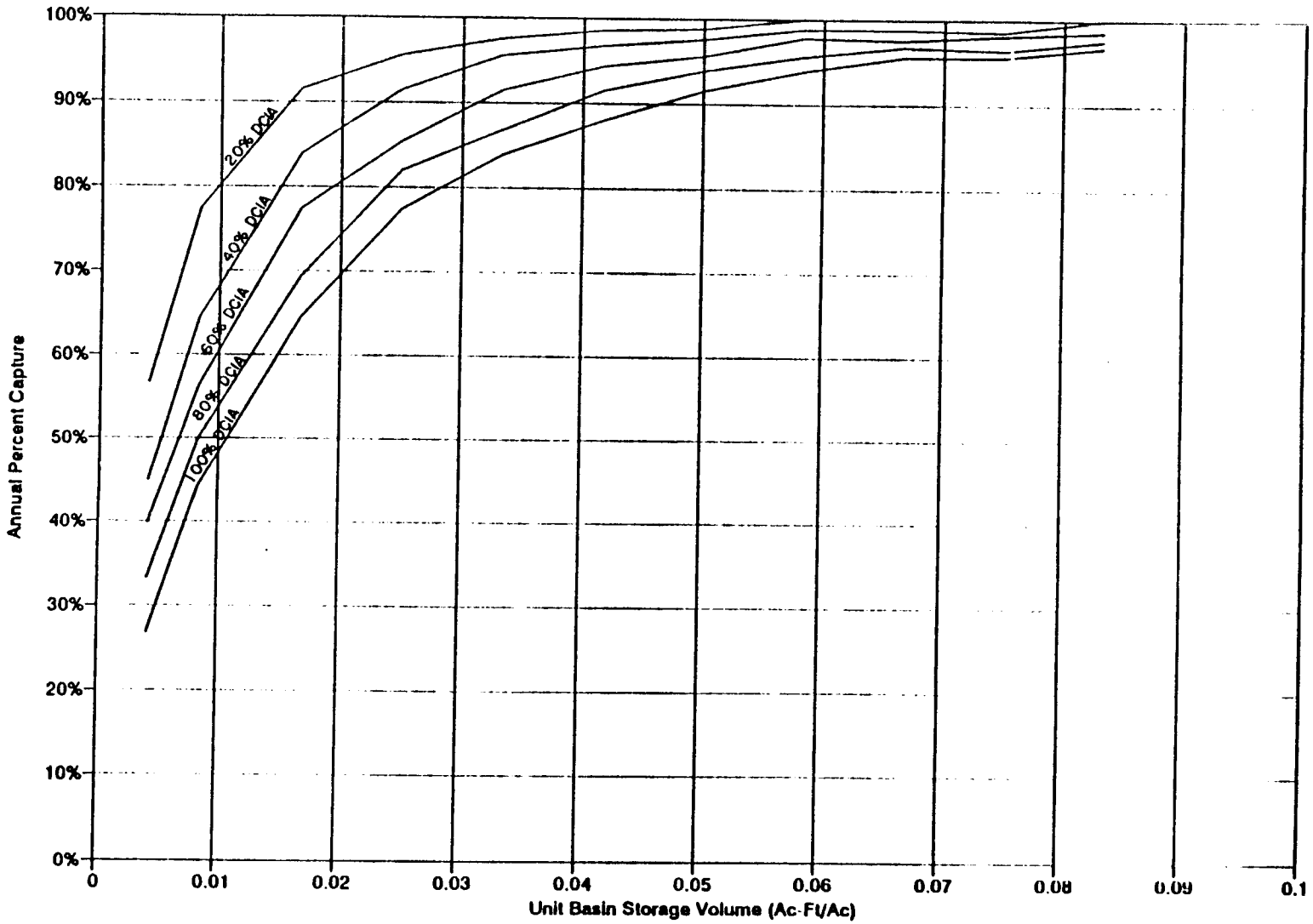
VOL 12

Bishop
40 Hour Detention Storage Analysis



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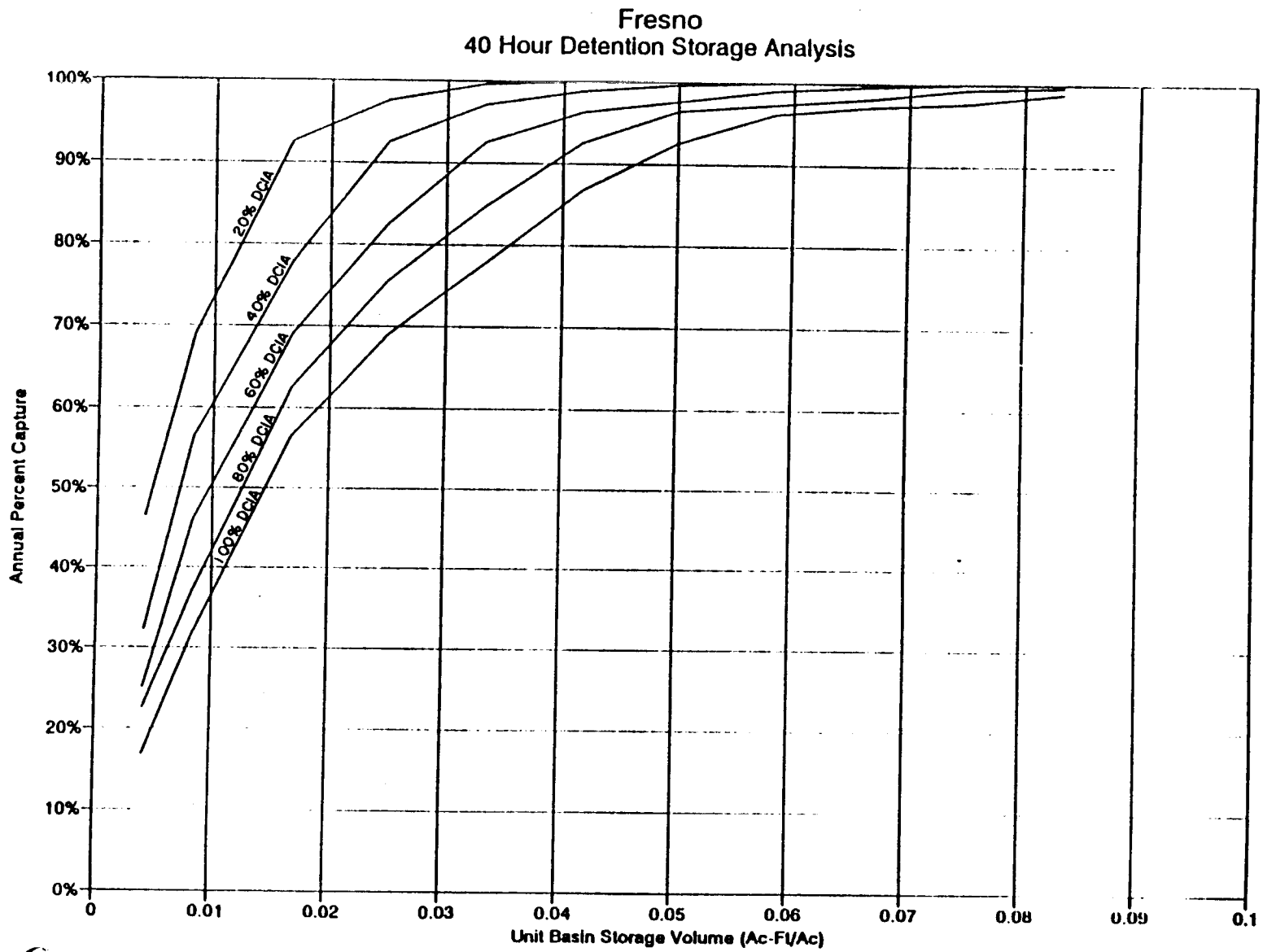
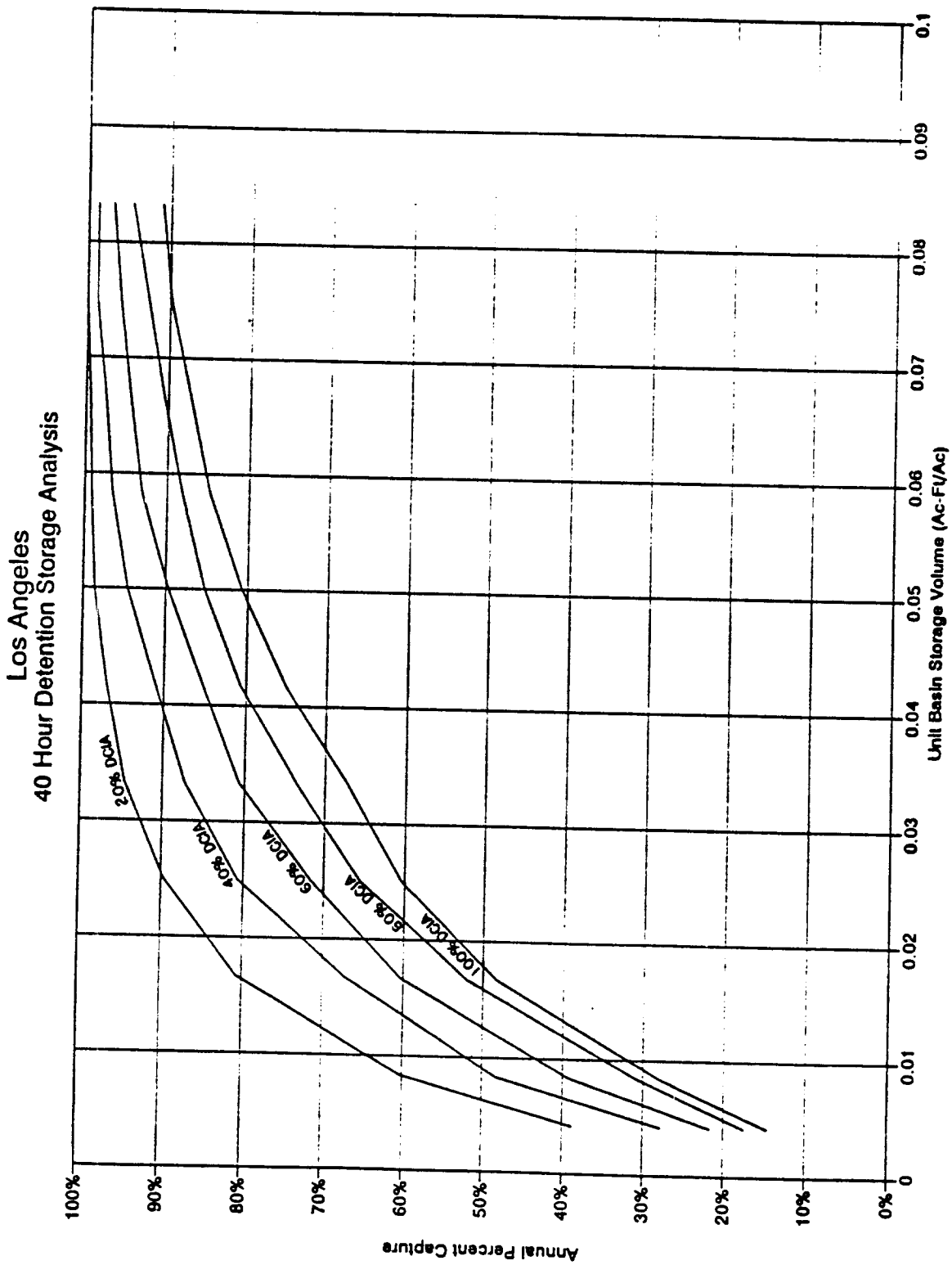

Fresno
40 Hour Detention Storage Analysis
Annual Percent Capture
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20% DCIA
40% DCIA
60% DCIA
80% DCIA
100% DCIA
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Unit Basin Storage Volume (Ac-Ft/Ac)

R0034236



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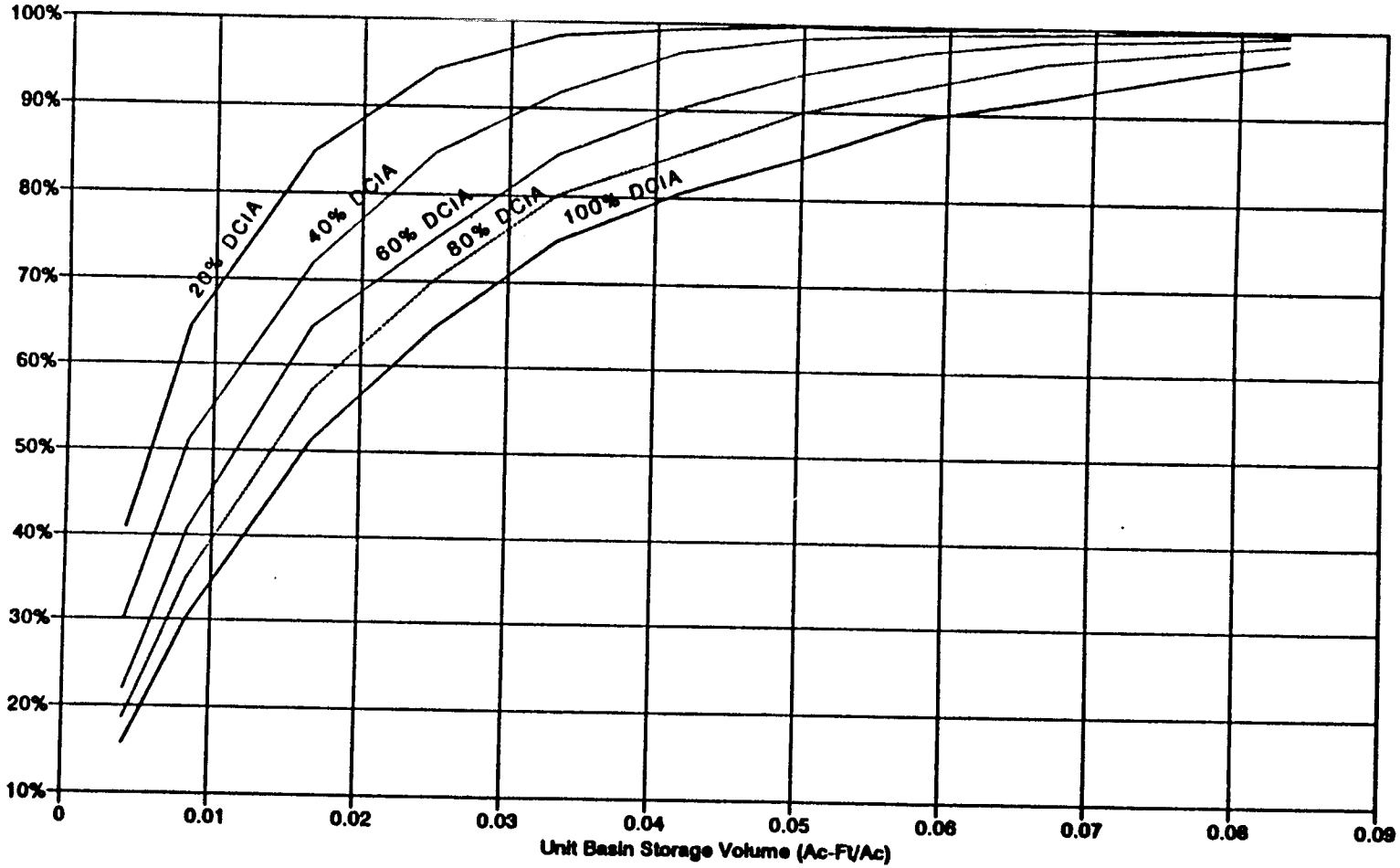
Oakland WSO Airport
40 Hour Detention Storage Analysis



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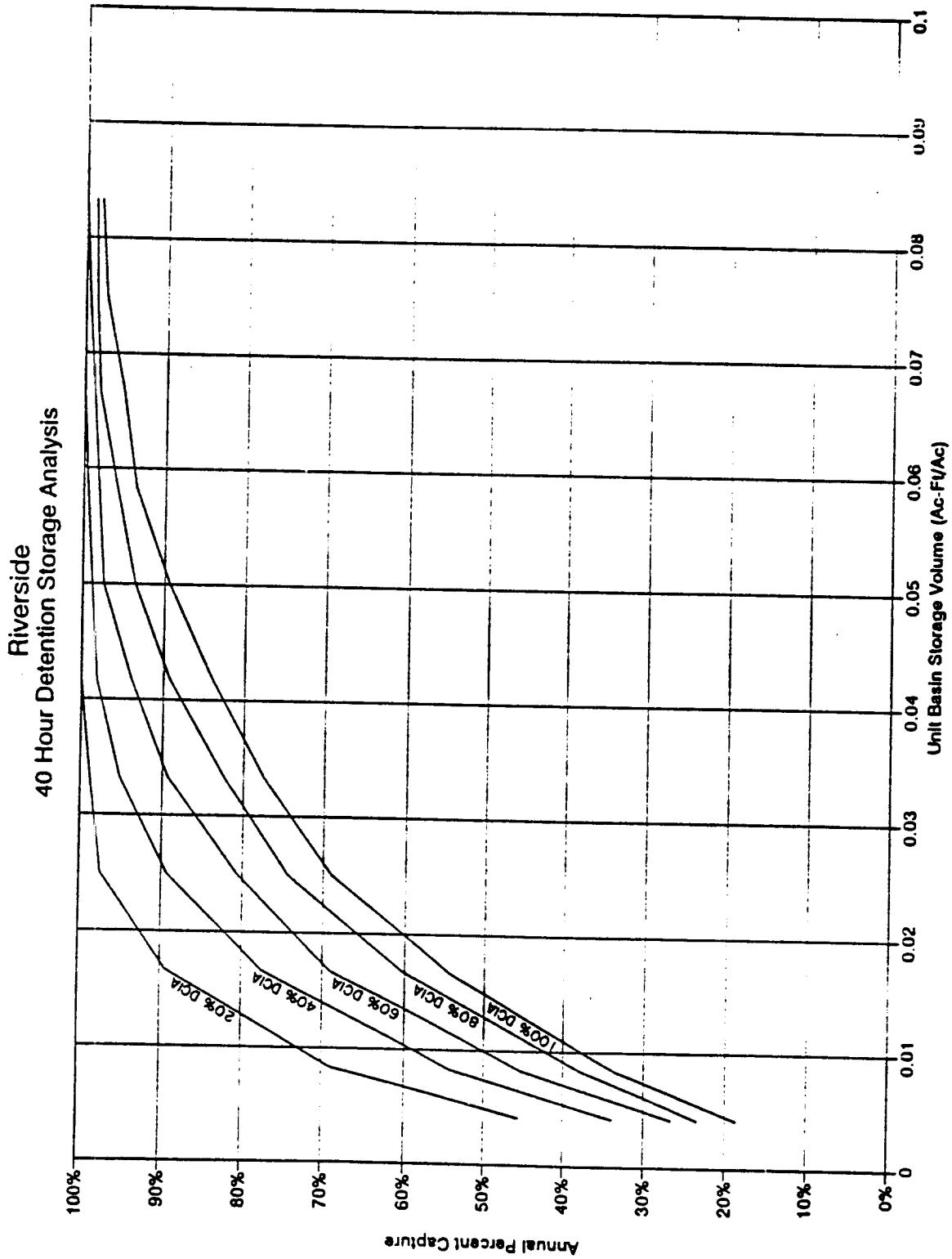

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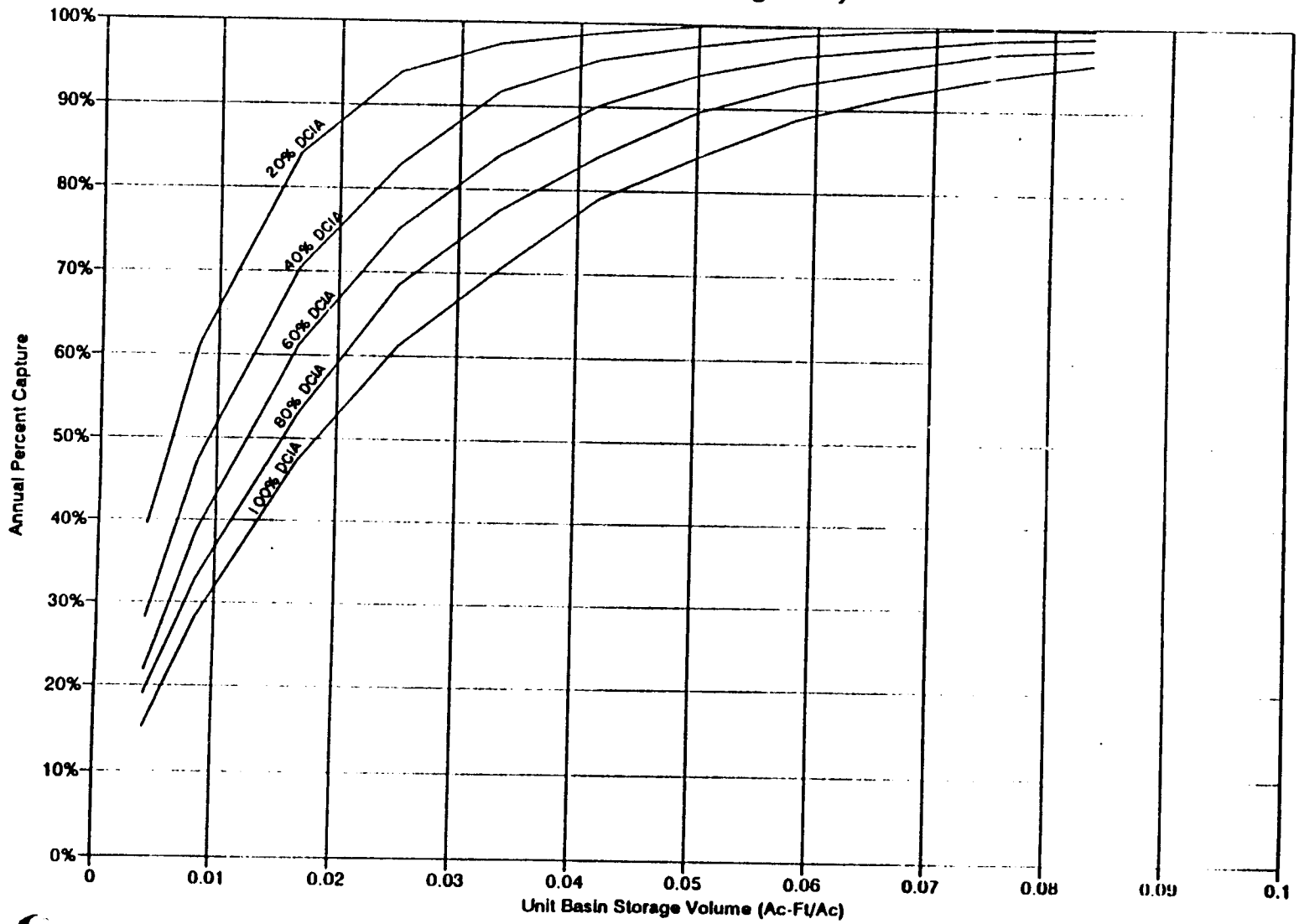
Sacramento
40 Hour Detention Storage Analysis



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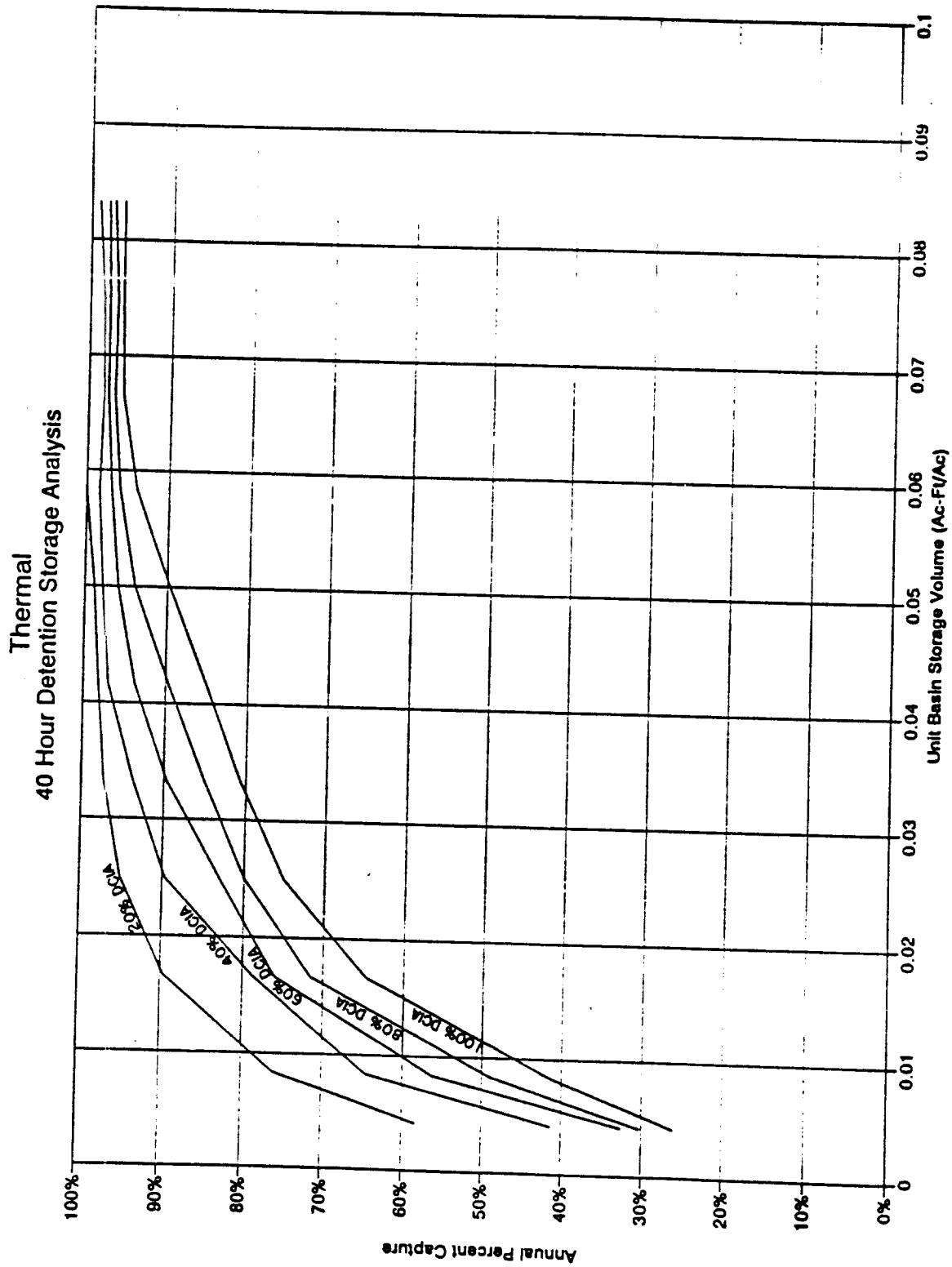

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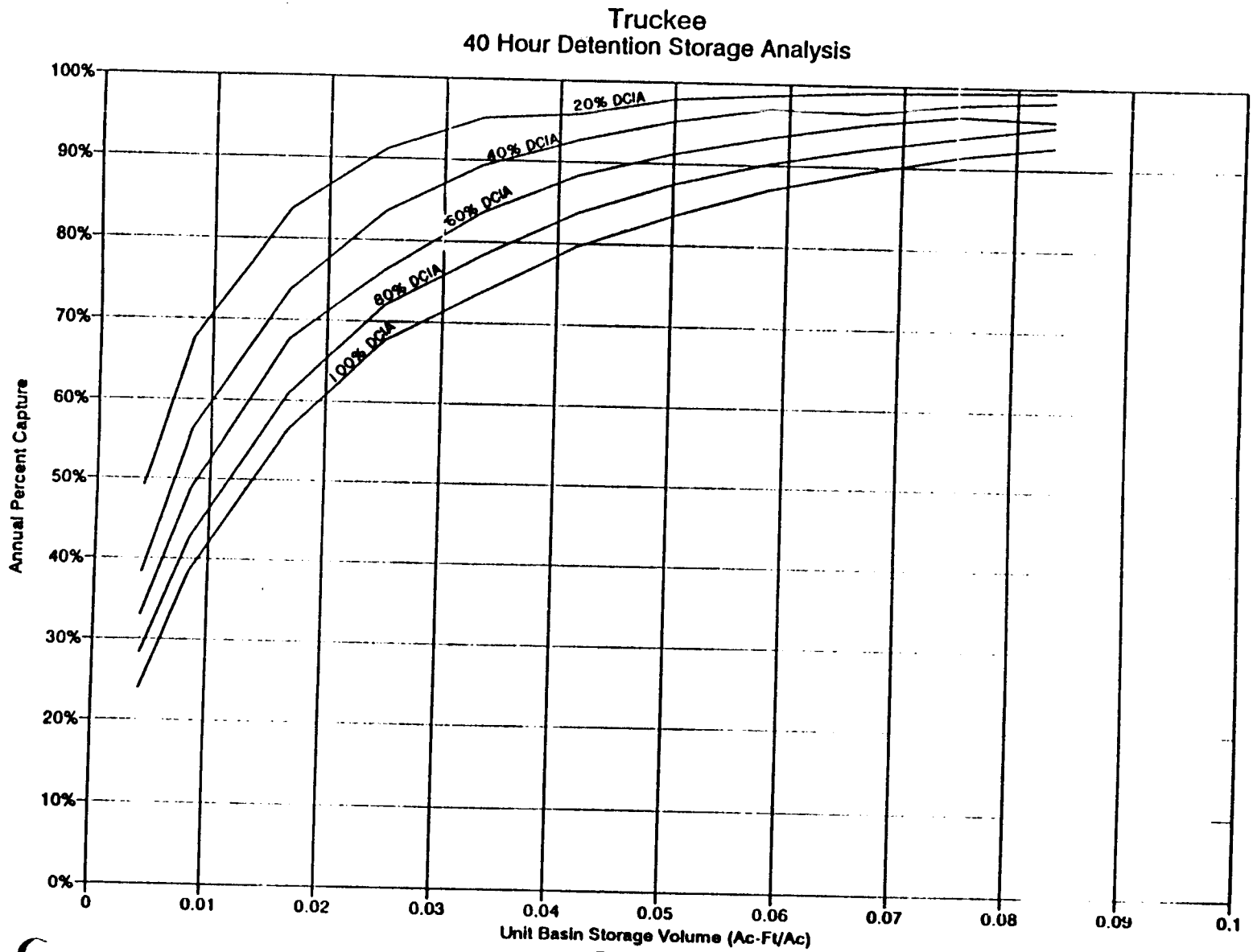

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APPENDIX E

GLOSSARY

APPENDIX E

GLOSSARY

Best Management Practices (BMPs): Include schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Catch Basin: Box-like underground concrete structure with openings in curbs and gutters designed to collect runoff from streets and pavement.

Conduit: Any pipe for collecting and directing the storm water.

Culvert: A covered channel or pipe that directs water flow below the ground level.

Discharge: The release of storm water or other substance from a conveyance system or storage container.

Effluent Limits (numeric effluent limits): Limitations on amounts of pollutants that may be contained in effluents. Can be expressed in a number of ways including as a concentration, as a concentration over a time period (e.g., 30-day average must be less than 20 mg/l) or as a total mass per time unit.

Inlet: An entrance into a ditch, storm sewer, or other waterway.

Illegal Discharges: Any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges authorized by an NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire-fighting activities, and other miscellaneous activities.

Land Application: Refers to the application of wastewater or storm water to agricultural land.

Non-Storm Water Discharge: Any discharge to municipal separate storm sewer that is not composed entirely of storm water. Discharges containing process wastewater, non-contact cooling water, or sanitary wastewater are non-storm water discharges.

Nonpoint Source Pollution: Pollution that does not come from a point source. Nonpoint source pollution originates from aerial diffuse sources that are mostly related to land use.

Outfall: The point where a storm drain discharges from a pipe, channel, ditch, or other conveyance to a waterway.

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Point Source: Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Generally any substance introduced into the environment that adversely affects the usefulness of a resource.

Precipitation: Any form of rain or snow.

Pretreatment: Treatment of wastewater before it is discharged to a wastewater collection system.

Process Wastewater: Wastewater that has been used in one or more industrial processes.

Reclaim (water reclamation): Planned use of treated effluent that would otherwise be discharged without being put to direct use.

Reuse (water reuse): (see Reclaim)

Runoff: Water originating from rainfall and other sources (e.g., sprinkler irrigation) that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, wetlands, and shallow groundwater.

Runon: Off-site flows which flow onto your site.

Significant Materials: Include, but not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designed under Section 101(14) of CERLCA; any chemical the facility is required to report pursuant to Section 313 of Title III or SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Significant Quantities: Is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance, that adversely impact human health or the environment, and cause or contribute to a violation of any applicable water quality standards for the receiving water.

Source Control BMPs: Operational practices that prevent pollution by reducing potential pollutants at the source.

Source Reduction (also source control): The technique of stopping and/or reducing pollutants at their point of generation so that they do not come into contact with storm water.

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Storm Drains: Above and below ground structures for transporting storm water to streams or outfalls for flood control purposes.

Storm Water: Rainfall runoff, snow melt runoff, surface runoff, and drainage. It excludes infiltration.

Treatment Control BMPs: Treatment methods to remove pollutants from storm water.

Toxicity: Poisonous.

Turbidity: Describes the ability of light to pass through water. The cloudy appearance of water caused by suspended and colloidal matter (particles).

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APPENDIX F

LIST OF ACRONYMS

APPENDIX F

LIST OF ACRONYMS

APWA	American Public Works Association
BMPs	Best Management Practices
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Register
CMA	Congestion Management Agency
CMP	Congestion Management Program
CWA	Clean Water Act (Federal Water Pollution Control Act of 1972 as amended in 1987)
DTSC	California Department of Toxic Substance Control
EMC	Event Mean Concentration
Hazmat	Hazardous Material
O&M	Operations and Maintenance
MEP	Maximum Extent Practicable
MSDS	Material Safety Data Sheet
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NURP	National Urban Runoff Program
OSHA	Occupational Safety and Health Administration
PAHs	Polyaromatic Hydrocarbons
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SPCC	Spill Prevention Control and Countermeasure
SWMP	Storm Water Management Program
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TSS	Total Suspended Solids
UFC	Uniform Fire Code
USEPA	United States Environmental Protection Agency

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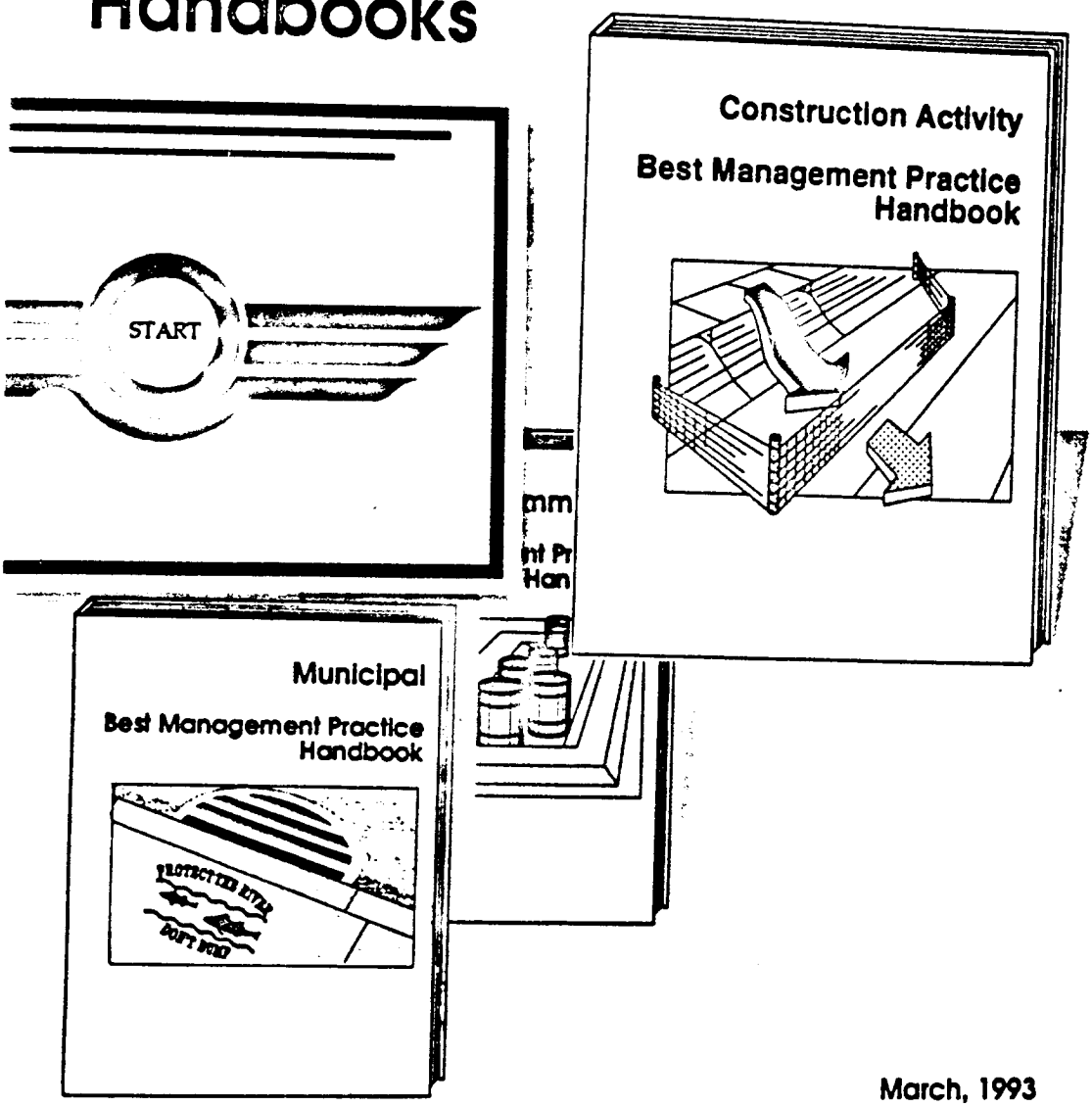
Califc 7
Storm Water Best Management Practice Handbooks



March, 1993

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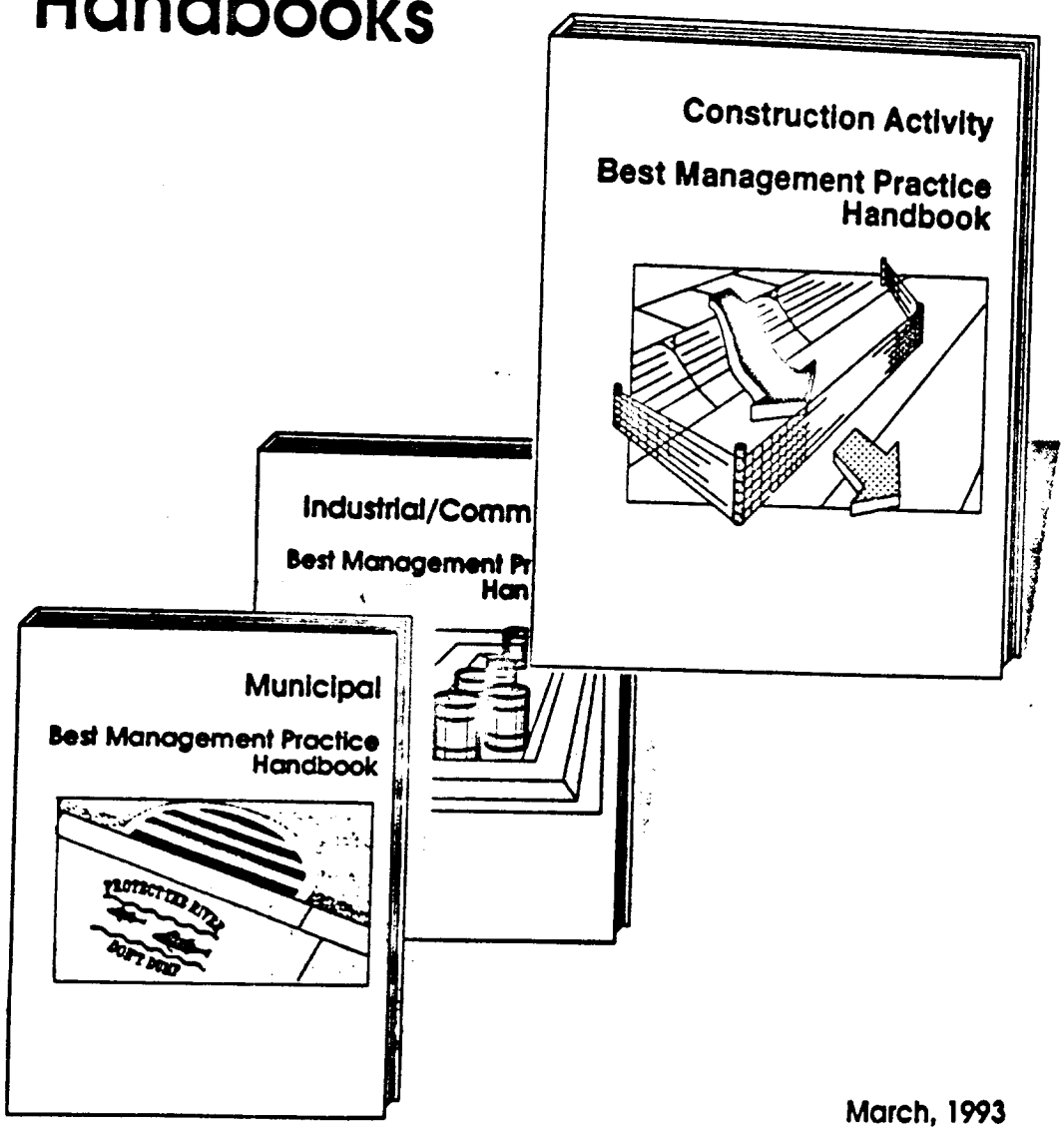
Califc 7
Storm Water Best Management Practice Handbooks



March, 1993

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STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

STATE WATER RESOURCES CONTROL BOARD

PAUL R. BONDERSON BUILDING
901 P STREET
P.O. BOX 1977
SACRAMENTO, CALIFORNIA 95812-01977
(916) 657-0757
FAX: (916) 657-1011

PETE WILSON, Governor

TO: STORM WATER DISCHARGER

SUBJECT: CHECK LIST FOR SUBMITTING A NOTICE OF INTENT

In order for the State Water Resources Control Board to expeditiously process your Notice of Intent (NOI), the following items must be submitted:

1. _____ NOI with all applicable sections filled out and signed by the owner/operator;

2. _____ Check made out to the "State Water Resources Control Board" with the appropriate fee; and

   - County Fees: $250.00 OR $500.00
   - Dairy Farms: $2,000.00

3. _____ Site map displaying the layout of premises.

Please return the above items to the address below. If you have any questions regarding this matter, please contact us at (916) 657-0757.

State Water Resources Control Board
Division of Water Quality
Attn: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

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STATE OF CALIFORNIA · CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

STATE WATER RESOURCES CONTROL BOARD
PAUL R. BONDERSON BUILDING
901 P STREET
P.O. BOX 100
SACRAMENTO, CALIFORNIA 95812-0100
(916) 657-0941
FAX: (916) 657-0932

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OCT 15, 1992

TO: INTERESTED PARTIES

AMENDED GENERAL INDUSTRIAL ACTIVITIES STORM WATER PERMIT

Enclosed is an updated copy of the General Industrial Activities Storm Water Permit (General Permit) adopted by the State Water Resources Control Board (State Water Board) on November 19, 1991 and amended on September 17, 1992. Dischargers who have not already filed their Notice of Intent (NOI) to comply with the terms of the General Permit and the first annual fee must submit a NOI accompanied by the first annual fee to the State Water Board in order to be covered by this General Permit. The NOI and fee must be sent to the following address:

State Water Resources Control Board
Division of Water quality
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

The NOI will only be processed if accompanied by the appropriate fee. The fee will be either $250.00 or $500.00. Enclosure 1 describes those areas in which the $250.00 annual fee applies. Dischargers in all other areas of the State must pay the $500.00 annual fee.

Attachment 2 to the Permit lists the nine California Regional Water Quality Control Boards' (Regional Water Boards) addresses and telephone numbers. You should discuss any questions or issues which relate to the implementation of the General Permit with Regional Water Board staff.

The updated General Permit contains amended monitoring and reporting requirements (Section B of the General Permit) that replace the original monitoring and reporting requirements. The new monitoring and reporting requirements have been simplified and now offer several sampling and analysis exemption options. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers (those beginning industrial activity after January 1, 1993) must develop and implement a monitoring program prior to the commencement of industrial activity.

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The amended monitoring and reporting provisions require that group monitoring proposals be submitted to the appropriate Regional Water Board(s) by December 1, 1992 and in subsequent years by August 1. Groups with participants within the boundaries of more than one Regional Water Board must send their group monitoring proposal to the State Water Board's Executive Director for approval to the above address.

Also, we would appreciate it if you would inform other industries similar to your own of the need to obtain a storm water permit. If you know of industries that need to obtain a permit but may be unaware of the State's program, please ask them to call Division of Water Quality staff at the telephone number shown below.

If you have any questions regarding this General Permit, please telephone the industrial activities storm water permit information line at
(916) 657-0919.

Sincerely,

/s/

Walt Pettit
Executive Director

Enclosures (2)

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January 31, 1995

Enclosure 1

AREAS OF THE STATE IN WHICH THE $250.00 ANNUAL FEE APPLIES

Municipality	Permitted Area
1. Alameda County	The permitted area consists of the westerly side of the county which drains to San Francisco Bay.
2. Bakersfield	The permitted area consists of the city of Bakersfield and the unincorporated portions of Kern County within the city limits.
3. Contra Costa County	The permitted area consists of the entire county except for the community of Brentwood.
4. El Dorado County	The permitted area consists of the easterly side of the county which drains into Lake Tahoe.
5. Fresno County	The permitted area consists of the cities of Fresno and Clovis, and the California State University of Fresno.
6. Los Angeles County	The permitted area consists of the five hydrologic subbasins which drain into the Pacific Ocean as follows: Santa Monica Bay, Upper Los Angeles River--including Sycamore Channel, Upper San Gabriel River, Lower Los Angeles River, and Lower San Gabriel River--including Santa Clarita Valley. The permit does not cover the cities of Avalon, Lancaster, and Palmdale.
7. Orange County	The permitted area consists of the entire county.
8. Placer Counties	The permitted area consists of the easterly side of the county which drains into Lake Tahoe.
9. Riverside County	The permitted area is delineated by the San Bernardino County line on the north and northwest, the Orange County line on the west, the San Diego County line on the south, and the Santa Ana/Colorado River Basin Regional Board's boundary line on the east (mountain crest).

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10. Sacramento County	The permitted area consists of the entire county except for the incorporated city of Isleton.
11. San Bernardino County	The permitted area is delineated by the Santa Ana/Lahontan Regional Board's boundary line on the north and northeast, the Santa Ana/Colorado River Basin Regional Board's boundary line on the east, the San Bernardino/Riverside County boundary line on the south and southeast, the San-Bernardino/ Orange County boundary line on the southwest, and the San Bernardino/Los Angeles County boundary line on the west.
12. San Diego County	The permitted area is delineated by the San Diego County lines on the north and south, the Pacific Ocean on the west, and the San Diego/Colorado River Basin Regional Board's boundary on the east (mountain crest).
13. San Joaquin	The permitted area consists of the city of Stockton and the unincorporated portions of the county within the city limits.
14. San Mateo County	The permitted area consists of the entire county.
15. Santa Clara County	The permitted area consists of the Santa Clara Valley Basin portion of the county containing eleven hydrologic subbasins which discharge into watercourses, which in turn flow into South San Francisco Bay.
16. Stanislaus	The permitted area consists of the city of Modesto and the unincorporated portions of the county within the city limits.
17. Ventura County	The permitted area consists of the cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks, as well as the unincorporated areas of Ventura County--defined as urban by the U.S. Census Bureau.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
901 P STREET
SACRAMENTO, CA 95814

FACT SHEET
FOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT (NPDES) GENERAL PERMIT (AS AMENDED SEPTEMBER 17, 1992) FOR STORM WATER DISCHARGES ASSOCIATED WITH INDUSTRIAL ACTIVITIES EXCLUDING CONSTRUCTION ACTIVITIES

BACKGROUND

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, the U.S. Environmental Protection Agency (USEPA) published final regulations that establish application requirements for storm water permits. The regulations require that storm water associated with industrial activity (industrial storm water) that discharges either directly to surface waters or indirectly, through municipal separate storm sewers, must be regulated by a NPDES permit. This includes the discharge of "sheet flow" through a drainage system or other conveyance.

The federal regulations allow authorized states to issue general permits or individual permits to regulate industrial storm water discharges. The State Water Board has elected to issue a statewide general permit that will apply to all industrial storm water discharges requiring a permit except construction activity. A separate statewide general permit has been issued for construction activity. To obtain authorization for continued and future industrial storm water discharge, owners, or operators when the owners do not operate the facility (dischargers), must submit a Notice of Intent (NOI) to be covered by this general permit. This approach is consistent with the four-tier permitting strategy described in federal regulations, i.e., Tier 1, Baseline Permitting. Tier 1, Baseline Permitting, enables the State to begin reducing pollutants in industrial storm water in the most efficient manner possible. Thus, as soon as possible, all dischargers will be required by this general permit to begin implementing practices to prevent storm water pollution. Time will not be lost preparing detailed individual and general permit applications before implementing practices to prevent storm water pollution.

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The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for specific industrial groups at this time. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual permit by October 1, 1992. The State Water Board bases this decision on the following factors:

1. USEPA does not allow the states to review and approve the group applications.

2. Review of hundreds of USEPA model permits and preparation of hundreds of group-specific general permits is administratively burdensome and is inconsistent with the State Water Board's long-term permitting strategy.

3. Allowing the group application action in California would result in an inequitable and ineffective storm water permitting program. While group applicants would not be required to implement best management practices (BMPs) to reduce pollutants in storm water discharge until they receive a permit (probably several years), dischargers under the State Water Board's general permit will be required to implement BMPs on October 1, 1992.

4. The State Water Board is providing a group monitoring alternative, somewhat similar to the group application monitoring requirements, that should provide reduced monitoring costs to the dischargers.

When USEPA issues model permits for any groups, the Regional Water Boards may consider, as appropriate, adopting group permits based upon the USEPA model permits.

The general permit accompanying this fact sheet is intended to regulate industrial storm water discharges. The consolidation of many discharges under one general permit will greatly reduce the otherwise overwhelming administrative burden associated with start up of a new program to regulate industrial storm water discharges. It is also the least costly way for a discharger to obtain a permit and comply with USEPA's regulations. It is expected that as the storm water program develops, the Regional Water Boards will issue individual and general permits which regulate discharges specific either to industrial categories or to watersheds. As new permits are adopted, dischargers subject to those permits will no longer be regulated by this general permit. As permits are reissued for discharges of treated wastewater that are currently regulated by a NPDES permit, Regional Water Boards may include storm water provisions in the revised permit.

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This general permit generally requires dischargers to:

1. Eliminate most non-storm water discharges (including illicit connections) to storm water sewer systems;
2. Develop and implement a storm water pollution prevention plan; and
3. Perform monitoring of discharges to storm water sewer systems.

TYPES OF STORM WATER DISCHARGES COVERED BY THIS GENERAL PERMIT

This general permit is intended to cover all new or existing discharges composed entirely of industrial storm water from facilities required by federal regulations to obtain a permit. This includes all facilities that are participating in a group application. The State Water Board notes that officials from USEPA have stated that the regulations include only those facilities which are operated by industries whose primary function is described in the categories listed below. The State Water Board does not agree with this interpretation of the regulations, as the regulations are based on the primary activity at each industrial facility, and not the primary business of the owner or operator of the facility. The State Water Board concludes that, based on its interpretation of the federal regulations, and its duty and authority to protect water quality within California, the general permit must extend to all facilities which are described in the categories below, whether the activity is primary or is auxiliary to the owner or operator of the facility. For example, even though a school district's primary function is education, a facility which it operates for vehicle maintenance of school buses is a transportation facility which is covered by this general permit.

Discharges from facilities and commercial enterprises which are not required by federal regulations to obtain a permit will not be covered by this general permit unless designated by the Regional Water Board.

Discharges requiring a permit are listed by category in 40 Code of Federal Regulations (CFR) Section 122.26(b)(14) (Federal Register, Volume 55 at Pages 48065-66). The facilities can be publicly or privately owned. A general description of these categories are:

1. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR Subchapter N);
2. Manufacturing facilities;
3. Mining and Oil and Gas facilities;
4. Hazardous waste treatment, storage, or disposal facilities;

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5. Landfills, land application sites, and open dumps that receive industrial waste;
6. Recycling facilities such as metal scrap yards, battery reclaimers, salvage yards, automobile yards;
7. Steam electric generating facilities;
8. Transportation facilities;
9. Sewage treatment plants;
10. Construction activity (covered by a separate general permit); and
11. Certain facilities if materials are exposed to storm water.

For the most part, these facilities are identified in the federal regulations by Standard Industrial Classification (SIC). Attachment 1 to the general permit contains a more detailed description including SIC codes of industries to be regulated.

Category 1 Dischargers

The following categories of facilities currently have storm water effluent limitations guidelines for at least one of their subcategories. They are cement manufacturing (40 CFR Part 411); feedlots (40 CFR Part 412); fertilizer manufacturing (40 CFR Part 418); petroleum refining (40 CFR Part 419); phosphate manufacturing (40 CFR Part 422); steam electric power generation (40 CFR Part 423); coal mining (40 CFR Part 434); mineral mining and processing (40 CFR Part 436); ore mining and dressing (40 CFR Part 440); and asphalt emulsion (40 CFR Part 443). A facility that falls into one of these general categories should examine the effluent guidelines to determine if it is categorized in one of the subcategories that have storm water effluent guidelines. If a facility is classified as one of those subcategories, that facility is subject to the standards listed in the CFR for that category, and is subject to this general permit. This general permit contains additional requirements (see Section B.7) for facilities with storm water effluent limitations guidelines.

Category 5 Dischargers

Inactive or closed landfills, land application sites, and open dumps that have received industrial wastes (Category 5) may be subject to this general permit unless the storm water discharges from the sites are already regulated by a NPDES permit issued by the appropriate Regional Water Board. Owners or operators of closed landfills that are regulated by waste discharge requirements (WDRs) may be required to comply with this general permit. In some cases, it may be appropriate for closed landfills to be covered by the State Water Board's General Construction Activity Storm Water Permit during closure activities. The appropriate Regional Water Board should be contacted for this determination.

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Category 11 Dischargers

Dischargers in Category 11 that believe they are not subject to this general permit because of no exposure should conduct a facility inspection and document that the following minimum conditions have been met:

1. All illicit connections to the storm drainage system have been eliminated;

2. All materials are completely contained at all times;

3. All unhoused equipment associated with industrial activity is not exposed to storm water; and

4. All emissions from stacks or exhaust systems and emissions of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

Dischargers should evaluate all direct and indirect pathways of exposure. Dischargers are not required to submit this documentation but are advised to keep the above documentation on site.

In a recent ruling, the Ninth Circuit Court of Appeals invalidated the exemption granted by USEPA for storm water discharges from facilities in Category 11 that do not have exposure and remanded the regulation to USEPA for further action. The State Water Board, at this time, is not requiring storm water discharges from facilities in Category 11 that do not have exposure to be covered by this general permit. Instead, the State Water Board will await future USEPA or court action clarifying the types of storm water discharges that must be permitted. If necessary, the State Water Board will reopen the general permit to accommodate such a clarification.

TYPES OF DISCHARGES NOT COVERED BY THIS GENERAL PERMIT

- CONSTRUCTION ACTIVITY: Discharges from construction activity of five acres or more, including clearing, grading and excavation. A separate general permit was adopted on August 20, 1992 for this industrial category.

- FACILITIES LOCATED IN SANTA CLARA COUNTY WHICH DRAIN TO SAN FRANCISCO BAY: The San Francisco Bay Regional Water Board has adopted a general permit for discharges from facilities located in Santa Clara County which drain to San Francisco Bay.

- FACILITIES COVERED BY INDIVIDUAL PERMITS: While it is the intent of the State Water Board, in order to reduce

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administrative burden, to regulate most discharges of industrial storm water by this general permit, dischargers may choose to apply for an individual NPDES Permit. Permit application requirements are set forth in the USEPA regulations at 40 CFR Section 122.21.

- FACILITIES WHICH HAVE NPDES PERMITS CONTAINING STORM WATER PROVISIONS: The NPDES permits for some industrial waste water discharges already contain requirements regulating storm water. These discharges are in compliance with storm water regulations and will not be regulated by this general permit. When the existing permit for such discharges expires, a Regional Water Board may authorize coverage under this permit, or another general permit, or issue a new permit consistent with the new federal and State storm water requirements.

- FACILITIES DETERMINED INELIGIBLE BY REGIONAL WATER BOARDS: Regional Water Boards may determine that discharges from a facility or groups of facilities, otherwise eligible for coverage under this general permit, have potential water quality impacts that may not be addressed by this general permit. In such cases, a Regional Water Board may require such dischargers to apply for and obtain an individual permit or a different general permit. Interested persons may petition the appropriate Regional Water Board to issue individual permits. The applicability of this general permit to such discharges will be terminated upon adoption of an individual permit or a different general permit.

- FACILITIES WHICH DO NOT DISCHARGE STORM WATER TO WATERS OF THE UNITED STATES: The discharges from the following facilities are not required to obtain a permit:

  1. FACILITIES THAT DISCHARGE STORM WATER TO MUNICIPAL SANITARY SEWER SYSTEMS: Facilities that discharge storm water to municipal sanitary sewer systems or combined sewer systems are not required by federal regulations to obtain a storm water permit or to submit a NOI to comply with this general permit. (It should be noted that many municipalities have sewer use ordinances that prohibit storm drain connections to their sanitary sewers.)

  2. FACILITIES THAT DO NOT DISCHARGE STORM WATER TO SURFACE WATERS OR SEPARATE STORM SEWERS: Dischargers that capture all industrial storm water runoff from their facilities and treat and/or dispose of it with their process waste water, and dischargers that dispose of their industrial storm water to evaporation ponds, percolation ponds, or combined sewer systems, are not required to obtain a storm water permit. To avoid liability, the discharger should

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be certain that a discharge of industrial storm water to surface waters will not occur under any circumstances.

- LOGGING ACTIVITIES: Logging activities described under SIC 2411.

- MINING AND OIL AND GAS FACILITIES: Oil and gas facilities that have not released storm water resulting in a discharge of a reportable quantity (RQ) for which notification is or was required pursuant to 40 CFR Parts 110, 117, and 302 at any time after November 19, 1988 are not required to be permitted unless the industrial storm water discharge contributed to a violation of a water quality standard. Mining facilities that discharge storm water that does not come into contact with any overburden, raw materials, intermediate product, finished product, by-product, or waste product located at the facility are not required to be permitted. These facilities must obtain a storm water permit if they have a new release of storm water resulting in a discharge of a RQ.

- FACILITIES ON INDIAN LANDS: Discharges from facilities on Indian lands will be regulated by the USEPA.

NOTIFICATION REQUIREMENTS

Dischargers of facilities described in the section entitled "Types of Storm Water Discharges Covered by This General Permit", must obtain a permit to discharge storm water. A NOI must be submitted for each individual facility to obtain coverage. Certification of the NOI signifies that the discharger intends to comply with the provisions of the general permit.

Dischargers that do not submit a NOI for facilities must submit an application for an individual permit. USEPA's regulations (40 CFR 122.21 [a]) exclude dischargers covered by a general permit from requirements to submit permit applications. The NOI requirements of this general permit are intended to establish a mechanism which can be used to establish a clear accounting of the number of dischargers complying with the general permit, their identities, the nature of operations at the facilities, and location.

Dischargers of existing facilities in California were required to obtain coverage by submitting a completed NOI no later than March 30, 1992. Dischargers of new facilities (those beginning operations after March 30, 1992) must submit a NOI 30 days prior to the beginning of operations. The NOI must be sent to the

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following address:

California State Water Resources Control Board
Division of Water Quality
P. O. Box 1977
Sacramento, CA 95812-1977
Attention: Storm Water Permitting Unit

Facilities that do not obtain coverage under this general permit or by an individual NPDES permit for a discharge of industrial storm water, by the appropriate deadlines, will be in violation of the Clean Water Act and the California Water Code. There are substantial penalties which can be pursued by the State or Regional Water Boards, USEPA, or by private citizens for violation of these laws. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late. In general, late filers should develop and implement their SWPPP and Monitoring Plan no more than 30 days following submittal of their late NOI. Dischargers that cannot develop and implement these plans within 30 days should notify the appropriate Regional Water Board.

DESCRIPTION OF GENERAL PERMIT CONDITIONS

Prohibitions

This general permit authorizes the discharge of industrial storm water from industrial facilities that are required to obtain industrial storm water permits. This general permit prohibits most non-storm water discharges (including illicit connections) and discharges containing hazardous substances in storm water in excess of reportable quantities established at 40 CFR 117.3 and 40 CFR 302.4. Allowable non-storm water discharges are discussed below under the heading Storm Water Pollution Prevention Plan (SWPPP).

Effluent Limitations

Permits for discharges of industrial storm water must meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require control of pollutant discharges that use best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to reduce pollutants, and any more stringent controls necessary to meet water quality standards.

USEPA regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories. For these facilities, the numeric

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effluent limitations constitute BAT and BCT for the specified pollutants, and must be met to comply with this general permit.

For storm water discharges from facilities not among the ten industrial categories listed in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. The reasons why establishment of numeric effluent limitations is not feasible are discussed in detail in State Water Board Orders No. WQ 91-03 and WQ 91-04. Therefore, the effluent limitations contained in this general permit are narrative and include best management practices (BMPs).

These effluent limitations constitute compliance with the requirements of the Clean Water Act.

The narrative effluent limitations in this general permit include prohibitions against most discharges of non-storm water. They require dischargers to control and eliminate the sources of pollutants in storm water through the development and implementation of storm water pollution prevention plans. The plans must include best management practices, which may include treatment of storm water discharges along with source reduction, which will constitute BAT and BCT and will achieve compliance with water quality standards. If water quality standards are not met, the appropriate Regional Water Board may specify any additional effluent limitations necessary to meet the specific standards.

Storm Water Pollution Prevention Plans (SWPPP)

This general permit requires development and implementation of SWPPP emphasizing storm water BMPs. This approach provides the flexibility necessary to establish controls which can appropriately address different sources of pollutants at different facilities. Existing dischargers must develop and implement a SWPPP by October 1, 1992. New dischargers must submit a NOI, and develop and implement a SWPPP prior to commencement of operations.

All dischargers must prepare, retain on site, and implement a SWPPP. The SWPPP has two major objectives: (1) to help identify the sources of pollution that affect the quality of industrial storm water discharges; and (2) to describe and ensure the implementation of practices to reduce pollutants in industrial storm water discharges.

The SWPPPs are considered reports available to the public under Section 308(b) of the Clean Water Act. Required elements of a SWPPP are: (1) source identification, (2) practices to reduce pollutants, (3) an assessment of potential pollution sources, (4) a materials inventory, (5) a preventive maintenance program,

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(6) spill prevention and response procedures, (7) general storm water management practices, (8) employee training, (9) recordkeeping, and (10) elimination of unpermitted non-storm water discharges to the industrial storm water system. Elimination of non-storm water discharges is a major element of the SWPPP. Non-storm water discharges include a wide variety of sources including illicit connections (i.e., floor drains), improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges can contribute a significant pollutant load to receiving waters. Measures to control spills, leakage, and dumping can often be addressed through BMPs. Non-storm water discharges and industrial storm water mixed with non-storm water prior to discharge should be covered by a separate NPDES Permit.

There are many discharges that may occur at a facility that are not related to industrial activity (i.e., air conditioning condensate, fire control water line testing, landscaping overflow, etc.). It is not the intent of this Permit to prohibit all non-industrial-related discharges. Non-industrial-related discharges may be appropriate if they:

1. Are not subject to local Regional Water Board permitting requirements.
2. Do not contain significant quantities of industrial-related pollutants.
3. Are infeasible to eliminate.
4. Are identified and addressed in the SWPPP and monitoring program.
5. Are in compliance with local municipal storm water permittee requirements.

Monitoring Program

The general permit requires development and implementation of a monitoring program. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers must develop and implement a monitoring program prior to commencement of operations, but no earlier than January 1, 1993. The objectives of the monitoring program are to (1) demonstrate compliance with the permit, (2) aid in the implementation of the SWPPP, and (3) measure the effectiveness of the BMPs in removing pollutants in industrial storm water discharge.

All dischargers (with the exception of inactive mining operations) are required to:

1. Perform visual observations during the dry and wet seasons. Dry season observations are required to verify that non-storm water discharges have been eliminated. Wet season

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observations are required to aid dischargers in evaluating the effectiveness of the SWPPP.

2. Conduct an annual inspection to determine compliance with this general permit.

3. Perform or participate in a sampling and analysis program. Analysis must include pH, total suspended solids (TSS), total organic carbon (TOC), specific conductance, toxic substances, and other pollutants which are likely to be present in storm water discharges in significant quantities. Dischargers subject to federal storm water effluent limitations guidelines in 40 CFR Subchapter N must also sample and analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N.

Dischargers are not required to collect samples or perform visual observations during adverse climatic conditions. Sample collection and visual observations are required only during scheduled facility operating hours or within two hours after scheduled facility operating hours. Visual observations are required only during daylight hours. Dischargers that are unable to collect any of the required samples or visual observations because of the above circumstances must provide documentation to the Regional Water Board in their annual report.

Dischargers may be exempt from performing sampling and analysis if they: (1) do not have areas of industrial activity exposed to storm water, (2) receive certification from a local agency which has jurisdiction over the storm sewer system that the discharger has developed and implemented an effective SWPPP and should not be required to sample, or (3) receive an exemption from the appropriate Regional Water Board. Dischargers must always perform sampling and analysis for any pollutant specified in storm water effluent limitations guidelines.

Local agencies that wish to provide certifications to dischargers within their jurisdiction should develop a certification program that clearly indicates the certification procedures and criteria used by the local agency. At a minimum, these programs should include site inspections, a review of the dischargers' SWPPP, and a review of other records such as monitoring data, receiving water data, etc. It is recommended that the certification program be sent to the local Regional Water Board for review and comment prior to implementation.

Group Monitoring

Each discharger may either perform sampling and analysis individually or participate in a group sampling program. A group monitoring program may be developed either by an entity

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representing a group of similar facilities or by a local agency which holds a storm water permit for a municipal separate storm sewer system, for industrial facilities within its jurisdiction. The entity or local agency responsible for the group monitoring program must perform sampling at a minimum of 20 percent of the facilities within the group (and at least four dischargers in a group of less than 20 dischargers). The facilities selected for sampling must be representative of all the facilities in the group. Dischargers subject to federal effluent limitations guidelines in 40 CFR Subchapter N must individually sample and analyze for pollutants listed in the appropriate federal regulations.

Facilities within a group may be located within the jurisdiction of more than one Regional Water Board. Multi-Regional Water Board groups must receive the approval of the State Water Board Executive Director (with the concurrence of the appropriate Regional Water Boards). Groups may request variance from the minimum 20 percent (and a minimum of four facilities for groups of less than 20 dischargers) with adequate justification. As a minimum, the justification should: (1) explain the need for the variance, and (2) show that the variance, if approved, will result in representative monitoring data.

Each entity or local agency responsible for group sampling must: (1) ensure that the monitoring is done correctly, (2) recommend appropriate BMPs to reduce pollutants in storm water discharges from group participants, and (3) evaluate and report the monitoring data to the appropriate Regional Water Board(s).

All group monitoring plans are subject to Regional Water Board(s) review. Consistent with the four-tier permitting strategy described in the federal regulations, the Regional Water Board(s) will evaluate the data and results from group monitoring to establish future permitting decisions. As appropriate, Regional Water Board(s) may terminate or require substantial amendment to the group monitoring plans, dependent, in part, on the group's overall success in meeting the objectives of the Permit.

The State Water Board recognizes that the group monitoring option will result in fewer facilities monitored. The State Water Board believes that this is a desirable trade-off for the following reasons:

1. Review of monitoring data from all individual facilities is administratively burdensome.

2. Monitoring of fewer facilities, but with more parameters and better quality control, will result in more accurate and meaningful monitoring data.

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3. Group monitoring is consistent with USEPA's four-tier permitting strategy.

4. As no numeric limits are specified in the Permit (with the exception of 40 CFR Subchapter N facilities), implementation of a SWPPP, performance of visual monitoring, and performance of an annual inspection are consistent with the minimum monitoring requirements of the CWA.

5. Data from group monitoring programs will be indicative of the effectiveness of BMPs to control pollution in storm water discharge. Additional BMPs, useful to the entire group, may be developed from the monitoring data.

6. A large percentage of dischargers are small businesses which do not have the regulatory sophistication, organizational structure, or resources to conduct an adequate individual monitoring program.

Retention of Records

The discharger is required to retain records of all monitoring information, copies of all reports required by this permit, and records of all data used to complete the NOI, for a period of five years from the date of measurement, report, or application. This period may be extended by the State and/or Regional Water Boards. All records are public documents.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
WATER QUALITY ORDER NO. 91-13-DWQ
(AS AMENDED BY WATER QUALITY ORDER NO. 92-12-DWQ)
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT NO. CAS000001

WASTE DISCHARGE REQUIREMENTS (WDRS)
FOR
DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES
EXCLUDING CONSTRUCTION ACTIVITIES

The State Water Board finds that:

1. Federal regulations for storm water discharges were issued by the U.S. Environmental Protection Agency on November 16, 1990 (40 Code of Federal Regulations (CFR) Parts 122, 123, and 124). The regulations require specific categories of facilities, which discharge storm water associated with industrial activity (storm water), to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate industrial storm water pollution.

2. This general permit shall regulate discharges of storm water from specific categories of industrial facilities identified in Attachment 1, excluding discharges covered by existing NPDES permits which already include provisions regulating discharges of storm water, discharges from construction activities, or discharges determined ineligible for coverage by this general permit by the California Regional Water Quality Control Boards (Regional Water Boards). Attachment 2 contains the addresses and telephone numbers of each Regional Water Board office.

3. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual general permit by October 1, 1992. The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for industrial groups at this time.

4. This general permit does not preempt or supersede the authority of local agencies to prohibit, restrict, or control discharges of storm water to storm drain systems or other watercourses within their jurisdictions, as allowed by State and federal law.

5. To obtain authorization for continued and future storm water discharge pursuant to this general permit, owners, or operators when the owners does not operate the facility (dischargers), must submit a Notice of Intent (NOI) and appropriate fee to the State Water Board. Dischargers who

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submit a NOI and appropriate fee are authorized to discharge storm water under the terms and conditions of this general permit.

6. If an individual NPDES general permit is issued to a discharger otherwise subject to this general permit, or an alternative general permit is subsequently adopted which covers storm water discharges regulated by this general permit, the applicability of this general permit to such discharges is automatically terminated on the effective date of the individual general permit or the date of approval for coverage under the subsequent general permit.

7. Effluent limitations, and toxic and effluent standards established in Sections 208(b), 301, 302, 303(d), 304, 306, 307, and 403 of the Federal Clean Water Act (CWA), as amended, are applicable to storm water discharges regulated by this general permit.

8. This action to adopt a NPDES general permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

9. The State Water Board adopted the California Ocean Plan on March 22, 1990, and the California Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan on April 11, 1991. In addition, the Regional Water Boards have adopted and the State Water Board has approved Water Quality Control Plans (Basin Plans).

   Discharges regulated by this general permit must be in compliance with the water quality standards in these Plans, and subsequent amendments thereto. The State Water Board shall, by April 1996, determine what further actions are appropriate to ensure that discharges subject to this general permit are in compliance with the numerical objectives in the Inland Surface Waters Plan and the Enclosed Bays and Estuaries Plan.

10. Federal regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories.

11. For facilities which do not have established numeric effluent limitations for storm water discharges in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. This is due to the large number of discharges and the complex nature of storm water discharges.

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12. Implementation of the provisions of this general permit constitutes compliance with BAT/BCT requirements, and with requirements to achieve water quality standards.

13. Best Management Practices (BMPs) to control and abate the discharge of pollutants in storm water discharges are authorized where numeric effluent limits are infeasible and the BMPs are reasonably necessary to achieve compliance with effluent limitations or water quality standards.

14. Following adoption of this general permit, the Regional Water Boards shall enforce the provisions of this general permit including the monitoring and reporting requirements.

15. Following public notice in accordance with State and Federal law and regulations, the State Water Board, in a public hearing held September 3, 1991, heard, considered, and responded to all comments pertaining to this general permit.

16. This Order is a NPDES general permit in compliance with Section 402 of the Clean Water Act and shall take effect upon adoption by the State Water Board.

IT IS HEREBY ORDERED that all dischargers that file a NOI indicating their intention to be regulated under the provisions of this general permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of material other than storm water, which are not otherwise regulated by a NPDES permit, to a storm sewer system or waters of the nation are prohibited.

2. Storm water discharges for those facilities listed in Category I of Attachment 1 of this general permit shall not exceed the numeric effluent limitations as specified in Federal Regulations (40 CFR Subchapter N). Dischargers subject to those regulations who do not have or are unable to obtain copies of the pertinent regulations from other sources (e.g., Government Printing Office) should contact the:

   State Water Resources Control Board
   Division of Water Quality
   P.O. Box 1977
   Sacramento, CA 95812-1977
   Attn: Storm Water Permitting Unit

3. Storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

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4. Storm water discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

B. RECEIVING WATER LIMITATIONS:

1. Storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. Storm water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters Plan, Enclosed Bays and Estuaries Plan, or the applicable Regional Water Boards' Basin Plan.

C. PROVISIONS

1. All dischargers must submit an NOI and appropriate fee for each facility covered by this general permit in accordance with Attachment 3: Notice of Intent--General Instructions.

2. All dischargers must develop and implement a Storm Water Pollution Prevention Plan for each facility covered by this general permit in accordance with Section A: Storm Water Pollution Prevention Plan.

3. All dischargers must develop and implement a Monitoring and Reporting Program Plan for each facility covered by this general permit in accordance with Section B: Monitoring Program and Reporting Requirements.

4. Feedlots as defined in 40 CFR Part 412 that are in full compliance with Section 2560 to Section 2565, Title 23, California Code of Regulations (Chapter 15) will be in compliance with all effluent limitations and prohibitions contained in this general permit. Feedlots must comply with any Regional Water Board WDRs or NPDES general permit regulating their storm water discharge. Feedlots that comply with Chapter 15, however, must perform monitoring in compliance with the requirements of Provisions 5(c) and 16 of Section B: Monitoring Program and Reporting Requirements.

5. All dischargers must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or other water courses under their jurisdiction, including applicable requirements in

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12. Implementation of the provisions of this general permit constitutes compliance with BAT/BCT requirements, and with requirements to achieve water quality standards.

13. Best Management Practices (BMPs) to control and abate the discharge of pollutants in storm water discharges are authorized where numeric effluent limits are infeasible and the BMPs are reasonably necessary to achieve compliance with effluent limitations or water quality standards.

14. Following adoption of this general permit, the Regional Water Boards shall enforce the provisions of this general permit including the monitoring and reporting requirements.

15. Following public notice in accordance with State and Federal law and regulations, the State Water Board, in a public hearing held September 3, 1991, heard, considered, and responded to all comments pertaining to this general permit.

16. This Order is a NPDES general permit in compliance with Section 402 of the Clean Water Act and shall take effect upon adoption by the State Water Board.

IT IS HEREBY ORDERED that all dischargers that file a NOI indicating their intention to be regulated under the provisions of this general permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of material other than storm water, which are not otherwise regulated by a NPDES permit, to a storm sewer system or waters of the nation are prohibited.

2. Storm water discharges for those facilities listed in Category I of Attachment 1 of this general permit shall not exceed the numeric effluent limitations as specified in Federal Regulations (40 CFR Subchapter N). Dischargers subject to those regulations who do not have or are unable to obtain copies of the pertinent regulations from other sources (e.g., Government Printing Office) should contact the:

   State Water Resources Control Board
   Division of Water Quality
   P.O. Box 1977
   Sacramento, CA 95812-1977
   Attn: Storm Water Permitting Unit

3. Storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

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4. Storm water discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

B. RECEIVING WATER LIMITATIONS:

1. Storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. Storm water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters Plan, Enclosed Bays and Estuaries Plan, or the applicable Regional Water Boards' Basin Plan.

C. PROVISIONS

1. All dischargers must submit an NOI and appropriate fee for each facility covered by this general permit in accordance with Attachment 3: Notice of Intent--General Instructions.

2. All dischargers must develop and implement a Storm Water Pollution Prevention Plan for each facility covered by this general permit in accordance with Section A: Storm Water Pollution Prevention Plan.

3. All dischargers must develop and implement a Monitoring and Reporting Program Plan for each facility covered by this general permit in accordance with Section B: Monitoring Program and Reporting Requirements.

4. Feedlots as defined in 40 CFR Part 412 that are in full compliance with Section 2560 to Section 2565, Title 23, California Code of Regulations (Chapter 15) will be in compliance with all effluent limitations and prohibitions contained in this general permit. Feedlots must comply with any Regional Water Board WDRs or NPDES general permit regulating their storm water discharge. Feedlots that comply with Chapter 15, however, must perform monitoring in compliance with the requirements of Provisions 5(c) and 16 of Section B: Monitoring Program and Reporting Requirements.

5. All dischargers must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or other water courses under their jurisdiction, including applicable requirements in

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municipal storm water management programs developed to comply with NPDES general permits issued by the Regional Water Boards to local agencies.

6. All dischargers must comply with the standard provisions and reporting requirements for each facility covered by this general permit contained in Section C: Standard Provisions.

7. This general permit will expire on November 19, 1996. Upon reissuance of the NPDES general permit by the State Water Board, the facilities subject to this reissued general permit are required to file a revised NOI.

D. REGIONAL WATER BOARD AUTHORITIES

1. Following adoption of this general permit, Regional Water Boards shall:

   (a) Implement the provisions of this general permit, including, but not limited to, reviewing storm water pollution prevention plans, reviewing group monitoring plans, reviewing monitoring reports, conducting compliance inspections, and taking enforcement actions.

   (b) Issue general permits as they deem appropriate to individual dischargers, categories of dischargers, or dischargers in a geographic area. Upon issuance of such general permits by a Regional Water Board, the affected dischargers shall no longer be regulated by this general permit. The new general permits may address additional storm water pollution prevention plan requirements, more stringent effluent limitations, or additional monitoring and reporting program requirements.

2. Regional Water Boards may provide guidance to dischargers on Storm Water Pollution Prevention Plan and Monitoring Program implementation.

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CERTIFICATION

The undersigned, Administrative Assistant to the State Water Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 19, 1991 (as amended by Water Quality Order No. 92-12-DWQ).

AYE: W. Don Maughan
Edwin H. Finster
Eliseo M. Samaniego
John P. Caffrey

NO: None

ABSENT: None

ABSTAIN: None

/s/
Maureen Marché
Administrative Assistant to the Board

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Section A: STORM WATER POLLUTION PREVENTION PLAN

1. A storm water pollution prevention plan (SWPPP) shall be developed and implemented for each facility covered by this general permit. The SWPPP shall be designed to comply with BAT/BCT and be certified in accordance with the signatory requirements of Standard Provision C.9. For existing facilities (and new facilities beginning operations before October 1, 1992), a SWPPP shall be developed and implemented no later than October 1, 1992. For facilities beginning operations after October 1, 1992, a SWPPP shall be developed prior to submitting a NOI and implemented when the facility begins operations. The SWPPP shall be retained onsite and made available upon request of a representative of the Regional Water Board and/or local storm water management agency (local agency) which receives the storm water discharge.

2. The Regional Water Board and/or local agency may notify the discharger when the SWPPP does not meet one or more of the minimum requirements of this Section. Within 30 days of notice, the discharger shall submit a time schedule that meets the minimum requirements of this section to the Regional Water Board and/or local agency that requested the changes. After making the required changes, the discharger shall provide written certification that the changes have been made.

3. The discharger shall amend the SWPPP whenever there is a change in construction, operation, or maintenance which may effect the discharge of significant quantities of pollutants to surface water, ground waters, or the local agency's storm drain system. The SWPPP should also be amended if it is in violation of any conditions of this general permit, or has not achieved the general objectives of controlling pollutants in storm water discharges.

4. The SWPPP shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from the facility. The SWPPP shall include, at a minimum, the following items:

   a. A map extending approximately one-quarter mile beyond the property boundaries of the facility, showing: the facility, general topography surface water bodies (including known springs and wells), and the discharge point where the facility's storm water discharges to a municipal storm drain system or other water body. The

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requirements of this paragraph may be included in the site map required under the following paragraph if appropriate.

b. A site map showing:

i. The storm water conveyance and discharge structures;

ii. An outline of the storm water drainage areas for each storm water discharge point;

iii. Paved areas and buildings;

iv. Areas of pollutant contact, actual or potential;

v. Location of existing storm water structural control measures (i.e., berms, coverings, etc.);

vi. Surface water locations;

vii. Areas of existing and potential soil erosion; and

viii. Vehicle service areas.

c. A narrative description of the following:

i. Significant materials that have been treated, stored, disposed, spilled, or leaked in significant quantities in storm water discharge after November 19, 1988;

ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharge;

iii. Material loading, unloading, and access areas;

iv. Existing structural and non-structural control measures (if any) to reduce pollutants in storm water discharge;

v. Industrial storm water discharge treatment facilities (if any);

vi. Methods of on-site storage and disposal of significant materials; and

vii. Outdoor storage, manufacturing, and processing activities including activities that generate significant quantities of dust or particulates.

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d. A list of pollutants that are likely to be present in storm water discharge in significant quantities, and an estimate of the annual quantities of these pollutants in storm water discharge.

e. An estimate of the size of the facility (in acres or square feet), and the percent of the facility that has impervious areas (i.e., pavement, buildings, etc.).

f. A list of significant spills or leaks of toxic or hazardous pollutants to storm water that have occurred after November 19, 1988. This shall include:

   i. Toxic chemicals (listed in 40 CFR Part 372) that have been discharged to storm water as reported on USEPA Form R.

   ii. Oil or hazardous substances in excess of reportable quantities (see 40 CFR Part 110, 117 or 302).

g. A summary of existing sampling data (if any) describing pollutants in storm water discharge.

5. The SWPPP shall describe the storm water management controls appropriate for the facility. The appropriate controls shall reflect identified potential sources of pollutants at the facility. The description of the storm water management controls shall include:

   a. Storm Water Pollution Prevention Personnel. Identify specific individuals (and job titles) who are responsible for developing, implementing, and revising the SWPPP.

   b. Preventive Maintenance. Preventive maintenance involves inspection and maintenance of storm water conveyance system devices (i.e., oil/water separators, catch basins, etc.) and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

   c. Good Housekeeping. Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

   d. Spill Prevention and Response. Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, and clean-up equipment

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and procedures should be identified, as appropriate. Internal reporting procedures for spills of significant materials shall be established.

e. Storm Water Management Practices. Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants to storm water discharges in significant quantities, additional storm water management practices to remove pollutants from storm water discharge shall be implemented.

f. Erosion and Sediment Controls. The SWPPP shall identify measures to reduce sediment in storm water discharges.

g. Employee Training. Employee training programs shall inform all personnel responsible for implementing the SWPPP. Training should address spill response, good housekeeping, and material management practices. Periodic dates for training should be identified.

h. Inspections. All inspections, visual observations and sampling as required by Section B, shall be done by trained personnel. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to these activities.

6. Non-storm water discharges to storm water conveyance systems shall be eliminated prior to implementation of this SWPPP. The SWPPP shall include a certification that non-storm water discharges have been eliminated and a description of any tests for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Such certification may not always be feasible if the discharger (a) must make significant structural changes to eliminate the discharge of non-storm water discharges to the industrial storm water conveyance system, or (b) has applied for, but not yet received, an NPDES general permit for the non-storm water discharges. In such cases, the discharger must notify the appropriate Regional Water Board prior to implementation of the SWPPP that non-storm water discharges cannot be eliminated. The notification shall include justification for a time extension and a schedule, subject to modification by the Regional Water Board, indicating when non-storm water discharges will be eliminated. In no case shall the elimination of non-storm water discharges exceed three years from the NOI submittal date.

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7. The SWPPP may incorporate, by reference, the appropriate elements of other program requirements (i.e., Spill Prevention Control and Countermeasures (SPCC) plans under Section 311 of the CWA, Best Management Programs under 40 CFR 125.100, etc.).

8. The SWPPP is considered a report that shall be available to the public under Section 308(b) of the CWA.

9. The SWPPP shall include the signature and title of the person responsible for preparation of the SWPPP and include the date of initial preparation and each amendment, thereto.

Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

[Note: This Section was modified by Order No. 92-12-DWQ adopted by the State Water Board on September 17, 1992.]

1. Implementation

A monitoring program shall be developed and implemented for each facility covered by this general permit. It shall be certified in accordance with the signatory requirements contained in Standard Provision C.9. A description of the monitoring program shall be retained on site and made available upon request of a representative of the Regional Water Board and/or local agency which receives the storm water discharge.

2. Schedule

For existing facilities (and new facilities beginning operations before January 1, 1993), a monitoring program must be developed and implemented no later than January 1, 1993. For facilities beginning operations after January 1, 1993, a monitoring program shall be developed and implemented concurrent with commencement of industrial activities.

3. Objectives

The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

a. Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in this general permit.

b. Ensure practices at the facility to control pollutants in storm water discharges are evaluated and revised to meet changing conditions.

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c. Aid in the implementation of the Storm Water Pollution Prevention Plan required by Section A of this general permit.

d. Measure the effectiveness of best management practices (BMPs) in removing pollutants in storm water discharge.

4. General Requirements for Monitoring Programs

The monitoring program shall contain:

a. Rationale for selection of monitoring methods.

b. Identification of the analytical methods to detect pollutants in storm water discharge.

c. Description of the sampling methods, sampling locations, and frequency of monitoring.

d. A quality assurance/quality control program to assure that:

i. All elements of the monitoring program are conducted; and

ii. All monitoring is conducted by trained personnel.

e. Procedures and schedules by which the effectiveness of the monitoring program in achieving the objectives above can be evaluated.

5. Specific Requirements for Monitoring Programs

The monitoring program shall document the elimination or reduction of specific pollutants, resulting from the implementation of the SWPPP required by Section A of this general permit.

a. Annual Site Inspection

Except for certain inactive mining operations (See Section B.8), all dischargers shall:

i. Conduct a minimum annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity and to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the general permit or whether additional control measures are needed. A record of the annual

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inspection must include the date of the inspection, the individual(s) who performed the inspection, and the observations.

ii. Certify, based on the annual site inspection, that the facility is in compliance with the requirements of this general permit and its SWPPP. The certification and inspection records must be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. Any noncompliance shall be reported in accordance with Section B.17.

b. Dry Season Observations

No less than twice during the dry season (May through September), all dischargers shall observe and/or test for the presence of non-storm water discharges at all storm water discharge locations. At minimum, all dischargers shall conduct visual observations of flows to determine the presence of stains, sludges, odors, and other abnormal conditions. Dye tests, TV line surveys, and/or analysis and validation of accurate piping schematics may be conducted if appropriate. Records shall be maintained of the description of the method used, date of testing, locations observed, and test results.

c. Wet Season Visual Observations

During the wet season (October through April), all dischargers shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharge[1] to observe the presence of floating and suspended materials, oil and grease, discolorations, turbidity, and odor, etc. Feedlots (subject to federal effluent limitations guidelines in 40 CFR Part 412) that are in compliance with Sections 2560 to 2565, Article 6, Chapter 15, Title 23, California Code of Regulations, shall, instead, conduct monthly inspections of their containment facilities to detect leaks and ensure maintenance of adequate freeboard.

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[1] "Significant storm water discharge" is a continuous discharge of storm water for approximately one hour or more.

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d. Sampling and Analysis

During the wet season (October through April), dischargers (unless exempted per Section B.9 below) shall collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge. The samples should be analyzed for:

i. pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC). Oil and grease (O&G) may be substituted for TOC; and

ii. Toxic chemicals and other pollutants that are likely to be present in storm water discharge in significant quantities.

6. Toxic Pollutant Analysis Reduction

Samples shall be analyzed for toxic chemicals and other pollutants as identified in Sections B.5.d.ii for at least two consecutive sampling events. If toxic chemicals or other pollutants are not detected in significant quantities after two consecutive sampling events, the facility may eliminate that toxic chemical or pollutant from future sampling events. A discharger may analyze for alternative representative parameters (e.g., whole effluent toxicity) as a substitute for the toxic chemicals and other pollutants identified in Section B.5.d.ii as long as the discharger submits the alternative monitoring procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

7. Facilities Subject to Federal Storm Water Effluent Limitations Guidelines

Facilities subject to federal storm water effluent limitations guidelines are defined in Attachment 1 of the general permit. In addition to the requirements in Section B.5 above, these facilities must collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge.

a. Analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N;

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b. Estimate or calculate the volume of effluent discharged from each outfall;

c. Estimate or calculate the mass of each regulated pollutant as defined in the appropriate category of 40 CFR Subchapter N; and

d. Identify the individual(s) performing the estimates or calculations in accordance with Subsections b and c above.

8. Inactive Mining Operations

Inactive mining operations are defined in Attachment 1 of this general permit. Where annual facility inspections, wet season visual observations, dry season observations, and sampling as required by Section B.5 are impracticable, inactive mining operations may instead obtain certification once every three years by a Registered Professional Engineer that a SWPPP has been prepared for the facility and is being implemented in accordance with the requirements of this general permit. By means of these certifications, the engineer, having examined the facility and being familiar with the provisions of this general permit, shall attest to the SWPPP which has been prepared in accordance with good engineering practices. Dischargers which cannot obtain a certification because of noncompliance must notify the appropriate Regional Water Board and, upon request, the local agency which receives the storm water discharge in accordance with Section B.17.

9. Sampling and Analysis Exemptions

A discharger is not required to collect and analyze samples in accordance with Section B.5.d if the discharger certifies that the facility meets all of the conditions set forth below in Section B.9.a, if the discharger obtains the local agency certification described in Section B.9.b, or if the discharger obtains a Regional Water Board exemption as described in Section B.9.d. A discharger who is not required to comply with Section B.5.d monitoring requirements is still required to comply with all other monitoring program and reporting requirements. If exempted from Section B.5.d monitoring requirements, dischargers subject to federal storm water effluent guidelines in 40 CFR Subchapter N must still comply with the provisions of Section B.7 above.

a. Self-Certification

The certification must state that areas of industrial

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activity are not exposed to storm water, including manufacturing, processing, and material handling areas and areas where material handling equipment, raw materials, intermediate products, final products, waste materials, byproducts, and industrial machinery are stored. (See definition of "storm water associated with industrial activity" in Attachment 4 to this general permit.) Exposure includes both direct contact with storm water and the possible release of industrial pollutants into storm water (e.g., spills or leaks). In order to demonstrate that these areas are not exposed to storm water, the following minimum conditions must be met:

i. All illicit (unpermitted) connections to the storm drainage system are eliminated;

ii. All materials must be completely contained at all times;

iii. All unhoused equipment associated with industrial activity is not exposed to storm water; and

iv. All emissions from stacks or air exhaust systems and emission of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

b. Certification by Local Agency

A local agency which has jurisdiction over the storm sewer system or other water course which receives storm water discharge from the discharger's facility has certified in writing that the discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

c. Submittal of Sampling Exemption Certifications

Dischargers must submit sampling exemption certifications to the appropriate Regional Water Board by December 1, 1992 for the 1992-93 wet season and by August 1 for subsequent years. Unless otherwise instructed by the Regional Water Boards, dischargers who file a sampling exemption certification are exempt from Section B.5.d.

d. Exemptions by Regional Water Board

A Regional Water Board may grant an exemption to Section B.5.d monitoring requirements if it determines that a

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discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

10. Group Monitoring

Group monitoring may be done in accordance with the following requirements:

a. A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers (entity) regulated by this general permit or by a local agency which holds a NPDES general permit (local agency permittee) for a municipal separate storm sewer system. Participants in a group monitoring plan may discharge storm water within the boundaries of a single Regional Water Board or within the boundaries of multiple Regional Water Boards (with State Water Board approval).

b. At least 20 percent of the dischargers who are members of a group (and at least 4 dischargers in a group of less than 20 dischargers) must collect and analyze samples in accordance with Section B.5.d. The entity or local agency permittee may request that fewer member dischargers be allowed to collect and analyze, but reasons for this exception must be stated in the group monitoring plan (Section B.10.e.v.). The entity or the local agency permittee shall select facilities from which samples are collected and analyzed which best represent the overall quality of the group members' storm water discharges.

c. The entity or the local agency permittee must have the authority to levy fees against the participating dischargers in the group or be able to otherwise pay for the implementation of the group monitoring plan.

d. The entity or the local agency permittee is responsible for:

   i. Developing and implementing the group monitoring plan;

   ii. Evaluating and reporting group monitoring data;

   iii. Recommending appropriate BMPs to reduce pollutants in storm water discharges;

   iv. Submitting a group monitoring plan to the

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appropriate Regional Water Board(s) and State Water Board, no later than December 1, 1992 and August 1 in subsequent years; and

v. Revising the group monitoring plan as instructed by the Regional Water Board or the State Water Board Executive Director.

e. The group monitoring plan shall:

i. Identify the participants of the group by name and location;

ii. Include a narrative description summarizing the industrial activities of participants of the group and explain why the participants, as a whole, are sufficiently similar to be covered by a group monitoring plan;

iii. Include a list of significant materials stored or exposed to storm water and material management practices currently employed to diminish contact of these materials with storm water discharge;

iv. Identify and describe why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of processes used or materials managed. To the extent possible, representative facilities with the most extended scheduled facility operating hours should be selected;

v. If an exception to the requirement that at least 20 percent of the dischargers in a group (and at least 4 dischargers in a group of less than 20 dischargers) is requested, explain why such an exception is necessary, and how the proposed monitoring will be representative of the entire group; and

vi. Contain all items specified in Section B.4 above.

f. Sampling and analysis must comply with the applicable requirements, including Sections B.5.d, B.6, B.7, and B.11 through 17.

h. Unless otherwise instructed by the Regional Water Board or the State Water Board Executive Director, the group monitoring plan shall be implemented by January 1, 1993 and, in subsequent years, at the beginning of the wet season.

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i. Upon approval of the State Water Board Executive Director, a group may perform representative monitoring which includes dischargers within the boundaries of more than one Regional Water Board area.

j. Upon approval by the appropriate Regional Water Board, a group within a single Regional Water Board area may perform representative monitoring.

k. All dischargers participating in an approved group monitoring plan that have not been selected to perform sampling are required to comply with all other monitoring program and reporting requirements in Sections B.5.a, b, and c.

l. If any group includes members which are subject to federal storm water effluent limitations guidelines, each of those members must perform the monitoring described in Section B.7, and submit the results of the monitoring to the appropriate Regional Water Board in the discharger's annual monitoring report.

11. Sample Locations

Samples shall be collected from all locations where storm water is discharged. Samples must represent the quality and quantity of storm water discharged from the facility. If a facility discharges storm water at multiple locations, the discharger may sample a reduced number of locations if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

12. Sampling Procedure

Sampling shall consist of a grab sample from a storm event that produces significant storm water discharge that is preceded by at least three (3) working days of dry weather. The grab sample should be taken during the first thirty minutes of the discharge. If collection of the grab sample during the first 30 minutes is impracticable, the grab sample can be taken as soon as practicable thereafter, and the discharger shall explain in the annual monitoring report why the grab sample could not be taken in the first 30 minutes. A discharger may select alternative monitoring procedures (e.g., composite sampling) as long as the discharger has submitted the proposed procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

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13. Visual Observation and Sample Collection Exceptions

a. When a discharger is unable to collect any of the required samples or perform visual observations due to adverse climatic conditions (drought, extended freeze, dangerous weather conditions, etc.), a description of why the sampling or visual observations could not be conducted, including documentation of all significant storm water discharge events, must be submitted along with the annual monitoring report.

b. Dischargers are required to collect samples and perform visual observations only if significant storm water discharges commence during scheduled facility operating hours[2], or within two hours following scheduled facility operating hours. Dischargers are required to perform visual observations only within daylight hours. If dischargers do not collect samples or perform visual observations during a significant storm water discharge due to these exceptions, the discharger shall include documentation in the annual monitoring report.

14. Standard Methods

All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this general permit or by the Regional Water Board. All metals shall be reported as total metals. All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Dischargers may conduct their own laboratory analyses only if the discharger has sufficient capability (qualified employees, laboratory equipment, etc.) to adequately perform the test procedures.

[2] "Scheduled facility operating hours" are the time periods when the facility is staffed to conduct any function related to industrial activity, including routine maintenance, but excluding time periods where only emergency response, security, and/or janitorial services are performed.

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15. Records

Records of all storm water monitoring information and copies of all reports required by this general permit shall be retained for a period of at least five years from the date of the sample, observation, measurement, or report.

These records shall include:

a. The date, place, and time of site inspections, sampling, visual observations, and/or measurements;

b. The individual(s) who performed the site inspections, sampling, visual observations, and/or measurements;

c. Flow measurements or estimates (if required);

d. The date and time of analyses;

e. The individual(s) who performed the analyses;

f. The analytical techniques or methods used and the results of such analyses;

g. Quality assurance/quality control results;

h. Dry season observations and wet season visual observation records (see Sections B.5.b & c);

i. Visual observation and sample collection exception records (see Section B.13);

j. All calibration and maintenance records of on-site instruments used; and

k. All original strip chart recordings for continuous monitoring instrumentation.

16. Annual Report

All dischargers shall submit an annual report by July 1 of each year to the Executive Officer of the Regional Water Board responsible for the area in which the facility is located and to the local agency (if requested).

The report shall include a summary of visual observations and sampling results, the certification required in Section B.5.a.ii, and information as required in Section B.13. The

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report shall be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. The first report will be due July 1, 1993.

17. Noncompliance Reporting

Dischargers who cannot certify compliance in accordance with Section B.16 above and/or who have had other instances of noncompliance must notify the appropriate Regional Water Board and/or, upon request, the local agency that receives the storm water drainage. The notifications shall identify the type(s) of noncompliance, describe the actions necessary to achieve compliance, and include a time schedule, subject to the modifications by the Regional Water Board, indicating when compliance will be achieved. Noncompliance notifications must be submitted within 30 days of identification of noncompliance.

Section C: STANDARD PROVISIONS

1. Duty to Comply

The discharger must comply with all of the conditions of this general permit. Any general permit noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action; for general permit termination, revocation and reissuance, or modification; or denial of a general permit renewal application.

The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this general permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

This general permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a general permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any general permit condition.

If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more

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stringent than any limitation on the pollutant in this general permit, this general permit shall be modified, or revoked and reissued to conform to the toxic effluent standard or prohibition, and the discharger so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the general permitted activity in order to maintain compliance with the conditions of this general permit.

4. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this general permit which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this general permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems, installed by a discharger when necessary to achieve compliance with the conditions of this general permit.

6. Property Rights

This general permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

7. Duty to Provide Information

The discharger shall furnish the Regional Water Board, State Water Board, USEPA, or local storm water management agency within a reasonable time specified by the agencies, any requested information to determine compliance with this general permit. The discharger shall also furnish, upon request, copies of records required to be kept by this general permit.

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8. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, USEPA, and local storm water management agency upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this general permit;

b. Have access to and copy at reasonable times, any records that must be kept under the conditions of this general permit;

c. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment) that are related to or may impact storm water discharge; and

d. Sample or monitor at reasonable times for the purpose of ensuring general permit compliance.

9. Signatory Requirements

a. All Notices of Intent submitted to the State Water Board shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of the facility if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. The principal executive officer of a Federal agency includes the chief executive officer of the agency, or the senior executive officer having responsibility for the overall operations of a

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principal geographic unit of the agency (e.g. Regional Administrators of USEPA).

b. All reports, certification, or other information required by the general permit or requested by the Regional Water Board, State Water Board, USEPA, or local storm water management agency shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above and retained as part of the Storm Water Pollution Prevention Plan.

(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

(3) If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization must be attached to the Storm Water Pollution Prevention Plan prior to submittal of any reports, certifications, or information signed by the authorized representative.

10. **Certification**

Any person signing documents under Provision 9 shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information,

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including the possibility of fine and imprisonment for knowing violations."

11. Reporting Requirements

a. Planned changes: The discharger shall give notice to the Regional Water Board and local storm water management agency as soon as possible of any planned physical alteration or additions to the general permitted facility. Notice is required under this provision only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged.

b. Anticipated noncompliance: The discharger will give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the permitted facility or activity which may result in noncompliance with general permit requirements.

c. Compliance schedules: Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this general permit shall be submitted no later than 14 days following each schedule date.

d. Noncompliance reporting: The discharger shall report any noncompliance at the time monitoring reports are submitted. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

12. Oil and Hazardous Substance Liability

Nothing in this general permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject under Section 311 of the CWA.

13. Severability

The provisions of this general permit are severable, and if any provision of this general permit, or the application of any provision of this general permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this general permit

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shall not be affected thereby.

14. Reopener Clause [modified by Order No. 92-12-DWQ, September 1992]

This general permit may be modified, revoked, and reissued, or terminated for cause due to promulgation of amended regulations, receipt of USEPA guidance concerning regulated activities, judicial decision, or in accordance with 40 CFR 122.62, 122.63, 122.64, and 124.5.

15. Penalties for Violations of General Permit Conditions.

a. Section 309 of the CWA provides significant penalties for any person who violates a general permit condition implementing Sections 301, 302, 306, 307 308, 318, or 405 of the CWA, or any general permit condition or limitation implementing any such section in a general permit issued under Section 402. Any person who violates any general permit condition of this general permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, in some cases greater than those under the CWA.

16. Availability

A copy of this general permit shall be maintained at the discharge facility and be available at all times to operating personnel.

17. Transfers

This general permit is not transferable to any person. A new owner or operator of an existing facility must submit a NOI in accordance with the requirements of this general permit to be authorized to discharge under this general permit.

18. Continuation of Expired General Permit

This general permit continues in force and effect until a new general permit is issued or the State Water Board rescinds the general permit. Only those dischargers authorized to discharge under the expiring general permit are covered by the continued general permit.

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19. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this general permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or by both.

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ATTACHMENT 1

FACILITIES COVERED BY THIS GENERAL PERMIT

Industrial facilities include Federal, State, municipally owned, and private facilities from the following categories:

1. FACILITIES SUBJECT TO STORM WATER EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS, OR TOXIC POLLUTANT EFFLUENT STANDARDS (40 CFR SUBCHAPTER N). Currently, categories of facilities subject to storm water effluent limitations guidelines are Cement Manufacturing (40 CFR Part 411), Feedlots (40 CFR Part 412), Fertilizer Manufacturing (40 CFR Part 418), Petroleum Refining (40 CFR Part 419), Phosphate Manufacturing (40 CFR Part 422), Steam Electric (40 CFR Part 423), Coal Mining (40 CFR Part 434), Mineral Mining and Processing (40 CFR Part 436), Ore Mining and Dressing (40 CFR Part 440), and Asphalt Emulsion (40 CFR Part 443).

2. MANUFACTURING FACILITIES: Standard Industrial Classifications (SICs) 24 (except 2411 and 2434), 26 (except 265 and 267), 28 (except 283 and 285) 29, 311, 32 (except 323), 33, 3441, and 373.

3. OIL AND GAS/MINING FACILITIES: SICs 10 through 14 including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l) because of performance bond issued to the facility by the appropriate Surface Mining Control and Reclamation Act (SMCRA) authority has been released, or except for area of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge stormwater contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products, or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined material, or sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim.

4. HAZARDOUS WASTE TREATMENT, STORAGE, OR DISPOSAL FACILITIES: Includes those operating under interim status or a general permit under Subtitle C of the federal Resource Conservation and Recovery Act (RCRA).

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5. LANDFILLS, LAND APPLICATION SITES, AND OPEN DUMPS: Sites that receive or have received industrial waste from any of the facilities covered by this general permit, sites subject to regulation under Subtitle D of RCRA, and sites that have accepted wastes from construction activities (construction activities include any clearing, grading, or excavation that results in disturbance of five acres or more).

6. RECYCLING FACILITIES: SICs 5015 and 5093. These codes include metal scrapyards, battery reclaimers, salvage yards, motor vehicle dismantlers and wreckers, and recycling facilities that are engaged in assembling, breaking up, sorting, and wholesale distribution of scrap and waste material such as bottles, wastepaper, textile wastes, oil waste, etc.

7. STEAM ELECTRIC POWER GENERATING FACILITIES: Includes any facility that generates steam for electric power through the combustion of coal, oil, wood, etc.

8. TRANSPORTATION FACILITIES: SICs 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication) or other operations identified herein that are associated with industrial activity.

9. SEWAGE OR WASTEWATER TREATMENT WORKS: Facilities used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day or more, or required to have an approved pretreatment program under 40 CFR Part 403. Not included are farm lands, domestic gardens, or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with Section 405 of the CWA.

11. MANUFACTURING FACILITIES WHERE MATERIALS ARE <u>EXPOSED</u> TO STORM WATER: SICs 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, and 4221-4225.

Note: Category 10, Construction activity, is covered by a separate general permit.

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Storm Water Contacts for the State and Regional Boards

STATE WATER RESOURCES CONTROL BOARD
Division of Water Quality Regional Water
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977
(916) 657-0919 FAX: (916) 657-2388
Contact: Bruce Fujimoto

1) NORTH COAST REGION
Mr. Benjamin D. Kor, Executive Officer
5550 Skyline Boulevard, Suite A
Santa Rosa, CA 94503
(707) 576-2220 FAX: (707) 523-0135
Contact: Nathan Quarles

2) SAN FRANCISCO BAY REGION
Mr. Steven R. Ritchie, Executive Officer
2101 Webster Street, Suite 500
Oakland, CA 94612
(510) 286-1255 FAX: (510) 286-1380
Contact: Tom Mumley

3) CENTRAL COAST REGION
Mr. Roger W. Briggs, Executive Officer
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5427
(805) 549-3147 FAX: (805) 543-0397
Contact: Adam White

4) LOS ANGELES REGION
Mr. Robert P. Ghirelli, Executive Officer
101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213) 266-7596 FAX: (213) 266-7600
Contact: Mark Pumford

5R) CENTRAL VALLEY REGION
Redding Branch Office
Mr. James C. Pedri, Supervising Engineer
415 Knollcrest Drive, Redding, CA 96002
(916) 224-4849 FAX: (916) 224-4857
Contact: Carole Crowe

5S) CENTRAL VALLEY REGION
Sacramento Office
Mr. William H. Crooks, Executive Officer
3443 Routier Road
Sacramento, CA 95827-3098
(916) 255-3000 FAX: (916) 255-3015
Contact: Pamela Barksdale

5F) CENTRAL VALLEY REGION
Fresno Branch Office
Mr. Loren J. Harlow, Principal Engineer
3614 East Ashlan Avenue
Fresno, CA 93726
(209) 445-5116 FAX: (209) 445-5910
Contact: Darrel Evensen

6SLT) LAHONTAN REGION
South Lake Tahoe Office
Mr. Harold J. Singer, Executive Officer
2092 Lake Tahoe Boulevard, Suite 2
South Lake Tahoe, CA 96150
(916) 542-5400 FAX: (916) 544-2271
Contact: John Short

6V) LAHONTAN REGION
Victorville Office
Mr. Hisam Bagai, Supervising Engineer
15428 Civic Drive, Suite 100
Victorville, CA 92392
(619) 241-6583 FAX: (619) 241-7308
Contact: Tom Rheiner

7) COLORADO RIVER BASIN REGION
Mr. Philip Gruenberg, Executive Officer
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
(619) 346-7491 FAX: (619) 341-6820
Contact: Orlando Gonzalez

8) SANTA ANA REGION
Mr. Gerard J. Thibeault, Executive Officer
2010 Iowa Avenue, Suite 100
Riverside, CA 92507-2409
(909) 782-4130 FAX: (909) 781-6288
Contact: Pavlova Vitale

9) SAN DIEGO REGION
Mr. Arthur L. Coe, Executive Officer
9771 Clairemont Mesa Boulevard, Suite B
San Diego, CA 92124
(619) 467-2952 FAX: (619) 571-6972
Contact: Deborah Jayne

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ATTACHMENT 3

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

NOTICE OF INTENT (NOI) TO COMPLY WITH THE TERMS OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES EXCLUDING CONSTRUCTION ACTIVITIES

GENERAL INSTRUCTIONS

Updated October 15, 1992

Who Must Submit

Facilities which have been defined by the USEPA regulations as having "storm water discharges associated with industrial activity" must obtain coverage under an NPDES permit for their storm water discharges. Facilities requiring coverage are defined in 40 CFR Section 122.26(b)(14). All facilities in California except those listed below, may seek coverage under the State Water Board's NPDES general permit.

Facilities Not Covered By This General Permit

Storm water discharges from the following facilities may not obtain coverage by this general permit:

a. Facilities in Santa Clara County which drain to San Francisco Bay must seek coverage under a separate general permit issued by the San Francisco Bay Regional Water Board.

b. Facilities with an existing NPDES permit that specifically limits and regulates storm water discharges.

c. Construction activities greater than five acres must obtain coverage under the NPDES construction activity storm water general permit.

d. Facilities on Indian lands will be regulated by the USEPA.

e. Logging Activities.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
P.O. Box 1977
Sacramento, CA 95812-1977
Attn: Storm Water Permitting Unit

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When to Apply

Owners/operators of existing facilities must file a NOI, along with the appropriate annual fee, prior to March 30, 1992. Owners/operators of new facilities (those beginning operations after March 30, 1992) must file a NOI at least 30 days prior to the beginning of operations. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late.

Fees

The annual fee is $250.00 for each facility which discharges into a municipal separate storm sewer system regulated by an areawide urban storm water general permit and $500.00 for all other facilities.

Facilities that have either a NPDES permit or waste discharge requirements (WDRs) and already pay an annual fee are not subject to an additional fee for the storm water general permit. Feedlots subject to this general permit will pay a one-time only fee of $2,000. Feedlots that already have a NPDES general permit or WDRs and have paid the $2,000 fee do not have to pay an additional fee for the storm water general permit.

Completing the NOI

Completion and submittal of the attached NOI (Form NOI-1) is required to gain coverage under the general permit. It must be completely and accurately filled out. A facility will be considered to be covered by the general permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. Each discharger will be given a distinct identification number. Upon receipt of the NOI and fee, each discharger will be sent a letter containing the discharger's identification number.

Questions?

If you have any questions completing the NOI after reading the following line-by-line instructions, please call the appropriate Regional Water Board or the State Water Board at (916) 657-0919.

NOI--LINE-BY LINE INSTRUCTIONS

The NOI consists of two parts--a NOI Form (Form NOI-1) and a site map. Please type or letter when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for an existing facility, box 2 if the facility is new (has not started operations), and box 3

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if the NOI is being submitted to report changes to a facility already covered by the general permit. An example of a change that warrants a resubmittal of the NOI would be a change of owner/operator of a facility. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID number must be included.

SECTION I--OWNER/OPERATOR

Enter the name of the person, company, firm, public organization, or any other entity which owns the facility (or operates the facility when the owner does not operate the facility) and check the box corresponding to the appropriate ownership status of the facility. The owner/operator information may or may not be the same as the facility information requested in Section II.

SECTION II--FACILITY/SITE INFORMATION

Enter the facility's official or legal name and provide the address, county, and contact person information for the facility. Facilities that do not have a street address must attach to the NOI a legal description of the facility site. The contact person should be the plant or site manager completely familiar with the facility and charged with compliance and oversight of the general permit.

SECTION III--BILLING ADDRESS

To continue coverage under the general permit, the annual fee must be paid. Use this section to indicate whether the annual fee invoices should be sent to the owner/operator, facility, or other party (include address).

SECTION IV--RECEIVING WATER INFORMATION

In Part A of this section, the owner/operator is required to indicate whether the facility's storm water runoff discharges to a separate storm sewer system, directly to waters of the United States, or indirectly to waters of the United States.

Discharges to separate storm sewer systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the United States will typically have an outfall structure directly from the facility to a river, creek, lake, ocean, etc. Indirect discharges are those that may flow over adjacent properties or right-of-ways prior to discharging to waters of the United States.

Regardless of point of discharge, the applicant must determine the closest receiving water for its storm water discharge. If

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discharge is to a separate storm sewer system, the owner of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V--INDUSTRIAL INFORMATION

Part A of this section requests the owner/operator to provide the standard industrial classification (SIC) codes(s) which best describes the industrial activity taking place at your facility. Briefly describe the nature of business in Part B. In Part C, check the general industrial activities that take place at the facility.

SECTION VI--MATERIAL HANDLING/MANAGEMENT PRACTICES

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If other types of materials other than those listed are maintained on site, please check "other" and describe the type of material.

Part B of this section requests information on any existing management practices employed at the facility. Check the appropriate categories or list other control measures you use at your facility. If none are used, leave this part blank.

SECTION VII--FACILITY INFORMATION

List the size, in acres or square feet, of the facility and the percentage of the site that is impervious.

SECTION VIII--REGULATORY STATUS

Check the appropriate box(es) and indicate the identification number of any permits currently in effect at the facility.

SECTION IX--CERTIFICATION

This section should be read by the owner/operator. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner/operator to certify that the provisions in the general permit will be complied with.

The NOI must be signed by:

For a Corporation: a responsible corporate officer (or authorized individual).

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For a Partnership or Sole Proprietorship: a general partner or the proprietor, respectively.

For a Municipality, State, or other non-federal Public Agency: either a principal executive officer or ranking elected official.

For a Federal Agency: either the chief or senior executive officer of the agency.

SITE MAP

Provide a "to scale" drawing of the site and its immediate surroundings. Include as much detail about the site as possible. At a minimum, show buildings, material handling areas, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets. The attached form may be used, if convenient. Thomas Guide maps, local street maps, or USGS quadrangle maps may be used to indicate the location of the facility if appropriate (e.g., very large facilities). The source of map and map number, or other identifiers should be shown in the lower left hand corner of the site map.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH INDUSTRIAL ACTIVITY (WQ ORDER Nos. (91-13 DWQ & 92-12-DWQ)
(Excluding Construction Activities)

MARK ONLY ONE ITEM	1. [ ] Existing Facility 2. [ ] New Facility	3. [ ] Change of Information WDID #

I. OWNER / OPERATOR

Name			A. Owner/Operator Type (Check one) 1. [ ] City 2. [ ] County 3. [ ] State 4. [ ] Federal 5. [ ] Special District 6. [ ] Gov. Combo 7. [ ] Private
Mailing Address			
City	State	Zip	Phone
Contact Person			B. 1. [ ] Owner 2. [ ] Operator 3. [ ] Owner/Operator

II. FACILITY / SITE INFORMATION

Facility Name			County
Street Address			Contact Person
City	State C I A	Zip	Phone

III. BILLING ADDRESS

Send to: [ ] OWNER / OPERATOR [ ] FACILITY [ ] OTHER (Enter information at right)	Name		
	Mailing Address		
	City	State	Zip

IV. RECEIVING WATER INFORMATION

A. Does your sites's storm water discharge to (Check one):

1. [ ] Storm drain system - Enter owners name
2. [ ] Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. [ ] Indirectly to waters of U.S.

B. Name of closest receiving water

STATE USE ONLY

WDID:	Regional Board Office	Date Permit Issued:	
NPDES Permit Number: CA	Order Number:	Fee Amount Received: $	Date NOI Received:

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V. INDUSTRIAL INFORMATION

A. SIC Code(s) 1. | | | | | 2. | | | | |
3. | | | | | 4. | | | | |

B. Type of Business

C. Industrial activities at facility (Check all that apply)

1. [ ] Manufacturing
2. [ ] Vehicle Maintenance
3. [ ] Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4. [ ] Material Storage
5. [ ] Vehicle Storage
6. [ ] Material Handling
7. [ ] Wastewater Treatment
8. [ ] Power Generation
9. [ ] Recycling
10. [ ] Landfill
99. [ ] Other: _____

VI. MATERIAL HANDLING / MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors (Check all that apply)

1. [ ] Solvents
2. [ ] Scrip Metal
3. [ ] Petroleum Products
4. [ ] Plating Products
5. [ ] Pesticides
6. [ ] Hazardous Wastes
7. [ ] Paints
8. [ ] Wood Treating Products
99. [ ] Other (Please list)

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges (Check all that apply)

1. [ ] Oil/Water Separator
2. [ ] Containment
3. [ ] Berms
4. [ ] Leachate Collection
5. [ ] Overhead Coverage
6. [ ] Recycling
7. [ ] Retention Facilities
8. [ ] Chemical Treatment
99. [ ] Other (Please list)

VII. FACILITY INFORMATION

A. Total size of site (Check one)

| | | | | | | | [ ] Acres [ ] Sq. Ft.

B. Percent of site impervious (including rooftops)

| | | | | %

VIII. REGULATORY STATUS (Check all that apply)

A. [ ] Regulated by Storm Water Effluent Guidelines (40 CFR Subchapter N)

B. [ ] Waste Discharge Requirements (Order Number) | | | | | | | | |

C. [ ] NPDES Permit CA | | | | | | | | |

D. [ ] RCRA Permit Number | | | | | | | | | | | | | | | | |

E. [ ] Regulated by California Code of Regulations Article 6, Chapter 15 (Feedlots).

IX. CERTIFICATIONS

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date _____

Title: _____

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ATTACHMENT 4

DEFINITIONS

1. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

2. Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500 as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; 33 USC. 1251 et seq.

3. "Facility" is a collection of industrial processes discharging storm water associated with industrial activity within the property boundary of operational unit.

4. "Non-Storm Water Discharge" means any discharge to storm sewer systems that is not composed entirely of storm water except discharges pursuant to a NPDES permit and discharges resulting from fire fighting activities. (See fact sheet, page 8, for clarification on non-storm water dischargers unrelated to industrial activity).

5. "Significant Materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERLCA); any chemical the facility is required to report pursuant to Section 313 of Title III of Superfund Amendments and Reauthorization Act (SARA); fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

6. "Significant Quantities" is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and cause or contribute to a violation of any applicable water quality standards for the receiving water.

7. "Storm water" means storm water runoff, snow melt runoff, and surface runoff and drainage. It excludes infiltration and runoff from agricultural land.

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8. "Storm Water Associated with Industrial Activity" means "the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program. The term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR Part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The term also includes storm water discharges from all areas listed in the previous sentence (except access roads) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery <u>are exposed to storm water</u>. Material handling activities include the: storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product, or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are federally, state, or municipally owned or operated that meet the description of the facilities listed in this paragraph) include those facilities designated under 40 CFR 122.26(a)(1)(v).

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STORM REPORT

REGIONAL WATER QUALITY CONTROL BOARD - LOS ANGELES
Vol. 1 - April 1994

We are now into our second monitoring season since the adoption of the General Permit for Storm Water Discharges Associated with Industrial Activities. Many industries are still unsure of what is required of them in order to comply with the Permit. This Newsletter provides you with some general guidance and information to assist you in conducting a quick self-evaluation of your compliance with the storm water program requirements.

MONITORING Requirements

Section B of the General Permit establishes requirements for individual site monitoring and for industries that are participating in a group monitoring plan. Many of the requirements are the same for every industry that has submitted a Notice of Intent (NOI) to the State Board Water Resources Control Board (SWRCB), regardless of whether they are members of a group plan or not. The following summarizes these requirements. More detailed information regarding monitoring requirements can be found in Table 1.

Non-Sampling Monitoring Requirements for all Industries - Individual Sites and all Participants of a Group Monitoring Plan

1. Annual Site Inspection - Conduct an annual site inspection to certify compliance.
2. Dry Weather Observations - Conduct two inspections during the dry season.
3. Wet Weather Visual Observations Conduct visual inspections during the wet season for one storm event per month.
4. Annual Reports - All industries must submit an annual report by July 1 of each year to the Regional Board.
5. Record Keeping - Records are to be kept for a period of at least five years.
6. Signature Requirements - All reports, Certifications, or other information required by the Permit or regulatory agency must be signed by a person described in Provision C.9 of the Permit or by a duly authorized representative. All signatures must be accompanied by the appropriate certification that is provided in Provision C.10 of the Permit.

Sampling Requirements for Individual Sites and Designated Participants of a Group Plan

1. Collect and analyze samples during two storm events.
2. All samples shall be analyzed for pH, total suspended solids (TSS), specific conductance, and either total organic carbon (TOC) or oil and grease (O&G), and toxic chemicals and other pollutants possibly present.
3. Samples are to be collected from all locations where storm water is discharged.

ANNUAL FEES - WHAT ARE THEY?

When you submitted your NOI to the SWRCB, you included some money. That was your first annual fee. The SWRCB receives and processes your NOI and annual fee. They will send you a bill for your next one about one year after you sent in your NOI, and if you have any questions about your bill, you may call them at (916) 657-0784. The amount of the annual fee depends on where your facility is located. Most of Los Angeles County is covered by an area-wide municipal storm water NPDES permit, and the annual fee is $250, otherwise it is $500. Ventura County is expected to receive an area-wide municipal permit in July of 1994. If your facility is in Ventura County, the next annual fee bill for your facility after issuance of the permit will reflect the lower fee amount. There are a few facilities that are not required to pay the annual fee. If a facility already has an individual waste discharge requirements or an NPDES permit and pays an annual fee for it, no annual fee for the Storm Water General Permit is charged; for example, landfills or Publicly Owned Treatment Plants.

What are the annual fees used for ?

The annual fees are used by the SWRCB and Regional Boards to run the program. The SWRCB processes NOIs, Notice of Terminations (NOTs) that had been previously approved by the Regional Boards, maintains the programs computer files and takes care of annual billing. The Regional Boards maintain the paper files, do site inspections, review Annual Reports and various requests, respond to complaints, initiate appropriate enforcement actions, and notify unpermitted facilities of their responsibility to apply for a permit. The SWRCB and the Regional Boards also answer numerous questions. So, what does that do for me? The Federal Clean Water Act (CWA) requires that dischargers of pollutants to surface waters have an NPDES permit. USEPA regulations specify the types of industries that must have a permit for their storm water discharges. The

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CWA gives the Regional Boards or USEPA the ability to fine anyone discharging pollutants without a permit in an amount up to $10,000 per day of discharge. Additionally, the CWA allows third parties to sue in civil court to recover such fines, if the Regional Boards or USEPA do not. Thus the fees fund a program that allows dischargers not only to improve the environment, but also comply with the law.

PROCEDURES

Notice of Intent Change of Information

During the term of coverage under the General Permit, there may be times when the information provided in an NOI needs to be revised; such as:

- Change in the type or scope of industrial activity or activities being conducted at the site.
- Change in ownership.
- Change in address of the owner, billing location, etc.
- Change in phone number for the owner, facility, etc.
- Change in owner or facility contact name.
- Change in signature authorities.

To change NOI information, complete a new NOI with the correct information, check the box Change of Information and provide your WDID number at the top of the NOI form. The revised NOI must be submitted to the SWRCB.

Notice of Termination (NOT)

Most industries identified in the Federal Regulations must remain covered under a storm water permit regardless of exposure to storm water. However, there may be instances that require a facility to request termination of coverage; such as:

- The business is closed, or specific industrial activities covered by the Federal Regulations have ceased, and all residual materials resulting from the activities have been removed, and the site adequately cleaned.
- Business is sold (this would require that you notify the State of the new owners name and address).
- Facility does not discharge, directly or indirectly, to waters of the State during any size storm event.

TABLE 1

Non-Sampling Monitoring Requirements for all Industries - Individual Sites and all Participants of a Group Monitoring Plan

- Annual Site Inspection: Conduct a minimum of one annual site inspection to identify industrial activities that could be a source of pollutants and evaluate whether the facility's pollution prevention plan is effective. After the inspection, a responsible person at the site must certify the site is in compliance with the General Permit and the facility's pollution prevention plan. Certification should be submitted with the Annual Report. Facilities that cannot be certified should report deficiencies in the Annual Report, and provide a plan and schedule for corrective action.

- Dry Weather Observations. No less than twice during the dry season (May through September) industries are to inspect their facilities to observe or test for the presence of non-storm water discharges, such as wash waters. Observations noted should include the presence of an actual flow, or evidence that non-storm water flows have occurred. Evidence would include stain marks, wet spots, residual material, etc. Non-storm water discharges should be reported to the Regional Board. Records shall be maintained of the inspections, including date of testing, locations observed, samples collected, name of inspector, and all other pertinent information. Inspection findings and corrective action should be reported in the Annual Report.

- Wet Weather Visual Observations. During the wet season (October through April) industries shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharges to observe and characterize the runoff. Examples of what should be observed are: does the flow have a sheen, an odor, is it muddy, are there floatable materials, etc.? Records must also be maintained for this activity similar to that for the dry weather inspections. Inspection findings and corrective action should be reported in the Annual Report.

- Annual Report. All industries must submit an annual report by July 1 of each year to the Regional Board. The State Water Resources Control Board has developed a report form that you should use. If you have not received a copy of this form by June 15, please contact the Regional Board or State Boerd office and request one be sent to you. The report will summarize all your activities and findings relating to your facility's storm water pollution prevention plan and monitoring program.

- Record Keeping. Records of all storm water monitoring information and copies of all reports required by the general permit are to be retained for a period of at least five years from the data of the sample, measurement, observation or report.

Sampling Requirements for Individual Sites and Designated Participants of a Group Plan

- When to Collect Samples: During the wet season (October through April) industries must collect and analyzed samples during two storm events that produce significant storm water discharges. Each sampling event must be proceeded by at least 72 hours of dry weather.

- All samples must be analyzed for: pH, total suspended solids (TSS), specific conductance, and either total organic carbon (TOC) or oil and grease (O&G). Samples must also be analyzed for: toxic chemical and other pollutants that the industry believes could be present in storm water discharges in significant quantities. The industry is to determine these pollutants. Sampling and analysis for additional constituents may be eliminated if toxic chemical or other pollutants are not detected in significant quantities after two consecutive sampling events. Samples must be collected as grab samples unless otherwise required by the Federal Regulations, or approved by the Regional Board. Sample results and evaluation of results should be submitted in the Annual Report.

- Sampling locations: Samples are to be collected from all locations where storm water is discharged. Locations with multiple discharge points may reduce the number of locations to be sampled if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

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The State has prepared a preprinted NOT form, with instructions. If you need to terminate coverage, please contact either the State or Regional Board and request a copy of this form. Your completed forms are to be submitted to the Regional Board for approval. Once approved, the Regional Board will forward the NOT to the State Board. They will be the agency responsible for insuring that your company's name and other permit information are removed from the Storm Water Program's database.

WHY DO MONITORING AND WHAT TO DO WITH YOUR RESULTS

The General Permit requires that each facility develop and implement a Storm Water Pollution Prevention Plan. Once your Plan is implemented you are to check to see if your Plan is effective in reducing or eliminating pollutants from leaving your site in storm water runoff. This is done through your monitoring activities. Typical questions your monitoring program should answer are: Did the Plan work? Where did it fail? Are there more discharge points than originally identified? Are there non-storm water discharges that have not been identified or eliminated? Did the Best Management Practices (BMPs) work? If not, why? What types of pollutants are present in your runoff, what are the potential sources of these pollutants and what BMPs need to be revised or implemented to eliminate the source of pollutants? All monitoring activity should be recorded on forms or logs, and evaluated by the appropriate personnel to determine if your Plan is effective. If the Plan is ineffective, then revisions must be made. Each site has to be evaluated on an individual basis.

Table 2 has been developed to provide general guidance to industries in evaluating the four required monitoring parameters. You may use the values provided in Table 2 as benchmarks. If your analytical results should indicate constituent levels at or above the benchmark values, you should investigate your site to ensure: you have identified all sources of pollutants; BMPs have been implemented if the BMPs need to be revised; and if new BMPs need to be implemented. If there are run-on sources of pollutants to your site, you may collect additional samples, and conduct additional inspections, to demonstrate that offsite pollutants are affecting your analytical results.

SAMPLING ADVICE

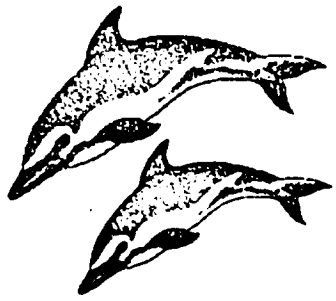
The General Permit requires that all sample analysis be conducted by a state certified laboratory (lab); so, how do you find one? You should first start by consulting your local telephone directory yellow pages under laboratories - Analytical. You would select a laboratory as you would any other professional service you use in your business. If possible, obtain quotations from several different labs. In addition to the analytical costs, you may wish to inquire about other related sampling services provided; such as:

- Sample collection training and advice for your employee
- Sample collection by lab employees
- Sample preservation, handling, pickup, and other requirements.

Collecting samples is not necessarily complicated. In most cases you need a simple sampling device, such as, a clean pail, ladle, bailer, and appropriate sample bottles (labs typically supply clean sample bottles). If there is not an obvious, or accessible storm drain pipe or outlet, you may consider creating a temporary weir, or drain, on paved areas that causes sufficient temporary backup of runoff to use your sampling device. A sample should be drawn from a well mixed area, below the water surface but above the ground level (do not let your pail or ladle scrape the ground). Alternative sampling locations should be located such that they best represent runoff from areas of industrial activity.

WHEN CAN YOU STOP COLLECTING SAMPLES OR NO LONGER NEED COVERAGE UNDER THE GENERAL PERMIT?

When is enough, enough? A common question asked often by both the regulated community and regulatory agencies. Currently Regional Board, State Board, and USEPA representatives (collectively known as the Urban Runoff Task Force) meet monthly to discuss these and other issues regarding the storm water program. At the present time, the Federal Regulations list specific industrial activities (defined by SIC codes) that are required to be covered under a storm water permit, regardless of their exposure to storm water. This means that an industry that conducts these activities could demonstrate their Plan is adequate and effective, or if all activities are no longer exposed to storm water, it would still be required to be covered under a permit. The State cannot allow less stringent requirements than the Federal Government. Currently USEPA is proposing changes that could reverse this position. However, until any such change occurs, the State's General Permit has provisions that would provide industries the opportunity to reduce its costs if it can demonstrate compliance. This is done by an industry self-certifying that it has implemented an adequate and effective storm water Plan. Self-certification would allow an industry to be exempt from the collection of storm water samples only, the industry must still comply with all other permit requirements. If you are interested in seeing how your industry may be eligible for self-certification, please contact your Regional Board representative. The State Urban Runoff Task Force is working towards developing various help/guidance documents to assist industries to determine when enough is enough. You should also work with your Regional Board Representative. We work with many industries, and may be able to share with you what others are doing to comply.



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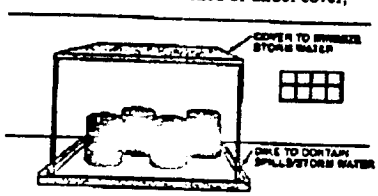
WHAT IS THE DIFFERENCE BETWEEN SOURCE CONTROL AND TREATMENT CONTROL BMPs?

Source control Best Management Practices (BMPs) are BMPs that prevent contact between storm water and the source of pollution. This can be handled in many ways; examples include:

- moving outdoor operations indoors;
- placing portable outdoor storage containers in a shed or under cover;

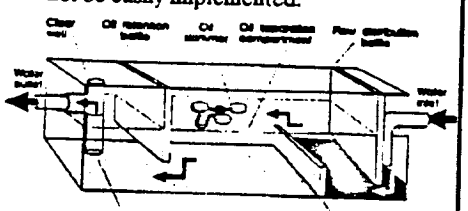


Source Control BMPs - Covering and Berming

- labelling containers and exposed piping;
- using drip pans;
- improving good housekeeping procedures, especially in areas of equipment and vehicle maintenance;
- improved spill response, or chemical/waste containment practices;
- conducting or improving preventative maintenance activities; and
- directing upstream storm water away from industrial activity area.

Source Control BMPs are typically low cost practices or procedures that are easily implemented.

Treatment Control BMPs are used to treat storm water once it has been in contact with an industrial activity to remove the pollutants. Examples of structural BMPs are grassy swales, catch basins with sumps, buildings, containment structures, etc. These BMPs are typically moderate to high cost, maintenance intensive, and may not be easily implemented.



Treatment Control BMP - Oil/Water Separator

TABLE 2 POLLUTANT BENCHMARK LEVELS

Pollutant	Acceptable Range	Recommend Investigation
pH	6.5 - 8.5	<6.5, >8.5
Total Suspended Solids(TSS)	0 - 100 mg/L	>100 mg/L
Specific Conductance (SC)	0 - 200 umhos/cm	>200 umhos/cm
Total Organic Carbon(TOC)	0 - 110 mg/L	>110 mg/L
Oil & Grease (O&G)	0 - 10 mg/L	>10 mg/L

The permit includes required parameters you must analyze your samples for, but it does not include numeric limitations for these parameters. The chart above reflects an example of the levels at which these parameters may raise concerns or the need for further investigation. These numbers reflect only the general views of the staff, and individual cases may cause concern or the need for further investigation at different levels.

The parameters required by the Permit are considered indicator parameters. In other words they are nonspecific tests that will provide enough information to indicate that there may be pollutants in your storm water runoff. The following briefly explains what these parameters mean, and why you must analyze your samples for them:

- pH: Is a measure of the hydrogen-ion concentration. It is an important water quality measure because the range of concentration suitable for biological life is narrow and critical. The neutral, or acceptable range can be defined as 6.5 to 8.5. At values less than 6.5, the water is considered acidic; above 8.5 it is considered caustic or alkaline. Rain water would tend to be naturally less than a pH of 7, however, there could be sources such as acids or other chemicals that could cause storm water runoff to be less than 6.5 or greater than 8.5. These pH levels in rain water do not occur naturally and are a result of it coming in contact with a chemical, such as lime, or other source that would raise the pH. If your pH levels are high or low, you should conduct a thorough evaluation of all sources at your site.
- TSS: Is a measure of the undissolved solids that are present in runoff. Sources for TSS would be sediment from erosion of exposed land, and dirt from impervious (i.e. paved) areas. Sediment by itself can be very toxic to aquatic life because it covers its feeding and breeding grounds, and smothers others that may live on the bottom of a water body. Toxic chemicals and other pollutants also adhere to sediment particles. This provides a medium by which toxic or other pollutants end up in our water ways and ultimately in human and aquatic life. TSS levels vary in runoff from undisturbed land. It has been shown that TSS levels increase significantly due to land development. If your levels of TSS are above 100 mg/l, it could be attributed to the site development, and a source of pollutants.
- TOC: Is a measure of the total organic matter present in water, and is especially applicable to detect small concentrations of organic matter. Organic matter occurs naturally from animals, plants, and man, and also from manmade synthetic organic compounds. Natural organic matter utilizes the oxygen in a receiving water to biodegrade. Too much organic matter could place a significant oxygen demand on the water, and possibly impact its quality. Synthetic organics are manmade; such as, pesticides, fuels, solvents, paints, etc. These substances either do not, or very slowly biodegrade. They are a source of toxic chemicals that can have adverse affects at very low concentrations. Some of these chemicals bioaccumulate in aquatic life. If your levels of TOC are high, you should evaluate all sources of synthetic organics you may use at your site.
- O&G: Is a measure of oil and grease. At very low concentrations, O&G can cause a sheen on the surface of water 11 qt. of oil can pollute 250,000 gallons of water!. O&G can interfere with aquatic life and create unsightly floating material and film on water. Sources of O&G are shops, vehicles, other machine or maintenance activities, roadways, etc.
- SC: Is a numerical expression of the ability of the water to carry an electric current. It can be used to assess the degree of mineralization, or estimate the total dissolved solids concentration of a water sample. Pure rain water should generally have an SC of < 50. High levels of dissolved solids could affect the usability of waters for drinking and other commercial or industrial use.

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The following is a simple statistical analysis of the data submitted with the annual reports for the 1992-1993 season. Facilities may have been required to sample for other constituents; however, the following is a list of the five indicator parameters that are required for all facilities:

1) Oil & Grease
379 facilities submitted results
Minimum value = 0.1 mg/L
Maximum value = 556 mg/L
Median value = 5.0 mg/L

2) pH
639 facilities submitted results
Minimum value = 1.2
Maximum value = 11.2
Median value = 6.9

» 206 facilities (32%) are outside the bench mark levels of 6.5 - 9.0 pH units.

3) Total Suspended Solids TSS
574 facilities submitted results
Minimum value = 0.6 mg/L
Maximum value = 42000 mg/L
Median value = 50.7 mg/L

» 189 facilities (33%) are above the bench mark level of 100 mg/L.

4) Total Organic Carbon TOC
238 facilities submitted results
Minimum value = 0.01 mg/L
Maximum value = 1640 mg/L
Median value = 11.7 mg/L

5) Specific Conductance
570 facilities submitted results
Minimum value = 0.1 umhos/cm
Maximum value = 10000 umhos/cm
Median value = 99.5 umhos/cm

» Median represents the value achieved by 50% of the facilities reporting.

WHERE TO GET MORE INFORMATION

Stormwater Unit Staff:

Mark Pumford - Unit Chief (213) 266-7596
Xavier Swamikannu - Lead Engineer (213) 266-7592
Carlos Urrunaga - Los Angeles County Municipal Permit (213) 266-7598
Dan Radulescu - Industrial Activities General Permit (213) 266-7630
Wen Yang - Ventura County Municipal Permit and Construction Activities General Permit (213) 266-7659

Business Assistance Desk: (213) 266-7671 or 1(800) 500-8008

Electronic Bulletin Board: (213) 266-7663.

Fax: (213) 266-7600

BOARD MEMBERS:
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Larry Zarian
Terry Dipple
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EXECUTIVE OFFICER: Robert P. Ghirelli, D.Env.

ANNUAL REPORT

Annual Reports are due to this Regional Board no later than July 1, 1994. The annual report form has changed since last year. This year's form, mailed by State Water Resources Control Board, will have a pre-printed first page that will contain the facility's WDID number, name, and address.

Your comments have been instrumental in developing this new report form. Your continued input is greatly appreciated. Additionally, we welcome your suggestions for topics for inclusion in subsequent issues of this newsletter.

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COMPLIANCE CHECKLIST

Where should an industry be today to be in compliance with the General Permit? The following quick checklist could help you make such a determination.

- ☐ Submitted NOI and fee to the State Board.
- ☐ Developed and implemented SWPPP.
- ☐ Trained employees regarding SWPPP.
- ☐ Developed and implemented Monitoring Program.
- ☐ Trained employees regarding Monitoring Program.
- ☐ Conducted at a minimum 2 dry weather season visual inspections.
- ☐ Conducted monthly wet weather visual inspections.
- ☐ Conducted annual site inspection and certified site was in compliance with Permit and SWPPP.
- ☐ Notified Regional Board of all noncompliance incidents.
- ☐ Revised SWPPP if inspections found deficiencies in Plan.
- ☐ Revised Monitoring Program if inspections found deficiencies in Plan.
- ☐ Collected two storm water samples from every discharge point, and analyzed samples for pH, TSS, SC, and TOC or O&G.
- ☐ Evaluated other pollutants of concern at the facility.
- ☐ Maintained written reports of all inspections, findings, follow up activities taken in response to inspection findings, and analytical results.
- ☐ Maintained written documentation explaining why monitoring activities could not be conducted.
- ☐ Submitted Annual Report to Regional Board by July 1 every year.
- ☐ Identified and either eliminated or permitted all non-storm water discharges. Or
- ☐ Notified Regional Board of discharge, and provided them with a schedule when the flow would be eliminated or permitted.

If you are able to check all of the items above then you can be comfortable that you are in compliance with key Permit requirements. If you are unable to check all of the above items, please review the Permit, and revise or amend your storm water program as appropriate. If you need assistance, please contact your Regional Board representative.

Regional Water Quality Control Board - Los Angeles
101 Centre Plaza Drive
Monterey Park, CA 91754

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Southern California Chapter Water Resources Committee

BEST MANAGEMENT PRACTICES FOR STORM WATER PERMIT COMPLIANCE

March 8, 1993 Agenda

Municipal BMP Handbook Workshop

Time	Topic	Speaker
8:30 - 8:55	Introductions	Ray Holland, City of Long Beach, Director of Public Works President, APWA S. Calif. Chapter Bob Collacott, Woodward-Clyde Consultants Chairman, APWA Water Res. Comm. Archie Matthews, State Water Resources Control Board
8:55 - 9:25	Purpose and Scope	Malcolm Walker, Larry Walker Assoc.
9:25 - 9:55	Development of a Storm Water Management Program	John Aldrich, Camp Dresser & McKee
9:55 - 10:10	Questions	
10:10 - 10:40	Break	
10:40 - 11:10	Source Control BMPs	Geoff Brosseau, Uribe & Associates
11:10 - 11:40	Treatment Control BMPs	Larry Roesner, Camp Dresser & McKee
11:40 - Noon	Questions	

Construction BMP Handbook Workshop

Time	Topic	Speaker
1:00 - 1:25	Introductions	Ray Holland, City of Long Beach, Director of Public Works President, APWA S. Calif. Chapter Bob Collacott, Woodward-Clyde Consultants Chairman, APWA Water Res. Comm. Archie Matthews, State Water Resources Control Board
1:25 - 1:40	Purpose and Scope	Malcolm Walker, Larry Walker Assoc.
1:40 - 2:25	Preparation of a Storm Water Pollution Prevention Plan	John Aldrich, Camp Dresser & McKee
2:25 - 2:40	Questions	
2:40 - 3:10	Break	
3:10 - 3:25	Erosion and Sediment Control BMPs	John Aldrich, Camp Dresser & McKee
3:25 - 3:55	Construction Activities BMPs	Geoff Brosseau, Uribe & Associates
3:55 - 4:10	Post Construction BMPs	Larry Roesner, Camp Dresser & McKee
4:10 - 4:40	Questions	

March 9, 1993 Agenda

Commercial/Industrial BMP Handbook Workshop

Time (AM/PM)	Topic	Speaker
8:30 - 8:55/1:00 - 1:25	Introductions	Ray Holland, City of Long Beach, Director of Public Works President, APWA S. Calif. Chapter Bob Collacott, Woodward-Clyde Consultants Chairman, APWA Water Res. Comm. Archie Matthews, State Water Resources Control Board
8:55 - 9:25/1:25 - 1:55	Purpose and Scope	Larry Roesner, Camp Dresser & McKee
9:25 - 9:55/1:55 - 2:25	Preparation of a Storm Water Pollution Prevention Plan	Malcolm Walker, Larry Walker Assoc.
9:55 - 10:10/2:25 - 2:40	Questions	
10:10 - 10:40/2:40 - 3:10	Break	
10:40 - 11:10/3:10 - 3:40	Source/Treatment Control BMPs	Geoff Brosseau, Uribe & Associates
11:10 - 11:40/3:40 - 4:10	Case Study	Susan Morea, Camp, Dresser & McKee
11:40 - Noon/4:10 - 4:30	Questions	

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Workshop Sponsors

The State Water Resources Control Board; the California Regional Water Quality Control Boards; Alameda County Public Works Agency; Fresno Metropolitan Flood Control District; City of Los Angeles; Los Angeles County Department of Public Works; Riverside County Flood Control and Water Conservation District; County of San Bernardino Flood Control District; City of San Diego; Contra Costa County Flood Control District; the County and Cities of Orange County; the Santa Clara Valley Water District; City of Modesto; City of Sacramento; Sacramento County Water Resources Division; City of Monterey; Placer County Flood Control and Water Conservation District; American Planning Association; American Society of Civil Engineers -- Los Angeles Section (Hydrology and Hydraulics Technical Group), San Bernardino/Riverside Section and Sacramento Section; Associated General Contractors of California Inc.; Association of Environmental Professionals; Bay Area League of Industrial Associations; Building Industry Association of Southern California; California Water Pollution Control Association; City Engineers and Land Surveyors Association; City and County Engineers Association -- Los Angeles and Inland Empire Sections; Construction Industry Federation, and the Chemical Industry Council of California.

List of Participating Vendors

Camp Dresser & McKee
430 N. Vineyard Ave., Suite 310
Ontario, CA 91764
Contact: Diane Omahen (909) 986-6811

GeoCon Environmental Consultants, Inc.
6970 Flanders Drive
San Diego, CA 92121-2974
Contact: Jeff O'Connor (619) 558-6100

Hart Crowser, Inc.
One World Trade Center, Suite 2300
Long Beach, CA 90831-2300
Contact: Anne O'Connor (310) 495-6360

Hilbert & Associates
4552 Lincoln Ave., Suite 203
Cypress, CA 90630
Contact: Andy Hilbert (714) 952-3568

R.C. Hoffman Co., Inc.
P.O. Box 5766
Pasadena, CA 91117
Contact: Judy Olsen (818) 568-9211

Kinnetic Laboratories, Inc.
5225-H Avienda de Encinas
Carlsbad, CA 92008
Contact: Elizabeth Fleschar (619) 438-8968

Petra Environmental, Inc.
3185-A Airway Ave.
Costa Mesa, CA 92626
Contact: Kathleen Dallaire (714) 549-8921

Psomas & Associates
3420 Ocean Park Blvd., Suite 1040
Santa Maria, CA 90405
Contact: Peggy O'Donnell (310) 450-1217

Willdan Associates
888 S. West St., Suite 300
Anaheim, CA 92802
Contact: Bill Goodwin (714) 758-8186

Woodward-Clyde Consultants
2020 E. First St., Suite 400
Santa Ana, CA 92705
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APWA Southern California Chapter Water Resources Committee

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Title

Organization

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To ensure accurate records and avoid duplication of records, we are requesting the cooperation of all our members to include their SS# Thanks

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03 City Employee ____
04 Special District Employee ____
05 County Employee ____
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07 Consultant ____
08 Student ____
09 Private Enterprise ____
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11 Sustaining Member Representative ____
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05 Other (Specify) ____

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02 Female ____

POPULATION SERVED:
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02 10,000— 25,000 ____
03 25,000— 50,000 ____
04 50,000— 100,000 ____
05 100,000— 300,000 ____
06 300,000— 500,000 ____
07 500,000— 1,000,000 ____
08 More than 1,000,000 ____

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03 Hispanic ____
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06 Other (Specify) _____

Date of Birth _____

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Fees include subscription to the monthly magazine, $5 per year.

Group Memberships

	Population Served	#Reps	Fee
Public Agency	0— 10,000	2	$110
	10,000— 25,000	4	$220
	25,000— 50,000	6	$330
	50,000— 100,000	10	$550
	100,000— 300,000	16	$880
	300,000— 500,000	20	$1,100
	500,000— 1,000,000	26	$1,430
	More than 1,000,000	30	$1,650
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Sustaining		6	$1,725

For counties, use 50% of population; for special districts, 20%; for state/provincial agencies, 10%.

Each public agency member may designate one representative or active member for each $55 of service fee paid.

Public Utility— minimum of five members. Each public utility member may designate one representative/associate member for each $65 of service fee paid.

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1. INTRODUCTION

Storm water runoff is part of a natural hydrologic process. However, human activities, including the disturbance of land from construction activities, can alter natural drainage patterns, adding pollutants to rivers, lakes, and streams. An increase in compacted and impervious surfaces increases both the volume of surface runoff, the peak rate of flow, and decreases groundwater recharge. Consequently, improperly managed storm water runoff can be a significant source of water pollution, causing declines in fisheries, habitat disruption, restrictions on swimming, and limiting our ability to enjoy many of the other benefits that water provides (USEPA, 1992).

For many years the effort to control the discharge of storm water has focused on quantity (e.g. flood control), and to a limited extent, on the quality of storm water (e.g. sediment and erosion control). However, in recent years awareness of the need to protect and preserve natural habitats and improve water quality has increased. With this awareness Federal, State and local programs have been established to pursue the ultimate goal of reducing the impacts of storm water discharges to our water ways. After October 1, 1992, construction activities must be covered by a National Pollutant Discharge Elimination System (NPDES) permit (SWRCB, 1992). **Failure to comply with these requirements may result in a fine of up to $25,000 per day of violation and possible imprisonment.**

The primary objectives of the NPDES storm water permit for construction activities are to:

- Reduce excessive erosion potential
- Minimize excessive sedimentation
- Prevent other materials used at a construction site from causing off site contamination
- Eliminate non-storm water discharges from the construction sites
- Install appropriate measures to reduce impacts on waterways from the finished project, and provide a commitment that these measures will be maintained.
- Establish maintenance commitments on post-construction sites.

PURPOSE AND SCOPE OF THE HANDBOOK

The purpose of this handbook is to provide guidance for selecting and implementing best management practices (BMPs) for construction activities. As will be discussed in this handbook, State and Federal programs require *owners* of construction sites to prepare storm water pollution prevention plans (SWPPPs) which includes the identification and implementation of various BMPs. It is not the intent of this handbook to dictate the actual BMPs (as this will be done by the permittee), but rather to provide the framework for preparing SWPPPs and selecting appropriate BMPs. It is intended that portions of this handbook be incorporated into SWPPP if modified to meet specific project conditions.

In addition, the use of the handbook does not ensure that the user will be in compliance with the requirements of its NPDES permit. Such compliance can only be provided through a review and concurrence of the appropriate Regional Water Quality Control Board.

This handbook does not describe local requirements for erosion and sediment control for storm water management. Although it is expected that the handbook will assist the users in complying with local requirements, you should consult with local authorities for their requirements.

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USERS OF THE HANDBOOK

A number of people will find this handbook helpful. The primary audience is the property owners, developers, contractors, engineers, and public agencies who are involved in construction and land disturbance. Municipal departments that oversee these activities will also find this handbook useful.

ORGANIZATION OF THE HANDBOOK

The overall goal of the storm water program is to reduce the impacts of storm water discharges on receiving waters. This handbook is organized to assist the user in developing and implementing such a program. The handbook explains:

- Why is storm water management needed? (Chapter 1)
- What is a SWPPP and how do you prepare one? (Chapter 2)
- What are best management practices, and how do you select them? (Chapter 3)
- What BMPs are available and how are they used? (Chapter 4 and 5)
- How do you monitor BMPs performance? (Chapter 6)

DEFINITIONS

Many of the common terms used in the storm water program are defined in the Glossary (Appendix C). However, the user will continually encounter the following terms:

- *NPDES Construction General Permit for Storm Water Discharges*. NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the national program for administering and regulating discharges to receiving waters according to the Clean Water Act (CWA). In California, the State Water Resources Control Board (SWRCB) has issued a general permit for storm water discharges associated with construction activities statewide (except for the Lake Tahoe Basin and Indian lands, which are covered by separate permits, see Appendix A).
- *Notice of Intent (NOI)* is a formal notice to the SWRCB submitted by the owner/ developer that a construction project is about to begin. The NOI provides information on the owner, location, type of project, and certifies that the permittee will comply with conditions of the construction general permit. The NOI is not a permit application and no approval is required.
- *The Storm Water Pollution Prevention Plan* is a report that includes site map(s), an identification of construction/ contractor activities that could cause pollutants in the storm water, and a description of measures or practices to control these pollutants. The SWPPP must be prepared and implemented before construction begins.
- *A Best Management Practice (BMP)* is defined as any program, technology, process, siting criteria, operating method, measure, or device which controls, prevents, removes, or reduces pollution.

CONSTRUCTION SITES AND THEIR IMPACTS ON WATER QUALITY

Excessive erosion and sedimentation caused by construction activities is dependent upon climatic and site conditions, as well as the type of construction activity taking place. Sediment which results from the excessive erosion of disturbed soils is the primary pollutant of concern. However, other pollutants of concern include metals, nutrients, soil additives, pesticides, construction chemicals, and miscellaneous waste from construction sites. Consequently the development of a comprehensive storm water management

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program to reduce pollutants from a construction site requires a basic understanding of the erosion and sedimentation processes and the factors that influence them as well as an understanding of how other construction activities impact water quality.

EROSION AND SEDIMENTATION PROCESS

Soil erosion is the process by which soil particles are removed from the land surface, by wind, water or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared or altered and left disturbed.

Sedimentation is defined as the settling out of soil particles transported by water. Sedimentation occurs when the velocity of water in which soil particles are suspended is slowed sufficiently to allow particles to settle out. Larger particles, such as gravel and sand, settle more rapidly than fine particles such as silt and clay. Sedimentation occurs after erosion has taken place. Effective construction site management first minimizes excessive soil erosion by keeping the soil stabilized as long as possible, and second directs runoff from remaining disturbed areas to locations where sediments are removed prior to discharge to water courses. Figure 1.1 shows five types of erosion which can occur on a construction project.

Erosion from Rainfall Impact - The impact of raindrops on bare soil causes erosion. Because the rainfall impact has a low velocity, this type of erosion will normally result in minimum surface erosion on undisturbed land. Even in areas of California with a semi-arid climate and minimal vegetative cover, natural desert soil conditions (including compacted hardpan) provide protection against erosion for all but the most intense rainfalls. Construction activities remove the protective cover of vegetation and natural soil resistance to impact erosion.

Sheet Erosion - After rainfall strikes the ground, it flows in a thin layer, called sheet flow for a short distance. The distance of sheet flow depends on slope, type of soil vegetative cover, and rainfall intensity. Sheet flow has a low velocity and causes little erosion on undisturbed soils. However, clearing the soil during construction makes the soil more susceptible to erosion, increases velocity, and causes the flow to concentrate in rivulets.

Rill and Gully Erosion - As runoff accumulates, it concentrates in rivulets cutting grooves into the soil surface. If the flow is sufficient, rills may develop into gullies. Rills/gullies form sooner on exposed soils than vegetated soils.

Stream and Channel Erosion - The banks and bottoms of natural drainage channels are commonly eroded by three factors which occur during construction:

- Clearing the soil during construction increases the runoff flows, velocities and volumes which reach natural streams;
- Covering the soil with buildings and pavement further increases runoff; and
- Site landscaping and improperly designed desiltation basins may disrupt the natural balance of erosion and sedimentation.

Excessive stream and channel erosion may be limited by controlling runoff flows, velocities and volumes before discharge into the stream and by widening and/or stabilizing the banks of the stream (subject to regulatory approval) to pass increased runoff without excessive erosion.

Wind Erosion - Dust is defined as solid particles or particulate matter which are predominately large enough to eventually settle out from the air but small enough to remain temporarily suspended in the air for an extended period of time. Dust from a construction site, originates as inorganic particulate from rock and soil surfaces, material storage piles and construction materials. The majority of dust generated and emitted into the air at a construction site is related to earth moving, demolition, construction traffic on unpaved surfaces, and wind over disturbed uncompacted soil surfaces (see box, page 1-5).

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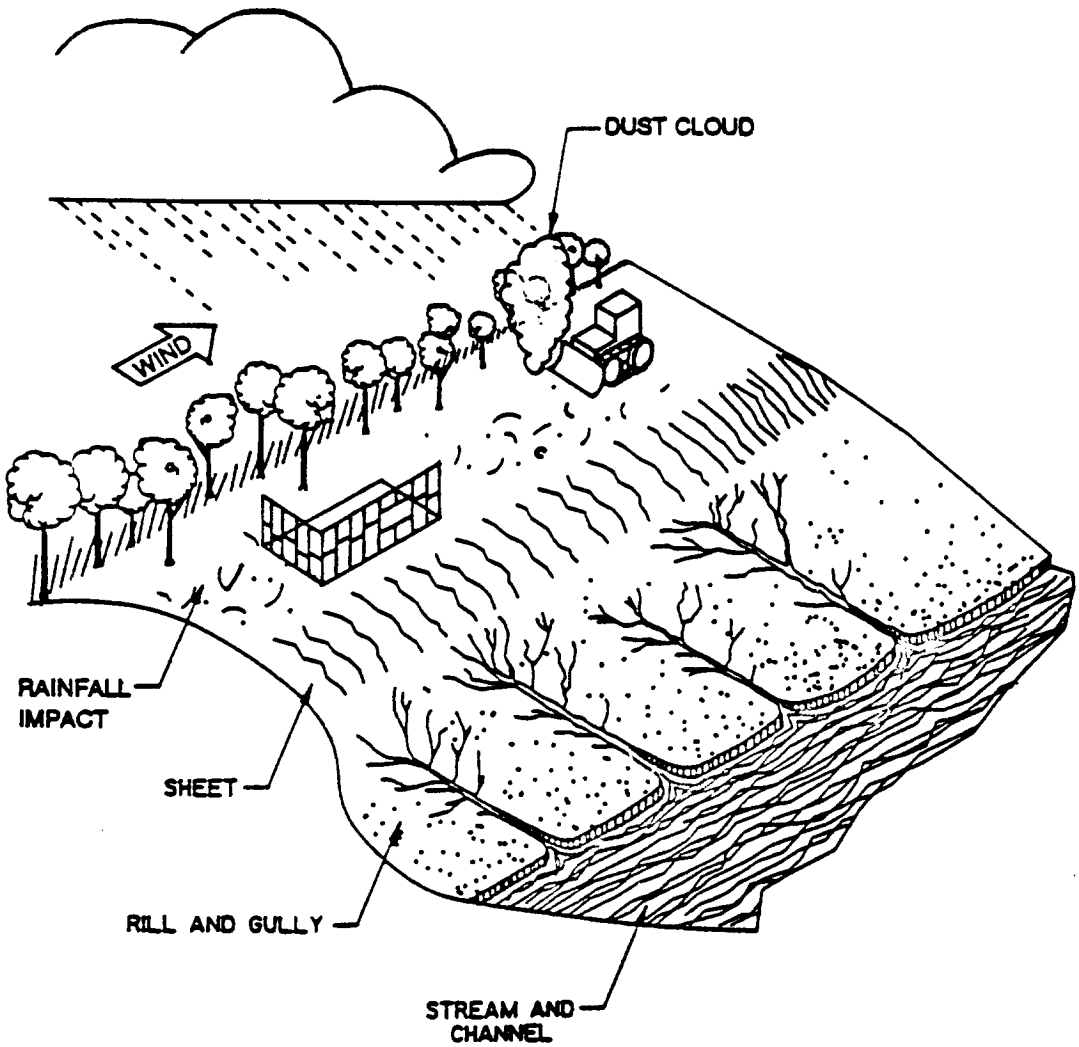

FIGURE 1.1 TYPES OF EROSION OCCURRING AT A CONSTRUCTION SITE

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Dust Sources at Construction Sites or From Off-Site Construction Activities

Unpaved Travel Surfaces
- Temporary parking lots and staging areas
- Construction stock piles
- Construction traffic
- Construction access and sediment tracking off-site

Exposed Areas
- Construction sites, bare ground areas
- Land clearing and grubbing activities
- Earthwork, dozing, grading, scraping
- Drilling and blasting
- Soil and debris piles
- Tilling

Materials Handling
- Batch drop, dumping
- Conveyor transfer and stacking
- Material transfer points
- Crushing, milling, and screening operations
- Spilled materials
- Demolition and debris disposal

IMPACTS OF EROSION AND SEDIMENTATION

Degradation of Aquatic and Riparian Ecosystems

Excessive sediment can cause increased turbidity and reduced light penetration resulting in reduction in prey capture for sight feeding predators, clogging of gills and filters of fish and aquatic invertebrates, reduced spawning and juvenile fish survival, reduced angling success, smothering of bottom dwelling community, changes in substrate composition, and reduction in aesthetic values (Schueler, 1987). It can also lead to suppression of both aquatic and terrestrial vegetation and addition of nutrient particles to lakes and streams (Beaton, et al, 1972).

Pollutant Transport

Sediment is a pollutant in its own right and also transports many substances (such as nutrients, hydrocarbons, and trace metals) which cause pollution problems (APWA, 1981). Other pollutants originating as topsoil losses include soil organic components, plant residues, nutrient elements, organic material, atmospheric pollutants, and liquid and solid wastes (Berman, et al., 1991). Toxic substances in storm water have been found to concentrate in the sediments where they interfere with the reproductive cycle of many plants and animals as well as cause tumors and lesions in fish (City of Seattle, 1989). Of additional concern is that pollutants in sediment can be remobilized under suitable environmental conditions.

Erosion and Sedimentation of Water Ways and Public Facilities

Construction usually increases the amount of impervious area causing more of the rainfall to runoff, and increasing the speed at which runoff occurs. Unless properly managed, this increased runoff will erode natural and/or unprotected watercourses causing the watercourse to widen and/or deepen until a stable channel is reformed. This erosion of the watercourse may potentially damage property along the watercourse. Sedimentation can also contribute to accelerated filling of reservoirs, harbors, and drainage systems.

The storm water impacts of construction/land-altering activities do not just result from too much sediment. In many parts of California, stabilization of the land in excess of natural conditions may result in too little sediment, thus removing the natural bedload and causing erosion of downstream watercourses and possibly depleting sand from the beaches.

FACTORS INFLUENCING EROSION

There are primarily four factors that influence erosion: soil characteristics, vegetative cover, topography, and climate. ***Soil characteristics*** which determine the erodibility of the soil are particle size and gradation, organic content, soil structure, and soil permeability. Soils with a high proportion of silt and very fine clays are generally the most erodible. Organic matter creates a favorable soil structure, improving its stability and permeability. This increases infiltration capacity, delays the start of erosion, and reduces the amount of runoff. Soil

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characteristics affect soil stability, permeability, and infiltration capacity. The less permeable the soil, the higher the likelihood for erosion.

Vegetative cover plays an extremely important role in controlling erosion by shielding the soil surface from the impacts of falling rain, slowing the velocity of runoff (thereby permitting greater infiltration), maintaining the soil's capacity to absorb water, and holding soil particles in place.

Regarding ***topography***, slope length and steepness are key elements in determining the volume and velocity of runoff. As slope length and/or steepness increase, the rate of runoff increases and the potential for erosion is magnified.

The frequency, intensity, and duration of ***rainfall*** are fundamental factors in determining the amounts of erosion produced. When storms are frequent, intense, or of long duration, erosion risks are high. In California, the erosion risk period is typically highest in the winter rainy season (October through April) except in and near the Sierra Nevada Mountains and southern deserts, where summer thunderstorms may occur. On the other hand, erosion from wind and vehicle traffic can occur year round.

OTHER IMPACTS OF CONSTRUCTION ACTIVITIES

Sediment from erosion is the pollutant most frequently associated with construction activities. However, other pollutants of concern include nutrients, trace metals, other toxic chemicals, and miscellaneous wastes. These pollutants originate from a variety of construction activities. A summary of construction site pollutants is shown in Table 1.1. (Also, see the Municipal BMP Handbook for a discussion regarding the impacts these pollutants have on water quality and aquatic habitat).

NUTRIENTS

Nitrogen, phosphorous, and potassium are the major plant nutrients used for fertilizing new landscape at construction sites. Heavy use of commercial fertilizers can result in discharge of nutrients to water bodies where they may cause excessive algae growth. Phosphorous and nitrogen from fertilizers, pesticides, petroleum products, construction chemicals, and solid waste are often generated by construction site activity (Berman, et al., 1991).

TRACE METALS

Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, or preserved wood (Berman, et al., 1991)) contain metals which enter storm water as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in storm water is associated with sediments (Schueler, 1987).

PESTICIDES

The three most commonly used forms of pesticides at construction sites are herbicides, insecticides, and rodenticides (USEPA, 1976). Unnecessary or improper application of these pesticides may result in direct water contamination, indirect pollution by drift or transport off soil surfaces into water (Washington DOE 1991).

OTHER TOXIC CHEMICALS

Often synthetic organic compounds (adhesives, cleaners, sealants, solvents, etc.) are widely applied and may be improperly stored and disposed. Deliberate dumping of these chemicals into storm drains and inlets (especially used crankcase oils) causes environmental harm to waterways.

MISCELLANEOUS WASTES

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid wastes resulting from trees and shrubs removed during land clearing, wood and paper materials derived from packaging of building products, food containers such as paper, aluminum, and metal cans and sanitary wastes. The discharge of these wastes can lead to unsightly and polluted waterways.

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TABLE 1.1 CONSTRUCTION SITE POLLUTANTS

CATEGORY	PRODUCT	POLLUTANTS
Adhesives	Adhesives, Glues Resins, Epoxy Synthetics Calks, Sealers, Putty, Sealing Agents Coal Tars (Naptha, Pitch)	Phenolics, Formaldehydes Phenolics, Formaldehydes Asbestos, Phenolics, Formaldehydes Benzene, Phenols, Naphthalene
Cleaners	Polishes, (Metal, Ceramic, Tile) Etching Agents Cleaners, Ammonia, Lye, Caustic Sodas Bleaching Agents Chromate Salts	Metals Metals Acidity/Alkalinity Acidity/Alkalinity Chromium
Plumbing	Solder (Lead, Tin), Flux (Zinc Chloride) Pipe Fitting (Cut Shavings) Galvanized Metals (Nails, Fences) Electric Wiring	Lead, Copper, Zinc, Tin Copper Zinc Copper, Lead
Painting	Paint Thinner, Acetone, MEK, Stripper Paints, Lacquers, Varnish, Enamels Turpentine, Gum Spirit, Solvents Sanding, Stripping Paints (Pigments), Dyes	VOC's Metals, Phenolics, Mineral Spirits VOC's Metals Metals
Woods	Sawdust Particle Board Dusts (Formaldehyde) Treated Woods	BOD Formaldehyde Copper, Creosote
Masonry & Concrete	Dusts (Brick, Cement) Colored Chalks (Pigments Concrete Curing Compounds Glazing Compounds Cleaning Surfaces	Acidity, Sediments Metals Asbestos Acidity
Floors & Walls	Flashing Drywall Tile Cutting (Ceramic Dusts) Adhesives*	Copper, Aluminum Dusts Minerals
Remodeling & Demolition	Insulation Venting Systems Brick, Cement, Saw, Drywall	Asbestos Aluminum, Zinc Dusts
Air Conditioning & Heating	Insulting Coolant Reservoirs Adhesives*	Asbestos Freon
Yard O&M	Vehicle and Machinery Maintenance Gasoline, Oils, Additives Marking Paints (Sprays) Grading, Earth Moving Portable Toilets Fire Hazard Control (Herbicides) Health and Safety Wash Waters (Herbicides, Concrete, Oils, Greases)	Oils and Grease, Coolants Benzene & Derivatives, Oils & Grease Vinyl Chloride, Metals Erosion (Sediments) BOD, Disinfectants (Spills) Sodium Arsenite, Dinitro Compounds Rodenticides, Insecticides
Landscaping & Earthmoving	Planting, Plant Maintenance Excavation, Tilling Masonry & Concrete* Solid Wastes (Trees, Shrubs) Exposing Natural Lime or Other Mineral Deposits Soils Additives Revegetation of Graded Areas	Pesticides, Herbicides, Nutrients Erosion (Sediments) BOD Acidity/Alkalinity, Metals Aluminum Sulfate, Sulfur Fertilizers
Materials Storage	Waste Storage (Used Oils, Solvents, Etc.) Hazardous Waste Containment Raw Material Piles	Spills, Leaks, Polluted discharge Spills, Leaks, Polluted discharge Dusts, Seduments, Polluted discharge

* See above categories.

Note: VOC = Volatile Organic Compounds, BOD = Biochemical Oxygen Demand due to the use of oxygen by microorganism decomposing materials.

References: USEPA, 1973. Processes, Procedures, and Methods to Control Pollution Resulting From Construction Activity. Office of Air and Water Programs, EPA 430/9-73-007. October, 1973.

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ALLOWABLE NON-STORM WATER DISCHARGES

The State construction general permit prohibits discharges which do not result from rainfall. However, certain "non-storm water" discharges are allowed if they do not cause a significant pollution problem (see box).

Allowable Non-Storm Water Discharges for Construction Sites

- Discharges from fire fighting
- Fire hydrant flushing
- Potable water sources including dechlorinated water line flushing
- Uncontaminated groundwater resulting from dewatering activities
- Foundation or footing drains where the flows are not contaminated with process materials
- Natural occurring water such as springs, wetlands and riparian habitat
- Irrigation water discharged during seeding, planting, and maintenance, provided fertilizer and pesticides are applied correctly
- Pavement wash waters for dust control and general housekeeping practices provided spills or leaks of toxic or hazardous materials have not occurred and where detergents are not used
- Individual car washing
- Air conditioning condensation

STORM WATER PROGRAMS

The need to protect our environment has resulted in a number of laws and subsequent regulations/programs. At times this has resulted in overlap and ambiguity between the programs. This situation is true for storm water programs. The Federal Clean Water Act, as amended in 1987, is the principal vehicle for the control of storm water pollutants. There are, however, other programs that directly or indirectly deal with the control of storm water pollutants. Examples include: Federal Coastal Zone Act Reauthorization Amendments of 1990, and the State required General Plan for municipalities.

In the following section, various Federal, State and local programs are discussed in relationship to the control of pollutants in storm water. The storm water regulatory programs are new and are expected to evolve over the next several years. Thus the user is advised to contact local regulatory and/or municipal officials for further information.

FEDERAL NPDES PROGRAM

In 1972, the Federal CWA was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. On November 16, 1990, US Environmental Protection Agency (EPA) published final regulations that establish application requirements for storm water permits for specific categories of industries. Construction activities of five (5) acres or more (or less than 5 acres if part of a common plan of development or sale) are defined in the regulations as an industrial activity.

STATE NPDES PROGRAM

In California, the NPDES storm water permitting program is administered by the State Water Resources Control Board (SWRCB) through the nine Regional Water Quality Control Boards. The SWRCB has established a construction general permit that can be applied to most construction activities in the State (see box next page and Appendix A). Construction permittees may also choose to obtain individual NPDES permits instead of the general permit.

MUNICIPAL NPDES PROGRAM

Municipalities with a population of over 100,000, drainage systems interconnected with these municipalities' systems, or municipalities

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Key Conditions of the Construction General Permit

Who Must Comply?

- Permit applies throughout California[1]
- Applies if a total of 5 or more acres is disturbed over the life of the project[2]
- Does not apply to routine or emergency maintenance sponsored by public agencies
- Does not apply to dredging and/or filling regulated by the U.S. Army COE
- The owner/developer of the land is responsible for compliance

How to Comply?

- Prepare the SWPPP before construction begins. It describes:
  - The project
  - Controls during construction: Measures selected to control excessive erosion and other constituents
  - Post-construction controls: Measures to prevent or control pollutants in runoff after construction is complete
  - A plan to inspect and maintain these measures
- Submit Notice of Intent: Notify the SWRCB prior to the beginning of construction
- Keep the SWPPP on site and follow it during construction
- Submit Notice of Termination: Notify the SWRCB that construction is complete

[1] Except the Lake Tahoe Basin and Indian lands which are covered by a separate permit.

[2] A recent U.S. District Court ruling may require that the permit cover smaller construction projects.

determined to be significant contributors of pollutants are required to obtain a NPDES storm water permit. In California, most of the major urbanized counties have already obtained an NPDES storm water permit (see box above).

Municipalities with NPDES storm water permits for their own municipal separate storm sewer system are responsible for developing a management program for construction activities in their jurisdiction. The program addresses appropriate planning and construction procedures; ensures the implementation, inspection, and monitoring of construction sites

California Counties with NPDES Storm Water Permits (1)

Alameda	Sacramento
Los Angeles	San Bernardino
Orange	San Diego
Riverside	Santa Clara

California Municipalities/Counties Pursuing NPDES Storm Water Permits

Cities

Bakersfield	Modesto	Stockton
Fairfield	Oxnard	Vallejo
Fresno	Suisun City	

Counties

Contra Costa	San Mateo
Kern	Ventura

(1) Consult with local RWQCB to determine if municipality within these counties is covered by the NPDES permit.

which discharge storm water into their systems; and provides for eduction or training for construction site operators.

While construction activities and municipal drain systems are covered by separate permits with distinct conditions, compliance requirements for these two NPDES permits include related activities. The requirements and interaction between these two permits are shown in Figure 1.2.

OTHER STATE AND LOCAL PROGRAMS

In many cases storm water pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA), provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the

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Construction General Permit Requirements
(Site-Specific)

- Submit Notice of Intent (NOI) to SWRCB (and local municipality if required).
- Prepare and implement a SWPPP.
  - Controls during construction
  - Post-construction controls
- Revise SWPPP as construction conditions change.

Interaction Between Permits

- SWRCB will expect municipality to enforce all local storm water ordinances, floodplain management regulations, and local standards for grading, erosion, sedimentation.
- NOI for construction provides the municipality with a method for anticipating construction of:
  - New public storm drain systems
  - New source identification
  - New outfall identification
  - Pollution control BMPs
  - Current construction NPDES permit holders
- Municipal storm water management and pollution control program provides construction policies and standards:
  - Site planning requirements
  - Design and construction requirements
  - Public inspection
  - Maintenance requirements
  - Training programs
  - Review and inspection staff.
  - Guidelines and training manuals
  - Technical standards and specifications
- Post-construction controls (e.g., final site grading, erosion control, storm water treatment controls and maintenance) required under the construction general permit will be subject to municipal review and approval through existing procedures.

Municipal Permit Requirements
(System-Wide)

- Prohibit, detect, and eliminate non-storm water discharges.
- Identify and reduce pollutant sources.
- Characterize current discharges with screening and monitoring.
- Detect and eliminate illicit connections and illegal dumping.
- Prepare and implement storm water management program.
- Ensure adequate funding.

Figure 1.2 Relationship Between Construction and Municipal NPDES Storm Water Permits

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projects may have on the environment, including impacts from storm water discharges.

Other regulations which may be applicable are summarized in Table 1.2. Actions taken under these regulations should be integrated with the SWPPP to promote consistency between activities required by local and State authorities. Because the General Plan Law, CEQA, and the subdivision map act may have a major impact on the development of SWPPP, a separate discussion on these regulations/laws is provided. For more information regarding other regulations shown in Table 1.2, the user is advised to confer with State and/or local authorities.

The General Plan Law: Each municipality is required by law to prepare a general plan to guide development. The general plan is a policy document that frames the long-term objectives for the physical development of the city/county. Each general plan must address at least seven elements (e.g., circulation, open space, conservation, etc.). The extent to which these elements are addressed is determined by the local agency. The municipality may incorporate storm water management objectives in the general plan, particularly objectives for post-construction controls, and adopt specific ordinances, policies, etc., for specific control measures required for new development. The specific plan and zoning ordinance are implementation tools of the general plan. A specific plan has a three-fold purpose: (1) refine the general plan for a "specific" area within the general plan boundaries; (2) regulate specific land uses within a "specific" area within the general plan boundary; and (3) establish detailed policies and regulations for the "specific" area. These policies and regulations may include storm water pollution controls. The specific plan can be adopted by resolution (making it a policy document) or by ordinance (making it a regulatory document).

A zoning ordinance establishes development standards for lots and parcels. Storm water pollution controls can be implemented in the specific plan and zoning stages through enactment of ordinances. These ordinances may preserve watercourses, specify detention and retention requirements, define storm water designs standards, and create open space and buffer areas within the project site (see box, below).

Typical Zoning Ordinances Providing Storm Water Pollution Control

- Preservation and use of flood plains and watercourses.
- Local detention and retention requirements.
- Erosion protection and sediment transport balance.
- Material/activity restrictions.

California Environmental Quality Act: The purpose of CEQA is to expose any adverse environmental impacts a project may have, and to suggest mitigation measures to minimize those impacts. Post-construction controls of storm water pollution are one of many possible mitigation measures which may be considered. If the project is determined to have no adverse impacts, then a negative declaration can be issued. Otherwise, an Environmental Impact Report (EIR) is written before the project will be considered for approval. The EIR discusses proposed project impacts, the means of reducing or eliminating the impacts, and realistic project alternatives. Mitigation measures for potential impacts are addressed by the EIR. Water quality impairment caused by storm water pollution from the site (during and after construction) may be one of these impacts.

Subdivision Map Act: Many privately funded construction projects within California are regulated under the authority of the Subdivision Map Act, which grants the municipality authority to develop subdivision ordinances. These ordinances may include standards for the planning and design of public facilities for proposed projects. Grading standards and erosion protection standards, detention/retention design standards, dust control regulations are

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TABLE 1.2 EXISTING REGULATIONS FOR STORM WATER POLLUTION CONTROL

REGULATION	ACTIVITY	POTENTIAL
General Plan Law	Municipal development objectives Adoption of ordinances	Storm water management controls, e.g., pollutants control, watershed protection
California Environmental Quality Act (CEQA)	Environmental review of projects	Mitigation measures for reduction of pollutants
Subdivision Map Act	Adoption of ordinances	Standard/Regulations for grading, erosion protection, detention/retention design, and dust control
Flood Plain Management & Drainage Ordinances	Control of velocity	Control of erosion
	Detention/retention	Control of sediment, pollutants, and quantity
	Bank stabilization and outlet controls	Erosion and Sediment controls
Clean Water Act 401 and 404 Permits	Permits Dredging and Filling in "Waters of the United States"	Erosion control, sediment control, long-term sediment balance & minimize pollutants
		Vegetative controls to preserve riparian areas
Zoning Ordinances	Cluster Development	Minimize Basin-wide runoff & impervious areas
	Hillside Development	Slope & erosion restriction. May include revegetation or stabilization.
	Landscape/Open space	Vegetative BMPs perimeter controls reduction of runoff
Sewer Use Ordinance	Control of illicit connections	Pollutant controls
Uniform Building Code	Chapter 70 - Excavating & Grading	Minimize erosion & sedimentation
		Standards for stable cut & fill slopes
Uniform Plumbing Code	Prevention of illicit connection	Pollutant controls
	Various Chapters on materials & application/use	Pollutant controls
Fire Code	Storage of Materials	Pollutant controls
Air Quality Management Plans	Emission	Sediment & dust controls
1601 and 1603 Stream Bed Alternation Agreements	Alternations to creek and stream beds	Pollutant controls
Coastal Zone Act	Regulation of non-point pollution near the ocean	Pollutant controls

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also enacted through subdivision regulations and ordinances. In addition, as part of the subdivision processes, the subdivisions must comply with the general plan, CEQA, zoning ordinances and specific plan policies and/or regulations. Such compliance may include storm water pollution control measures.

Subdivision plan review is accomplished in a two-stage process: a tentative map conditioning stage and final map review stage. The tentative map review/approval process presents the final opportunity for the municipality to require conditions of approval for the project, such as the selection of post-construction BMPs. After the tentative map approval, the project proponents must complete the second stage, submitting a final map showing that the conditions established by the tentative map are satisfied. Improvement plans for the construction of the project facilities (e.g., post-construction BMPs) are processed concurrently with the preparation of the final map. A plan for controlling erosion and sedimentation during construction should also be prepared at the time improvement and grading plans are prepared. Upon acceptance, the local agency may approve the final maps, and improvement plans based on conformance with previously established standards, ordinances, policies, and conditions of approval.

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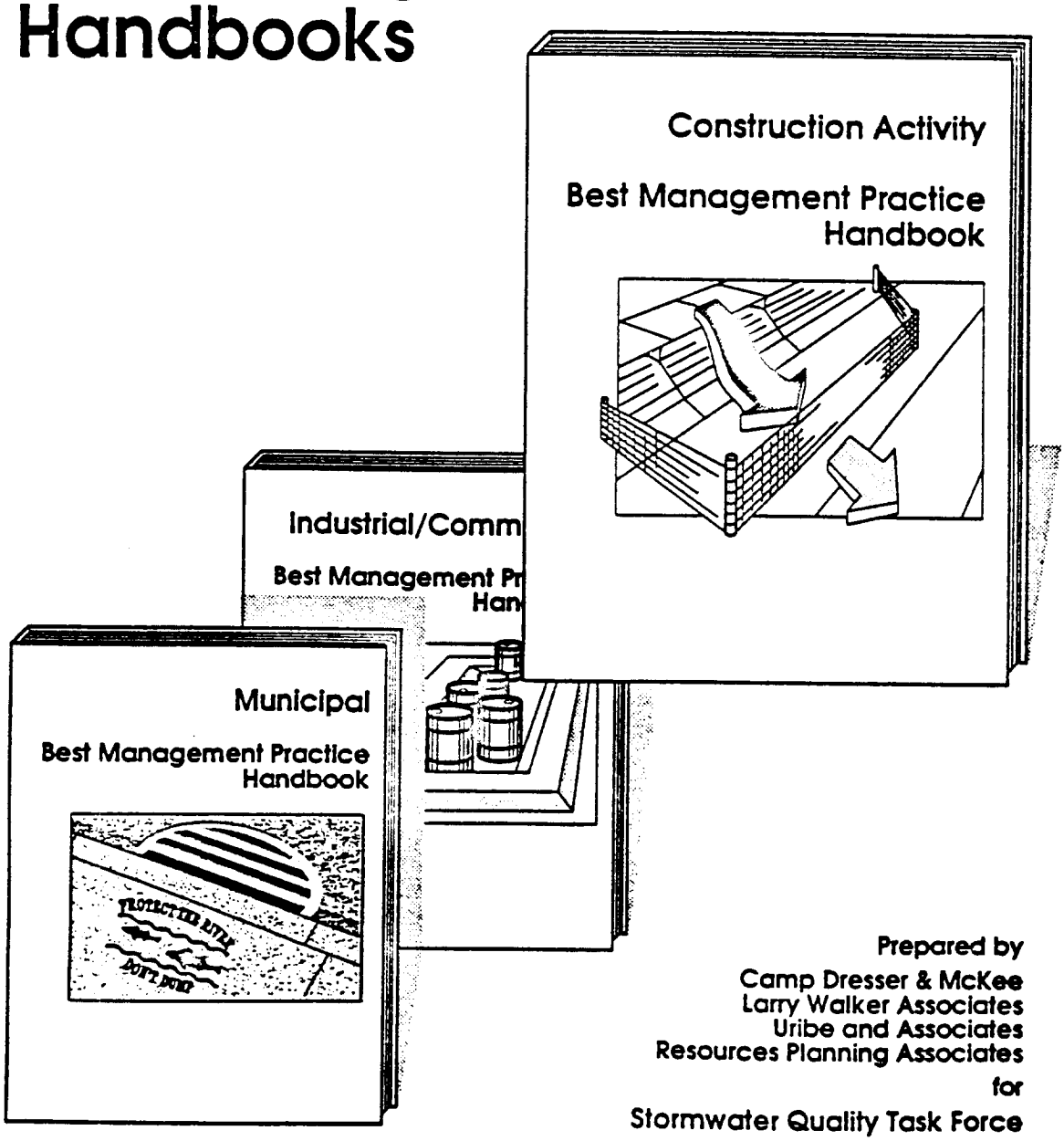
California Storm Water Best Management Practice Handbooks



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DISCLAIMER

The statements and conclusions of this Handbook are those of the Grantee and not necessarily those of the State of California. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

This Handbook was produced and published by the Storm Water Quality Task Force, an advisory body of municipal agencies regulated by the storm water program. This Handbook is not a publication of the State Water Resources Control Board or any Regional Water Quality Control Board, and none of these Boards has specifically endorsed the contents thereof. The purpose of this Handbook is to assist the members of the Task Force and other dischargers subject to storm water permits, in attaining compliance with such permits.

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ABSTRACT

The Construction Best Management Practices (BMPs) Handbook presents specific guidance on selecting best management practices for reducing pollutants in storm water discharges from construction activities. The primary audience of the handbook is the owners/developers of the construction sites that are required to obtain a State of California NPDES general permit for storm water discharges. The handbook outlines a procedure and provides worksheets for preparing a Storm Water Pollution Prevention Plan (SWPPP) as required under the general permit and for selecting BMPs that become a part of the SWPPP.

Detailed fact sheets are provided for the BMPs which include information regarding where they should be applied, what are the targeted pollutants of the BMP, design criteria (when applicable), and examples of their application. The handbook also gives guidelines for measuring BMP performance.

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FOREWORD

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from storm water is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination (NPDES) permit. The 1987 amendments to the CWA added Section 402(p) which established a framework for regulating municipal, industrial, and construction storm water discharges under the NPDES program. In California, these permits are issued through the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCB). In general, municipalities with a population of over 100,000, industries which have been identified by the Environmental Protection Agency to be a probable source of storm water pollutants, and construction projects that disturb more than five acres must obtain an NPDES permit.

The SWRCB and California members of the American Public Works Association (APWA), recognizing the complex issues involved with developing and implementing an NPDES permit system from storm water discharges, formed the Storm Water Quality Task Force to work as a team to develop a state regulatory program that complies with federal requirements, addresses California's unique demography, topography and climatology, and is affordable for the permittee. The Task Force, in turn, identified the need to have a State handbook to guide permittees in selecting Best Management Practices (BMPs) to reduce pollutants in storm water discharges. This series of Storm Water Best Management Practices Handbooks was funded by members of the Task Force and is directed specifically at developing and implementing storm water quality management programs in California.

The Handbook consists of three volumes:

- Volume 1: Municipal BMP Handbook - Addresses storm water quality management for most municipal activities, particularly those required under the NPDES municipal permit program.
- Volume 2: Commercial/Industrial BMP Handbook - Addresses storm water quality management for facilities that are (or will eventually be) covered by a NPDES general permit for industrial activities.
- Volume 3: Construction BMP Handbook - Addresses erosion control and other storm water quality management concerns required under a NPDES general permit for construction activities.

Each handbook is comprised of six chapters. Chapter 1 describes the pertinent regulations regarding the NPDES permit and defines who must obtain a permit. Chapter 2 describes how to develop a Storm Water Management Program or Storm Water Pollution Prevention Plan, while Chapter 3 provides guidance on the selection of BMPs for the plan. Chapters 4 and 5 describe the details of individual BMPs. Chapter 6 gives guidelines for measuring BMP performance. While the handbooks are meant to provide guidance to regulators and permittees, it should be understood that any final interpretation of the regulations will be done by the appropriate Regional Water Quality Control Board.

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CONSTRUCTION HANDBOOK

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Chapter 1

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2. *HOW TO PREPARE A STORM WATER POLLUTION PREVENTION PLAN*

INTRODUCTION

This chapter describes how to prepare and implement a storm water pollution prevention plan (SWPPP) for a construction project. The SWPPP is the focus of the NPDES General Permit issued by the California State Water Resources Control Board (SWRCB) for most construction activities in the State.

Preparing and implementing the SWPPP need not be time-consuming, and can best be accomplished using and/or slightly revising current planning, design, and construction activities employed by most projects (as shown with the accompanying Figure 2.1). The best SWPPPs are those which are prepared as an integral part of these typical project activities. This is because much of the information required by the SWPPP is already part of the project design documentation, and because the design may need to be modified to incorporate controls during construction and post-construction controls.

The SWPPP must be prepared *before* construction begins, ideally during the project planning and design phases. It may be completed at the end of the design phase or early in the construction phase, as shown in Figure 2.1. Implementation of the SWPPP begins when construction begins, typically before the initial clearing, grubbing, and grading operations since these activities can usually increase erosion potential on the site. During construction, the SWPPP should be referred to frequently, and refined by the owner and contractors as changes occur in construction operations which have significant effects on the potential for discharge of pollutants.

The SWPPP may be very dynamic for large, complicated projects constructed in multiple stages over a long period of time. For these projects, planning, design, and construction may be occurring simultaneously. The guidelines for preparing a SWPPP given in this chapter apply to complicated projects as well. In this case, it may be useful to prepare the SWPPP in sections, with each section covering each stage/portion of the project, and an overview section generally discussing the entire project. Remember--there is no required format for the SWPPP, just particular subject matter and guidance which must be provided under the General Permit.

This chapter is organized according to the phases of a construction project: planning, design and construction. For each phase guidelines are given on how to incorporate SWPPP preparation into the work effort. A series of worksheets is included at the end of this chapter to aid in preparation of the SWPPP.

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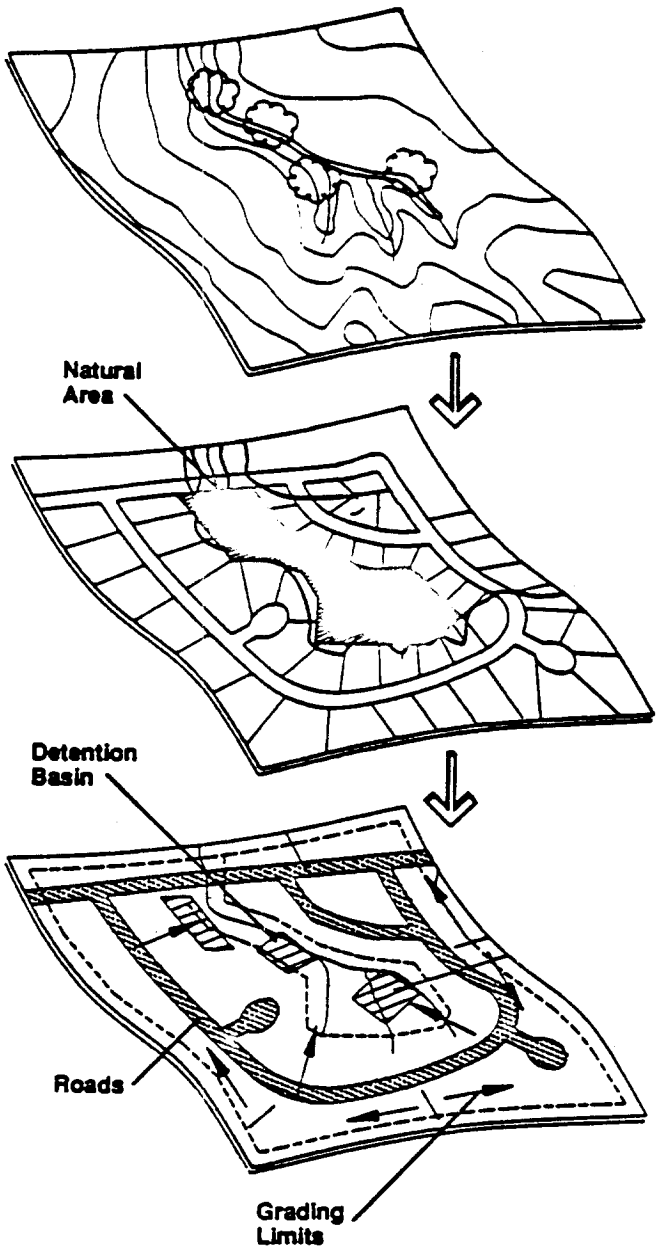

Planning Phase

- Asess Site Conditions
- Develop Base Map
- Select Post-Construction BMPs
- Establish Maintenance Agreements

Design Phase

- Prepare Project Site Plan
- Define BMP Objectives
- Design Post-Construction BMPs

Construction Phase

Bidding and Mobilization
- Select BMPs
- Complete the SWPPP
- Submit the Notice of Intent

Construction Operations
- Inspect and Maintain BMPS for Construction Activities
- Construct Post-Construction BMPs
- Revise the SWPPP as Construction Evolves or Property is Sold

Complete Construction
- Permanent Site Stabilization
- Maintenance Agreement for Post-Construction BMPs
- Submit Notice of Termination

Figure 2.1

Integrating Preparation of the SWPPP Into the Normal Site Development Process

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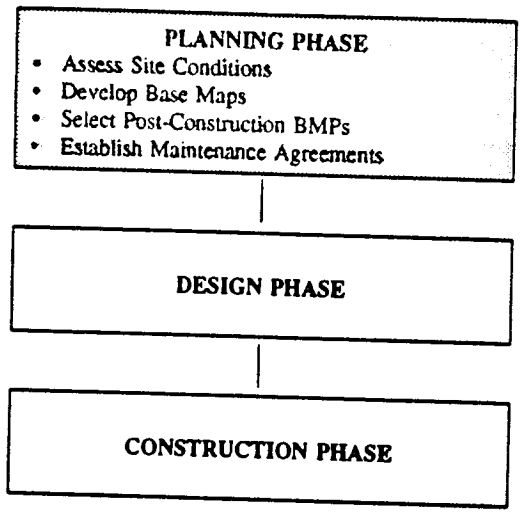
PLANNING PHASE

The planning phase is the source of much of the information needed for the SWPPP. The basis for storm water pollution control decisions are also made at this phase via the normal review process with the local municipality. This section addresses three activities which occur during planning that are important to preparation of the SWPPP:

- Assess Site Conditions
- Develop Base Map(s)
- Select Post-construction BMPs
- Establish Long-Term Maintenance Agreements



ASSESS SITE CONDITIONS

The planning phase of any construction project defines the characteristics of the site and how these characteristics will impact the project. Information on what will be built, how it will be constructed, drainage patterns, soils, topography, rainfall, and special site conditions (e.g., existing vegetation, unique cultural or environmental features) is usually obtained and used for initial planning of public works or land development projects. This information will be used in selecting BMPs for the project, and typically should be included in or referenced by the SWPPP.

DEVELOP A BASE MAP(S)

The designer will generally prepare a site analysis as either a formal document or as an informal plan. The site analysis reviews the site's physical conditions, adjacent areas, constraints, applicable zoning, and development requirements. To avoid duplication of effort and reduce costs, the owner and the designer should prepare a site base map (Figure 2.2) to be shared by the SWPPP and other site analyses (see box above). Worksheet 2 at the end of this chapter is a checklist for preparing a topography base map.

Base Map(s) of Site for SWPPP and Other Site Planning
(See Figure 2.2)

- *Use scale large enough to distinguish existing and proposed features of the site*
- *Location map must extend 1/4 mile beyond the property boundary*
- *Site map(s) should show:*
  - *Topography*
  - *Limits of Construction*
  - *Conceptual project layout*
    Surface water bodies, water courses, known wetlands, springs and wells
  - *Locations where drainage leaves/will leave the property*
  - *Existing land use*
  - *Existing vegetation*
  - *Steep or unstable slopes*
  - *Areas used to store soils and wastes*
  - *Areas of cut and fill*
  - *Existing and planned paved areas and buildings*

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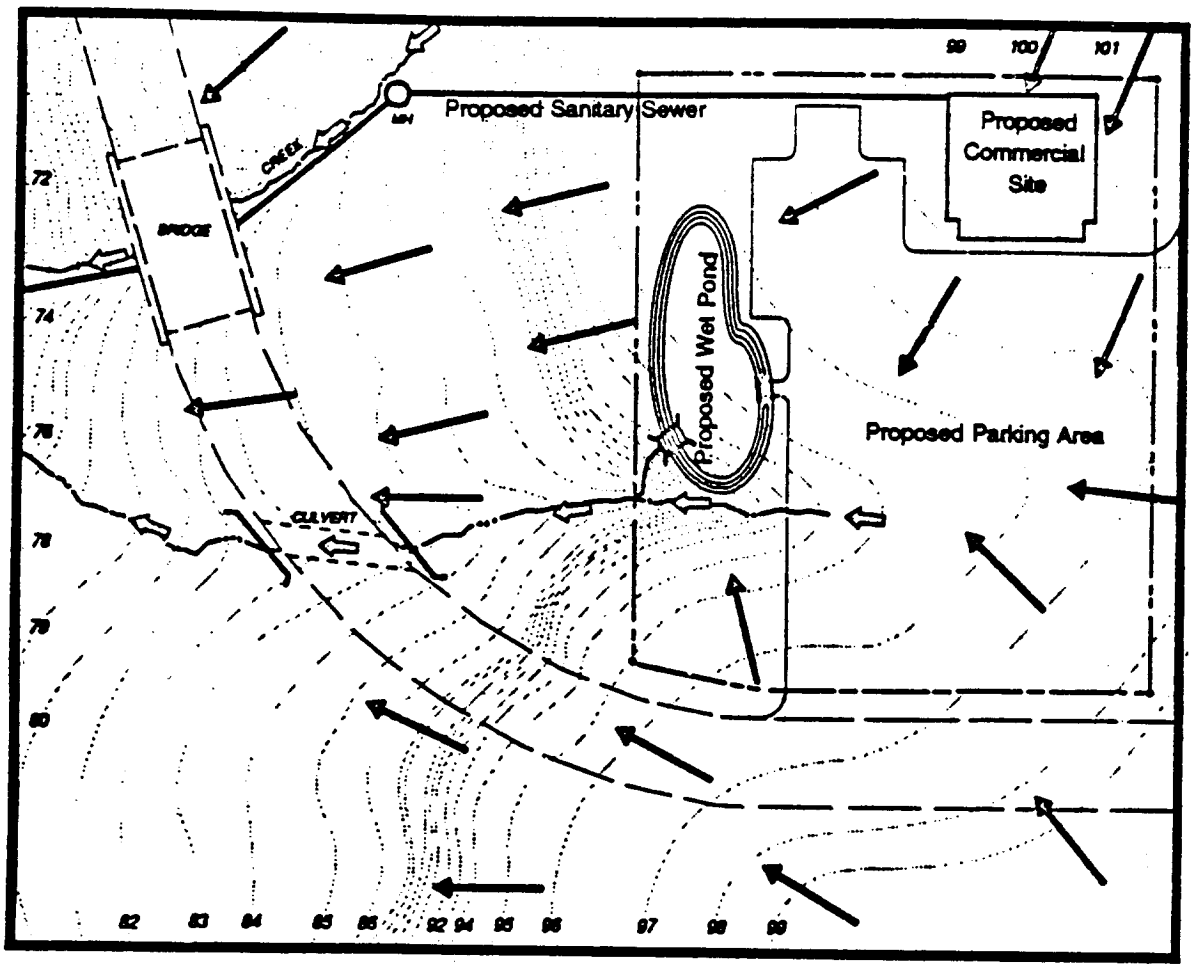

EXISTING FLOW CONDITIONS

OVERLAND

CHANNELIZED (CONCENTRATED)

0 60 120 180

SCALE IN FEET

Source: Adapted from City of Austin

FIGURE 2.2 SITE BASE MAP

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SELECT POST-CONSTRUCTION BMPs

Post-construction BMPs are the final improvements to and configuration of the project which are designed to control long-term storm water pollution. Post-construction BMPs are normally selected in the planning phase in conjunction with the approval of the tentative map, designed during the design phase of a project and completed to the satisfaction of the municipality and/or the ultimate owner. Occasionally, unforeseen natural or man-made factors may require revisions to or additions of post-construction BMPs during the construction phase. Post-construction BMPs are typically integrated with the normal project features (see box). In the planning phase (tentative map), it is important to indicate the maintenance responsibility for the post-construction BMPs.

During construction the contractor must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is complete it will then be the responsibility of the owner, private or public, to provide for long term operation and maintenance. A discussion of selecting post-construction BMPs is presented in Chapter 3 as well as in the Municipal Handbook.

ESTABLISH MAINTENANCE AGREEMENTS

The General Permit requires that the project owner arrange for the maintenance of any drainage/storm water pollution control measures after construction is complete. The local municipality usually will have an established policy defining maintenance responsibilities for community infrastructure, and may require a maintenance agreement as a condition for approval of a tentative map. Two fundamental choices exist:

- Private maintenance: Here, the owners of the property, after construction is complete, retain the responsibility for maintenance. The responsible party may be the owner or an association of property owners/homeowners. It is advisable that a formal agreement such as a deed restriction recorded on the property, be drawn between the municipality and the party responsible for maintenance.

- Public Maintenance: Here, a public agency agrees to assume the maintenance for some or all of the infrastructure. Such maintenance may be incorporated into a municipality-wide program, funded from the municipality's general fund or user fee structure. Alternatively, an agency or special district may be established, to assess property owners within the district. Common examples of special funding methods in California include community service areas (CSA), area drainage plans, and benefit assessment areas.

Typical Post-Construction BMPs

1. *Stabilize the site by establishing final land grades, contours, and drainage patterns.*
2. *Control of the volume, flow, and/or velocity of storm water runoff by such means as detention/retention basins, porous pavement, dry wells, debris basins, etc.*
3. *Channel stabilization, energy dissipators, or other drainage structures.*
4. *Permanent landscaping, rock rip rap, vegetation, or other permanent ground cover designed to stabilize the soil or slopes.*

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DESIGN PHASE

There are three principal activities which are typically incorporated into the SWPPP during the design phase:

- Prepare Project Site Plan
- Define BMP Objectives
- Design Post-Construction BMPs

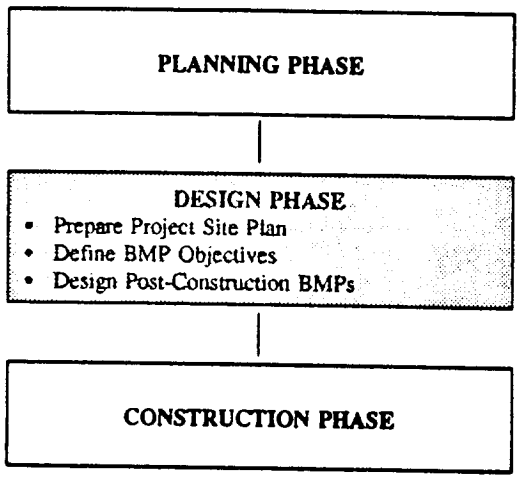
Design considerations for Post-Construction BMPs can be found in Chapter 5 of the Municipal BMP Handbook. The remainder of this section discusses how to incorporate the other two activities at little additional effort beyond normal project design activities.

PREPARE PROJECT SITE PLAN

Numerous studies, reports, and documents are typically prepared during preliminary and final design as the basis for many decisions about the project (see box, this page).

The Hydrology Report, Drainage Study, or similar document is typically required as part of project infrastructure design. Such a study is often required by the local municipality as a condition of a Tentative Map for a land development project, or as part of improvement plans or concept plans for public projects. The Hydrology Report should address the design storm which will be used for erosion and sedimentation control. A common design storm is a two-year, 24-hour storm.

The Soils Report is normally prepared based upon site soil sampling which will identify soil constraints, design criteria, slope stability, etc. Both of these reports are used by the engineer in preparation of the preliminary grading and drainage plan. They also form the technical basis for selection of erosion and sedimentation control BMPs and post-construction BMPs.



Studies and Reports Prepared during Project Design

Type of Report	*Information Available for the SWPPP*
Preliminary Design	
Soils Report	*Areas of highly erodible soils*
EIR/EA	*Previous and proposed uses of toxic materials on the site*
Preliminary Site Layout	*Locations of buildings and paved surfaces and/or lot layouts*
Final Design	
Drainage or Hydrology Report	*Drainage patterns and drainage area boundaries*
	Storm water conveyance structures
	Detention/retention facilities
Grading/Drainage Plan	*Areas of cut and fill*
	Slopes during and after construction
	Protection of existing vegetation
	Areas of soil disturbance
Landscape Plan	*Buffer areas and set backs*
	Permanent site stabilization
	Multi-purpose uses of open space

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Figure 2.3 shows a typical preliminary site layout based on information which is usually readily available during the preliminary design phase of a building project. This preliminary site plan includes several items which are required for the SWPPP:

- Locations of buildings and paved areas
- Proposed flow paths:
  - On-site flow paths where erosion during construction may occur and erosion and sedimentation BMPs should be applied.
  - Locations where runoff will leave the property.
  - Diversion of or conveyance for upstream runoff.
- Locations of flood control facilities and post-construction BMPs.
- Approximate locations where cut and fill will occur.
- Access points for construction traffic.
- Areas where existing vegetation may be preserved.
- Areas to be paved.
- Areas most suitable for the contractors yard, material storage area, and vehicle maintenance area (consider location in areas to be paved).

DEFINE BMP OBJECTIVES

During the final project design process, the engineer, architect or landscape architect will prepare detailed grading plans, paving and drainage plans, landscape plans, and other plans as necessary for the successful construction of the project. These plans provide the construction design requirements, specifications, and other construction documents necessary for the construction bidding, permitting, and inspection. For the SWPPP to be compatible with the other engineering plans, the most practical process may be for the engineer or architect to develop BMP objectives for the construction period based on contractor activities, and the grading and drainage plan for the site (see box).

BMP Objectives

- *Practice Good Housekeeping*
- *Contain Waste*
- *Minimize Disturbed Area*
- *Stabilize Disturbed Area*
- *Protect Slopes and Channels*
- *Control Perimeter of Site*
- *Control Internal Erosion*

A narrative discussion of these objectives should be prepared suitable for inclusion in the SWPPP, as well as to guide the BMP selection process. Worksheets 3, 4, and 5, at the end of this chapter, may be used in conjunction with the site map to define BMP objectives. The locations of various objectives can be shown on a site map (Figure 2.3). Determining objectives facilitates the selection of BMPs.

This step can occur as part of the grading and drainage plan and included in the bid package and/or construction documents for consideration by the contractor. This allows the owner to explicitly address unique site conditions which may impact storm water pollution control during construction. Alternatively, the owner could require the contractor to prepare such a map to justify the selection of BMPs.

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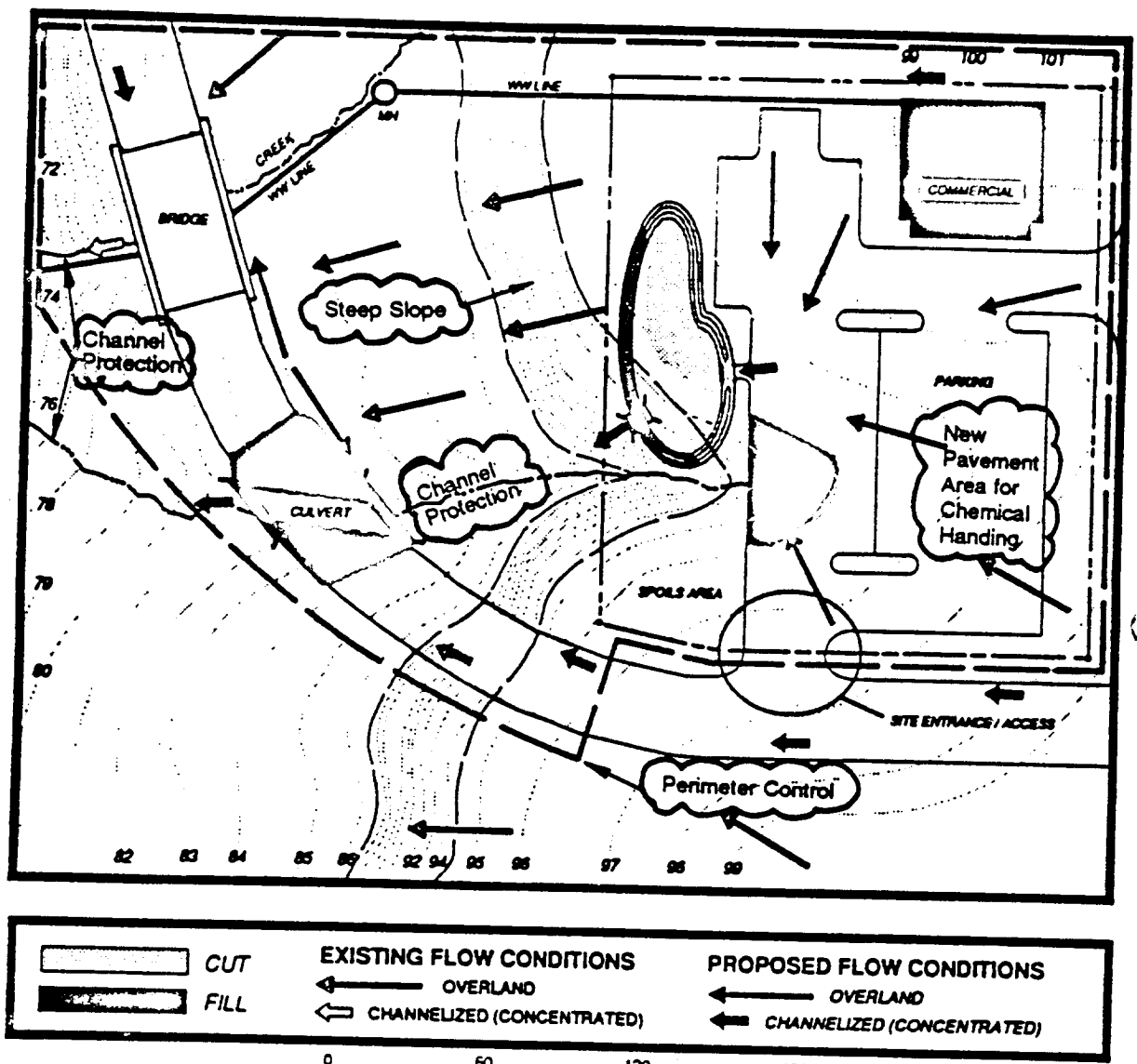

Source: Adapted from City of Austin

FIGURE 2.3 IDENTIFICATION OF BMP OBJECTIVES ON PRELIMINARY BASE MAP

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CONSTRUCTION PHASE:

BIDDING AND MOBILIZATION

During bidding and mobilization, the owner selects a contractor(s), who in turn, plans and prepares to construct the project according to the construction plans and specifications. Four activities which must be addressed during this phase include:

- Select BMPs
- Complete the SWPPP
- Submit the Notice of Intent (NOI)
- Train Personnel

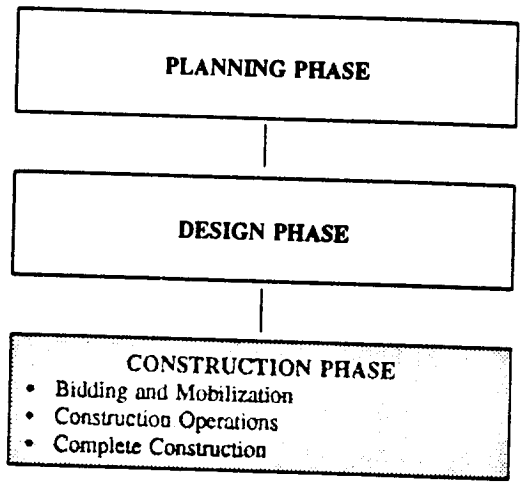
Select BMPs

Either the owner, the owner's design consultant, or the contractor may perform these activities, at the discretion of the owner and the local municipality. The construction documentation should specify what the responsibilities of the owner and the contractor are with regard to storm water pollution control both before, during and after construction.

Chapter 3 presents a complete discussion on selecting BMPs for construction activities which can be used by the owner, the project engineer, and the contractor, as appropriate. The following sections discuss how to complete the SWPPP and to prepare the NOI.

Complete the SWPPP

The SWPPP should be directed at personnel on the construction project (e.g., supervisors, foreman, inspectors). The SWPPP should provide specific guidance on actions to be taken by these personnel, and should be presented in a format which



accommodates day-to-day use (e.g., loose leaf, pullout sections, check lists). Worksheets for preparing the SWPPP are included at the end of this chapter.

Contents of the SWPPP - The SWPPP should provide a simple narrative and diagram that locates the construction site, identifies potential pollutant sources on-site, shows the location of the management practices to be used to *minimize* erosion and sedimentation during construction, describes measures which *eliminate* pollution of storm runoff by any chemicals and materials used during the construction process, and shows areas of long-term post-construction control measures. Information is provided either in narrative or site plan form (see box, next page). The level of detail will vary with the intensity, size and type of construction. The SWPPP may include copies of detail plans and specifications of the construction work.

Guidelines for SWPPP Preparation - The SWPPP should be an independent document which concisely provides the erosion, sedimentation and pollution control measures to be used. All of the necessary planning work has been done during the site

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planning and design process. The final step consists of consolidating the pertinent information and developing it into a specific erosion and sediment control plan for the project. The plan consists of three parts: a site plan, a narrative, and an inspection and maintenance plan. The site plan is one or more of a series of maps or drawings pictorially explaining information contained in the narrative. The narrative verbally explains the problems and their solutions with all necessary documentation. The inspection and maintenance plan describes the procedures whereby the BMPs are maintained in good and effective condition.

Contents of the SWPPP

Project Information (Worksheet 1)

- *Project Name and Location*
- *Owners Name and Address*
- *Contractors present on-site*
- *The Notice of Intent (NOI)*

Site Map(s) (Worksheet 2)

- *Project Location*
- *Area to be Disturbed*
- *Improvements to be Constructed*
- *On-site or Downstream Water Bodies and Water Courses*
- *Pre- and Post-Construction Drainage Patterns*
- *Locations where BMPs will be used*
  - *BMPs for Erosion and Sedimentation Control During Construction*
  - *BMPs for Other Contractor Activities (as appropriate)*
  - *Post-Construction BMPs to be Installed during Construction*

Narrative Descriptions (Worksheets 3, 4, 5 and 6)

- *Known sources of contamination on site before construction*
- *Construction activities which may cause storm water pollution*
- *Pollutants expected to be present on the construction site*
- *BMPs for these constituents/pollutant sources*
- *Responsible party for maintenance*

Monitoring, Inspection and Maintenance (Worksheet 7)

- *Inspection and reporting procedures*
- *Maintenance procedures*
- *Training program*

- *Site Plan*: The SWPPP site plan should be a simple illustration of the project site, showing key physical features and the location of erosion and sediment control measures and all construction operation measures such as entrance drives and construction yards. To the extent possible locally required grading plans and/or erosion control plans should be used in preparing the SWPPP.

  Two scales of site maps will usually be required for all but the smallest construction sites:

  Project Location Map: A figure showing the project site and the surrounding area (one-quarter mile beyond the project limits and with additional areas if necessary to clearly show local drainage patterns). A USGS 1:24000 scale topographic map is often used as a project location map.

  Detailed Site Plan: A series of one or more drawings of the construction site at a scale (typically, no smaller than 1 inch = 400 feet) sufficient to clearly show on-site drainage patterns and the location of erosion and sedimentation controls.

  Typical project construction drawings usually include a project site plan which includes most (if not all) of the required information. Simplified details and drawings may also be included or referenced where standard specifications exist. Worksheet 2 may be used as a check list for preparing a site plan.

  When the layout of the site has been decided upon, a plan to control erosion, sedimentation, and other pollutants from the disturbed areas must be formulated.

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Figure 2.4 is a typical site plan showing locations of BMPs for erosion and sedimentation control based for the BMP objectives indicated in Figure 2.3. Chapter 3 describes procedures for site assessment and BMP selection.

- *Narrative*: The narrative is a written statement which explains the erosion, sediment, and other pollutant control decisions made for a particular project and the justification for those decisions. The narrative should contain concise information concerning existing site conditions, construction schedules, and other pertinent items which are not contained in a typical site plan.

  Worksheets 3, 4, 5 and 6 are intended for guidance on preparing the narrative portions of the SWPPP.

  The narrative is important to the construction superintendent and inspector who are responsible for implementing the plan. It provides them with a single report which describes where and when the various BMPs for contractor activities, erosion and sediment control, and post-construction control should be installed.

- *Monitoring, Inspection, and Maintenance Plan*: Every BMP installed on a construction site must be checked periodically and maintained sufficiently to ensure proper performance. The construction general permit requires that an Inspection and Maintenance Plan be implemented which:

  - Assigns personnel responsible for BMP inspection and maintenance.
  - Requires maintenance of any BMPs whose effectiveness is compromised (e.g., replace failed BMPs, remove trapped sediment, increase size of spill containment flushed out by rain).
  - Keep inspection and maintenance records on file for at least three years.

  Maintenance requirements for each BMP are presented in Chapters 4 and 5. Chapter 6 discusses inspection requirements and methods for assessing the effectiveness of the BMPs.

Submit Notice of Intent

The construction general permit requires that a NOI be submitted to the State Water Resources Control Board (SWRCB) prior to the start of construction. The NOI is not an application for a permit and is not subject to approval--it simply notifies the SWRCB that a construction project is about to begin, the location of that project, the responsible parties, and a certification that a SWPPP has been prepared and will be followed. The owner of the construction project (i.e., permittee) is responsible for submitting the NOI. Owners who submit NOIs are authorized to discharge storm water under the terms and conditions of the construction general permit. The completed NOI must be attached to the SWPPP.

Where to Send the NOI - In California, all permit correspondence regarding the construction general permit (including the NOI and the appropriate annual fee) is submitted to:

California State Water Resources
Control Board
Division of Water Quality
Storm Water Permit Unit
P.O. Box 1977
Sacramento, California 95812-1977

The permittee may also be required to submit NOIs, as well as all other construction general permit correspondence,

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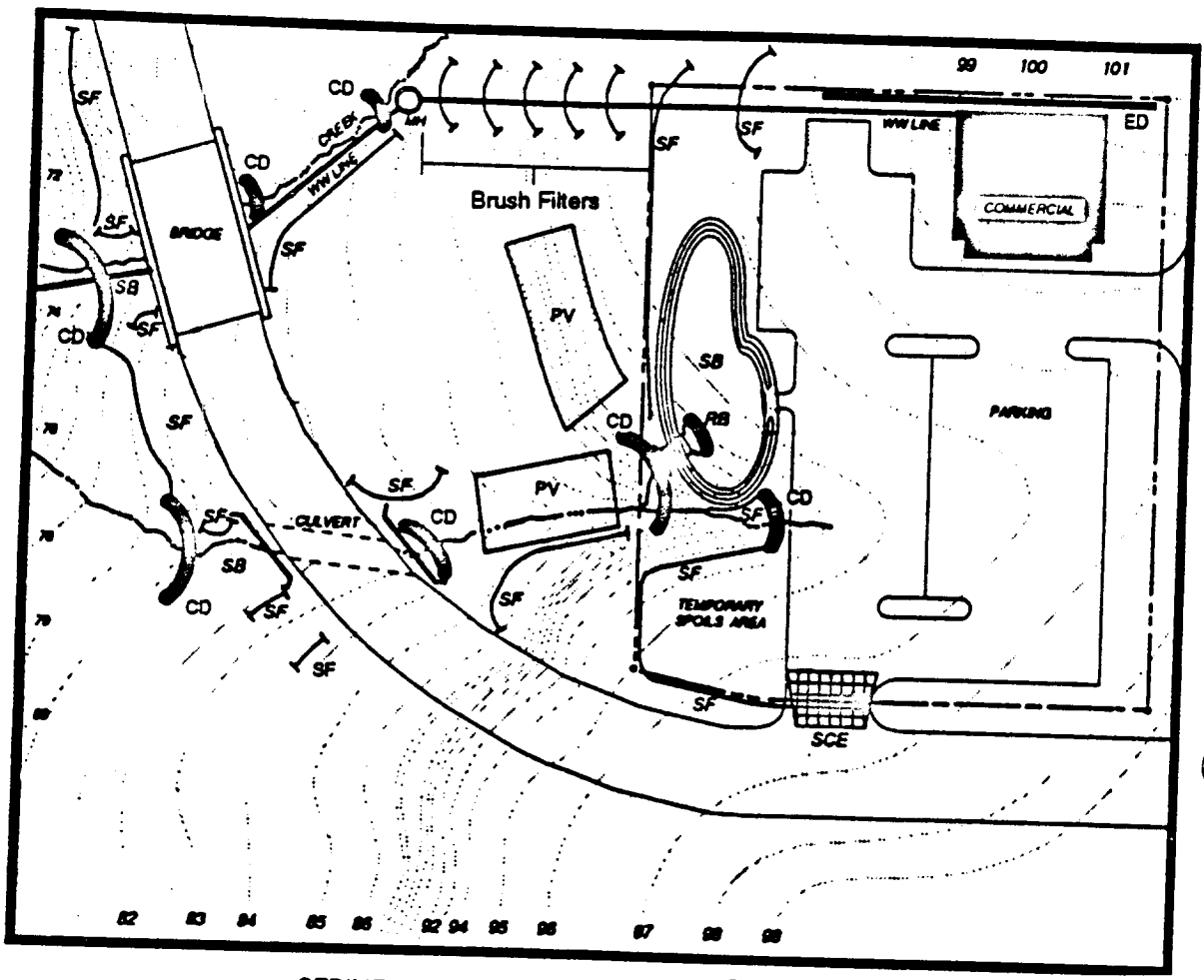

SEDIMENTATION CONTROL BMPs

RB	ROCK BERM
SF	SILT FENCE
BF	BRUSH FILTER
SB	SEDIMENT BASIN (TEMPORARY)
SCE	STABILIZED CONSTRUCTION ENTRANCE
ED	EARTH DIKE

EROSION CONTROL BMPs

CD	CHECK DAM
PV	PRESERVE EXISTING VEGETATION

0 60 120 180
SCALE IN FEET

Source: Adapted from City of Austin (1989)

FIGURE 2.4 SITE PLAN SHOWING LOCATIONS OF BMPs FOR EROSION AND SEDIMENTATION CONTROL

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to the local municipality. (Check with your local municipality.)

Failure to Submit the NOI - If a construction project begins before the NOI is submitted, the NOI should be submitted as soon as possible thereafter. All construction projects are subject to the general permit including projects which began before the general permit was issued. Owners of active construction projects without an NOI on file with the SWRCB, or without a SWPPP in place, are discharging storm water without an NPDES permit and are in violation of the Clean Water Act. Violations may result in fines or imprisonment. **Failure to comply with the Clean Water Act may result in fines up to *$25,000* per day of violation or any other appropriate sanction.** In California, the State may also bring forth civil and criminal penalties under the Porter-Cologne Water Quality Act. Municipalities may make plan approval, building permits, etc., subject to submittal of the NOI.

Contents of the NOI - The construction general permit and NOI are included in Appendix A. Much of the information provided on the NOI should have been developed for the SWPPP (see box).

The SWRCB has provided line-by-line instructions on the NOI. An annual fee must be submitted with the NOI. The SWRCB will send an annual invoice each year that the project is under construction.

TRAIN PERSONNEL

Training is imperative to the success of the BMPs identified in Chapters 4 and 5. Adequate training is required if these BMPs are to be installed and maintained properly.

Contents of the Notice of Intent

- *Owner/Developer's Name, Address, and Telephone Number*
- *Construction Site Information*
  - *Project Name and Address*
  - *Construction Start and Completion Date*
- *Site Map*
  - *Existing and proposed buildings and paved areas*
  - *Storm drainage system*
  - *Adjacent streets*
- *Receiving Water Information*
  - *Municipality where project is located*
  - *Nearest downstream water course or water body (from USGS Map or equivalent)*
- *Type of Construction*
  - *Size of site*
  - *Change in impervious surface area*
- *Material Handling/Management Practices*
  - *Materials to be used during construction*
  - *Management practices to control possible pollutants*
- *Regulatory Status*

These BMPs will fail if not properly installed and maintained. Thus, only trained personnel should be assigned these responsibilities.

An effective training program is based on four objectives:

- How to identify a storm water pollution problem;
- How to define solutions (i.e., select BMPs);
- Making every employee responsible for storm water pollution and its solution; and
- Soliciting feedback to improve the BMPs.

More information on employee training can be found in BMP CA40 in Chapter 4.

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CONSTRUCTION OPERATIONS

The construction bid package will usually contain specifications that the contractor comply with the construction general permit by implementing the SWPPP. This may be done contractually, or the owner may require the contractor/subcontractor to prepare some or all of the SWPPP, and submit the NOI/fee to cover their particular construction activity. During construction, the contractor then implements the BMPs according to the SWPPP. The owner/contractor is also responsible for maintenance and inspection of BMPs for erosion and sediment control and other contractor activities, and the installation of the post-construction BMPs. Because site conditions will vary during construction, the SWPPP should be revised as necessary, with any changes highlighted on the copy maintained at the construction site. There is no formal revision process; upon inspection the SWPPP must reflect the existing status and condition of these site.

If the plan is found to be deficient in meeting one or more of the minimum construction general permit requirements and/or requirements of the local municipality, the owner will be notified by the SWRCB. The owner then has 30 days to provide the SWRCB and/or the municipality written certification that the requested changes have been made.

COMPLETE CONSTRUCTION

During construction, the post-construction BMPs (if any) should have been installed according to construction plans and specifications (see the Design Phase section of this chapter). The general construction permit remains in force until construction is complete. Post-construction BMPs should be properly installed, and responsible parties must be designated and funds committed to the long-term maintenance needs of these BMPs. The local municipality will often have a policy about the installation and maintenance of these post-construction BMPs, and should be consulted.

The SWRCB (and possibly the local municipality) must be notified of two conditions:

- When construction is completed
- When a change of ownership occurs

The SWRCB requires that a Notice of Termination be provided for such notification. If a new owner is assuming responsibility for some or all of the construction site, a revised Notice of Intent and annual fee must also be submitted, and the SWPPP must be revised by the new owner for any changes in construction conditions. It may be appropriate to notify the SWRCB of other significant changes in the status of the property (e.g., the construction site is part of an annexation or incorporation, a change in address) to eliminate any confusion about a particular site. As conditions of project approval, the municipality may also require that the owner be responsible for the performance of post-construction BMPs for a set period of time after the municipality has accepted the improvement and/or after an Occupancy Certification is issued.

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REVISIONS	DATE

NOI attached?
[ ] Yes
[ ] No

Storm Water Pollution Prevention Plan (SWPPP) Worksheet
California Construction General Permit

Worksheet 1. Project Information

Project Name: _____

Project Location: Street Address (or Equivalent): _____

City: _____ County: _____ Zip Code: _____

Project Owner: _____

Contact Person: _____ Phone No. _____

Owner's Mailing Address: Street Address (or Equivalent): _____

City: _____ County: _____ Zip Code: _____

[ ] Identify responsible personnel:

[ ] Implementing and revising the SWPPP: _____

[ ] Inspecting equipment: _____

[ ] Regular inspections of BMPs: _____

[ ] Training employees about BMPs affecting their job: _____

List all Contractors and Subcontractors responsible for implementing SWPPP for the project:

NAME	CONTACT PERSON	DATE WORK BEGINS	DATE WORK ENDS

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Worksheet 2. Project Site Map Requirements

Please Check the Boxes, and provide supporting information as requested:

[ ] Topographic Base Map Attached? Map shows:

- [ ] An area extending one-quarter mile beyond the property boundaries of the construction site:
- [ ] The boundary of the construction site. Construction Area = _____ Acres.
- [ ] Nearby surface water bodies, including water courses, wetlands, springs and wells.
- [ ] The location(s) where storm water drains onto or off of the property.
- [ ] Boundary of off-site areas that drain into the construction site.

[ ] Site map(s) attached? Maps show:

- [ ] Temporary storm water structures used during construction.
- [ ] Areas used to store soils and construction waste.
- [ ] Areas of cut and fill.
- [ ] Drainage patterns and slopes anticipated after major grading activities, including the location of storm water structures to be constructed on the property (e.g., storm drains, detention ponds, channels).
- [ ] Areas of soil disturbance.
- [ ] Locations of potential soil erosion requiring BMPs during construction.
- [ ] Existing and proposed paved areas and buildings.

  Existing Area:_____ percent of site Proposed Area: _____ percent of site

- [ ] Estimated runoff coefficient before construction: _____ after construction _____
  (See the local municipality for approved runoff coefficients for your community.)
- [ ] Locations where storm water structures and controls will be built to control storm water pollution after construction is complete.
- [ ] The boundary of the drainage area upstream of each location where storm water leaves the property.
- [ ] Any vehicles storage and service areas.
- [ ] Areas of existing vegetation.

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Worksheet 3. Inventory of Contractor's Activities and Special Site Conditions

Provide a description of contractor's activities that could result in the discharge of pollutants in the storm water runoff from the site. In addition, provide a description of special site conditions that may impact pollutants in storm water discharges.

Contractor's Activities

[ ] Describe toxic materials that are known to have been stored, disposed, spilled, or leaked in significant quantities onto the construction site:

[ ] Describe construction materials, equipment and vehicles that comes in contact with storm water:

[ ] Describe construction material loading, unloading and access areas/activities:

[ ] Describe equipment storage, cleaning, and maintenance areas/activities:

[ ] Describe storage and disposal of construction materials (on-site and off-site):

Special Site Conditions

[ ] Describe storm water structures and controls on the site prior to construction and how these structures/controls will be integrated into the SWPPP to reduce sediment and other pollutants in storm water discharges:

[ ] List materials/waters other than storm water which will flow from the site during dry weather, the approximate amount of flow, and methods for preventing other dry weather flows:

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Worksheet 4. BMPs for Contractor Activities

Provide a list of BMPs selected to reduce pollutants associated with contractor activities (see Worksheet 3). For each BMP selected, identify the pollution(s) of concern (see Table 1.1). Attach modified BMP fact sheets and/or appropriate information for the BMP selected. (See Chapter 4, BMPs for Contract or Activities.)

Contractor Activities (Worksheet 3)	Construction Practices			Materials Management			Waste Management					Vehicle & Equipment Management			Primary Pollutant(s) of Concern
	CA1	CA2	CA3	CA10	CA11	CA12	CA20	CA21	CA22	CA23	CA24	CA30	CA31	CA32	
1. Toxic material on-site															
2. Construction material equipment & vehicles in contact with storm water															
3. Material loading, unloading and access areas/activities															
4. Equipment storage cleaning, and maintenance areas/activities															
5. Storage and disposal of construction materials (on-site and off-site)															

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Worksheet 5. BMPs for Erosion and Sedimentation Control

[ ] Describe the source and composition of the existing soil and fill material (Soil Report Attached? Yes____ No____)

[ ] Provide a site map showing locations where BMPs for erosion and sediment control are placed. This map should be updated when BMPs are revised to meet evolving construction conditions. Provide a brief description of BMP selected, and, if appropriate, attach modified fact sheets or additional information for erosion and sedimentation control BMPs.

✔	BMPs SELECTED	DESCRIPTION OF BMPs FOR EROSION & SEDIMENTATION CONTROL
SITE PLANNING CONSIDERATIONS		
	Scheduling	
	Preservation of Existing Vegetation	
SOIL STABILIZATION		
	Seeding and Planting	
	Mulching	
PHYSICAL STABILIZATION		
	Geotextiles and Mats	
	Dust Control	
	Temporary Stream Crossing	
	Construction Road Stabilization	
	Stabilized Construction Entrance	

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✓	BMPs SELECTED	DESCRIPTION OF BMPs FOR EROSION & SEDIMENTATION CONTROL
DIVERSION OF RUNOFF		
	Earth Dike	
	Temporary Drains and Swales	
	Slope Drain	
VELOCITY REDUCTION		
	Outlet Protection	
	Check Dams	
	Slope Roughening/Terracing	
SEDIMENT TRAPPING/FILTERING		
	Silt Fence	
	Straw Bale Barrier	
	Sand Bag Barrier	
	Rock or Brush Filter	
	Storm Drain Inlet Protection	
	Sediment Trap	
	Sediment Basin	

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Worksheet 6. Post-Construction BMPs

Provide a site map locating treatment control BMPs which will be constructed as part of this project to reduce storm water pollution after construction is complete. Selection of these and other post-construction BMPs may be guided using the Municipal BMP Handbook, and must consider site-specific and seasonal conditions. Provide on the worksheet below the BMP selected, the responsible party for maintenance and operation, and source for funding the operation and maintenance.

✔	BMPs SELECTED	MAINTENANCE RESPONSIBILITY	FUNDING SOURCE FOR O&M
	TREATMENT CONTROL BMPs (See Chapter 5, Municipal Handbook)		
	Infiltration		
	Wet Ponds		
	Constructed Wetlands		
	Vegetated Swales and Strips		
	Extended Detention Basins		
	Media Filtration		
	Oil/Water Separators and Water Quality Inlets		
	Multiple Systems		
	SOURCE CONTROL BMPs (See Chapter 4, Municipal Handbook)		

Describe other measures which will be employed on the project site to control storm water pollution after construction is complete, and steps to be taken by the current owner to ensure that these measures are conducted.

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Worksheet 7. Monitoring, Inspection and Maintenance Plan

[ ] Describe maintenance/repair efforts to ensure BMPs are in good and effective condition:

[ ] Describe inspection procedures and record keeping efforts:

[ ] Annual Inspection:

[ ] Pre-storm Inspection:

[ ] Post-storm Inspection:

[ ] Describe training program/material for site personnel responsible for installing, inspecting, and maintaining BMPs:

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Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name_____ Title_____

Signature_____ Date_____

This SWPPP was prepared by:

Name_____ Title_____

Signature_____ Date_____

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3. BMP SELECTION

OVERVIEW

BMPs are generally selected in a three step process:

- Define BMP Objectives: Define locations where erosion is likely to occur, and where other construction related pollutants may be generated.
- Identify BMP Category: Select the appropriate category or categories of BMPs which address each objective.
- Select appropriate BMPs: BMPs for contractor activities and erosion and sedimentation control are chosen from each category based on site constraints, construction requirements, and cost-effectiveness considerations.

Table 3.1 shows the relationship between BMP objectives and categories of BMPs. Chapters 4 and 5 present the particular BMPs by each category, including key information describing appropriate applications and cost-effectiveness considerations. The number in parentheses correspond to the BMP Fact Sheets in Chapters 4 and 5 (CA stands for Contractor Activities and ESC stands for Erosion and Sedimentation Control). The remainder of this chapter outlines a BMP selection process. **The selection procedures for post-construction BMPs are discussed briefly at the end of this chapter and in more detail in the Municipal BMP Handbook.**

DEFINE BMP OBJECTIVES

Each construction project is unique. Therefore, an understanding of the pollution risks of the construction activity is essential for selecting and implementing BMPs. Defining these risks requires review of the characteristics of the site and the nature of the construction, information which you should have assembled for the SWPPP. Once these pollution risks are defined, BMP objectives are developed, and BMPs selected. The BMP objectives for construction projects are as follows:

- Practice Good Housekeeping: Perform activities in a manner which keeps potential pollutants from either draining or being transported off-site by managing pollutant sources and modifying construction activities.
- Contain Waste: Dispose of all construction waste in designated areas, and keep storm water from flowing on to or off of these areas.
- Minimize Disturbed Areas: Only clear land which will be actively under construction in the near term (e.g., within the next 6-12 months), minimize new land disturbance during the rainy season, and avoid clearing/disturbing sensitive areas (e.g., steep slopes and natural watercourses) and other areas where site improvements will not be constructed.
- Stabilize Disturbed Areas: Provide temporary stabilization of disturbed soils whenever active construction is not occurring on a portion of the site. Provide permanent stabilization during finish grade and landscape the site.

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BMP CATEGORY	BMP OBJECTIVES						
	Practice Good Housekeeping	Contain Waste	Minimize Disturbed Areas	Stabilize Disturbed Areas	Protect Slope & Channels	Control Site Perimeter	Control Internal Erosion
BMPs FOR CONTRACTOR ACTIVITIES (Chapter 4)							
Construction Practices (CA 1 to 10)	✓			✓	✓	✓	✓
Material Management (CA 10 to 19)	✓						
Waste Management (CA 20 to 29)		✓	✓	✓			
Vehicle & Equipment Management (CA 30 to 39)	✓					✓	✓
Contractor Training (CA40)	✓	✓					
BMPs FOR EROSION & SEDIMENT CONTROL (Chapter 5)							
Site Planning Considerations (ESC 01 to ESC 10)	✓	✓	✓	✓	✓	✓	✓
Vegetative Stabilization (ESC 10 to ESC 19)				✓	✓		
Physical Stabilization (ESC 20 to ESC 29)	✓		✓	✓	✓	✓	
Diversion of Runoff (ESC 30 to ESC 39)		✓			✓	✓	✓
Velocity Reduction (ESC 40 to ESC 49)				✓	✓		
Sediment Trapping/Filtering (ESC 50 to ESC 59)					✓	✓	✓
POST CONSTRUCTION BMPs (See Municipal BMP Handbook)				✓	✓	✓	✓

TABLE 3.1 CATEGORIES OF BMPs AND THE BMP OBJECTIVES MET BY EACH

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- Protect Slopes and Channels: Outside of approved grading plan area, avoid disturbing steep or unstable slopes. Safely convey runoff from the top of the slope, and stabilize disturbed slopes as quickly as possible. Avoid disturbing natural channels. Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in runoff velocity caused by the project do not erode the channel.

- Control Site Perimeter: Upstream runoff should be diverted around or safely conveyed through the construction project. Local codes usually state that such diversions must not cause downstream property damage or be diverted into another watershed. Runoff from the project site should be free of excessive sediment and other constituents.

- Control Internal Erosion: Detain sediment-laden waters from disturbed, active areas within the site.

Site characteristics and contractor activities affect both the potential for erosion and contamination by other constituents used on the construction site. Before defining BMP objectives, you should carefully consider:

1. Site conditions that affect sedimentation and erosion including:
   a. Soil type, including underlying soil strata which are likely to be exposed to storm water.
   b. Natural terrain and slope.
   c. Final slopes and grades.
   d. Location of concentrated flows, storm drains, and streams.
   e. Existing vegetation and ground cover.

2. Climatic factors, which in arid and semi-arid regions include:
   a. Seasonal rainfall patterns.
   b. Appropriate design storm
      - quantity of rainfall
      - intensity of rainfall

3. Type of construction activity.

4. Construction schedules.

5. Construction sequencing and phasing of construction.

6. Size of construction project and area to be graded.

7. Location of the construction activity relative to adjacent uses and public improvements.

8. Cost-effectiveness considerations.

9. Types of construction materials and potential pollutants present on-site.

Chapter 2 discussed how these considerations are incorporated into site planning (see Figure 2.3) and design activities.

IDENTIFY BMP CATEGORIES

Once the BMP objectives are defined, it is necessary to identify the category of BMPs that is best suited to meet each objective. A category is a groupings of BMPs which are related in how they control storm water pollution (see Table 3.1). The particular BMP selected from each category depends on the specific site conditions, construction activities, and cost-effectiveness considerations.

To determine where to place categories of BMPs, a map of the project site is prepared (Chapter 2) with sufficient topographic detail to show existing and proposed drainage patterns and existing and proposed permanent storm water control structures. The project site map should identify the following:

- Locations where storm water enters and exits the site. Include both sheet and channel flow for the existing and final grading contours.

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- Locate permanent storm water collection and control structures.

- Identify locations subject to high rates of erosion such as steep slopes and unlined channels. Long, steep slopes over 100' in length are considered as areas of moderate to high erosion potential.

- Categorize slopes as:

  - Low Erosion Potential (0 to 5 percent slope)
  - Moderate Erosion Potential (5 to 10 percent slope)
  - High Erosion Potential (slope greater than 10 percent)

- Identify sensitive areas which must not be disturbed, as well as other areas where site improvements will not be constructed. Establish clearing limits around these areas to prevent disturbance by the construction activity.

- Identify the boundaries of drainage areas if your site has more than one drainage outlet. Then calculate the approximate area of each drainage area.

- Define areas where various contractor activities have a likely risk of causing a pollutant discharge.

With this site map in hand, categories of BMPs can be selected and located. In Figure 3.1, the example presented in Chapter 2 is modified to show the integration of BMP categories into the site plan. In general, the categories of BMPs should be considered in the order listed in Table 3.1. This is because it is more effective to prevent erosion/pollution than to remove sediment/pollutants, and because erosion prevention is achieved most cost-effectively by planning before construction begins and phasing construction activities.

As shown in Table 3.1, many BMPs achieve more than one BMP objective. This should be taken into account when selecting BMPs to achieve maximum cost-effectiveness. For instance, it is not always necessary to install extensive sediment trapping controls during construction. In fact, sediment trapping should be used only as a short-term measure for active construction areas, and replaced by permanent stabilization measures as soon as possible. In arid and semi-arid areas of California, the seasonal rainfall patterns are such that for *short* duration construction activities, the scheduling of the grading activities is often a site planning management strategy. However, because the timing of construction may be difficult to predict and rainfall may occur in off seasons, the contractor should always stabilize each portion of the construction site as soon as active construction ends, and install sediment trapping BMPs.

SELECTING BMPS FOR CONTRACTOR ACTIVITIES

Certain contractor activities (see box, page 3-6) may cause pollution if not properly managed. BMPs should be selected for each activity shown in the box.

Chapter 4 describes BMPs for preventing storm water pollution potentially caused by these contractor activities. Not all of the BMPs listed on each fact sheet will apply to every construction site. However, all of the suggested BMPs in Chapter 4 should be considered, and those which are appropriate for the project at hand should be selected. When the Fact Sheets in Chapter 4 suggest several BMPs for a particular construction activity, the activity must be evaluated and the risk assessed of pollutants reaching the drainage system or otherwise being transported off-site. Considerations include the following:

- Is it expected to rain? BMPs may be different on rainy days vs. dry days, winter vs. summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer.

- How much material is used? Less stringent BMPs may be used if a "small" amount of

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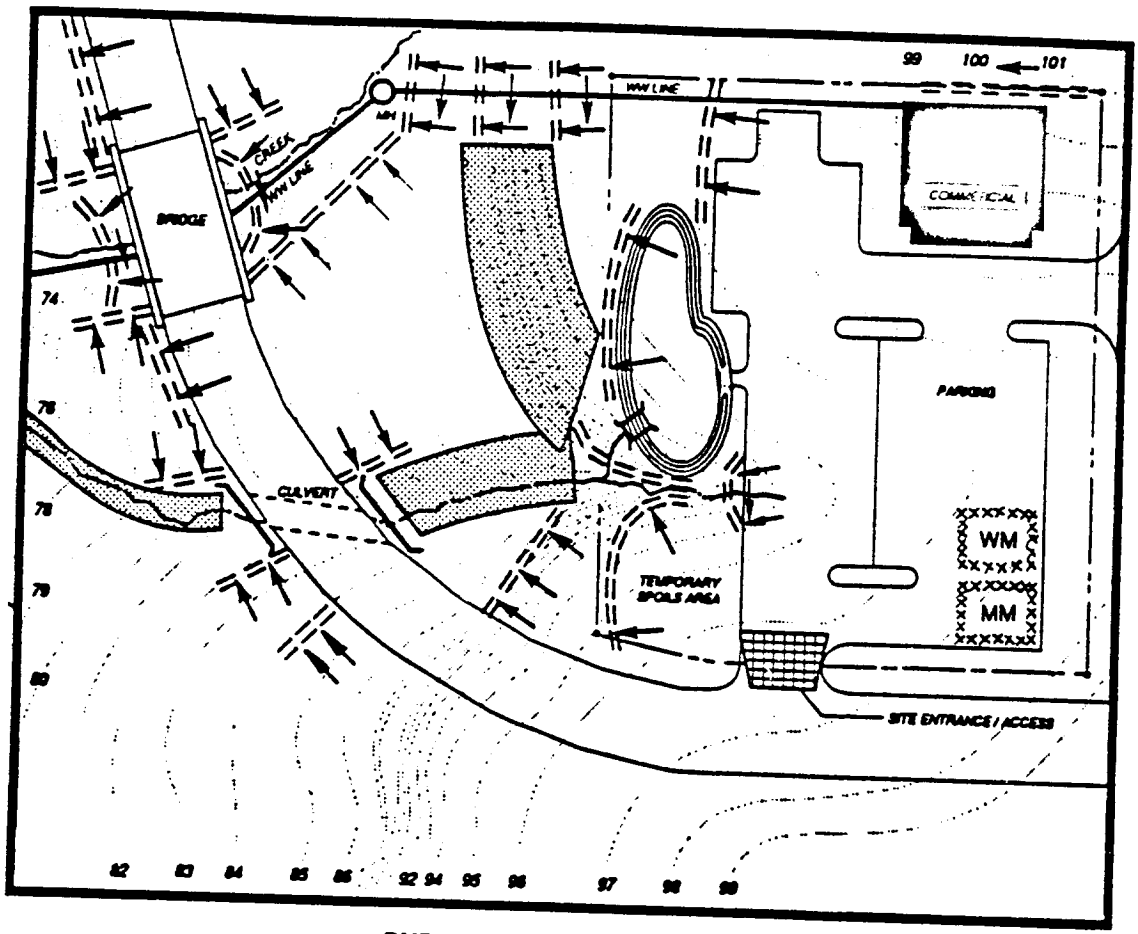

BMP CATEGORIES

- MM — MATERIAL MANAGEMENT
- WM — WASTE MANAGEMENT
- SITE PLANNING
- PHYSICAL STABILIZATION
- DIVERSION
- VELOCITY REDUCTION
- SEDIMENT TRAPPING
- POST-CONSTRUCTION

0 60 120 180
SCALE IN FEET

FIGURE 3.1 SELECTION OF BMP CATEGORIES

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Contractor Activities That Impact Storm Water Quality

Construction Practices
- Dewatering Operations (CA1)
- Paving Operations (CA2)
- Structure Construction (Wood, Concrete, Steel) and Painting (CA3)

Material Management
- Material Delivery and Storage (CA10)
- Material Use (CA11)
- Spill Prevention and Control (CA12)

Waste Management
- Solid Waste (CA20)
- Hazardous Waste (CA21)
- Contaminated Soils (CA22)
- Concrete Wastes, Sandblasting Grit (CA23)
- Sanitary/Septic Waste (CA24)

Vehicle and Equipment Management
- Cleaning (CA30)
- Fueling (CA31)
- Maintenance (CA32)

Note: The number in parenthesis corresponds to the BMP Fact Sheet in Chapter 4.

material is used (however, remember that different materials pollute in different amounts).

- How much water is used? The more water used and wastewater generated, the more likely that pollutants transported by this water will reach the drainage system or be transported off-site. Washing out one concrete truck on a flat area of the site may be sufficient (as long as the concrete is safely removed later), but a containment pit should be constructed if a number of trucks will be washed out at the same site. Consideration should be given to recycling water whenever possible.

- What are the site conditions? BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a drainage structure or watercourse, etc. Anticipating problems and conducting activities away from certain sensitive areas will reduce the cost and inconvenience of performing BMPs.

- What about accidents? Pre-establishing a BMP for every conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common activities, and be prepared to respond quickly to accidents (define the difference--not everything can be called an accident).

Therefore, keep in mind that the BMPs for contractor activities in Chapter 4 are suggested practices which may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs which are more cost-effective for a particular project. **The best BMP is a construction work force aware of the pollution potential of their activities, and committed to a clean worksite.**

SELECTING BMPs FOR EROSION AND SEDIMENT CONTROL

BMPs for erosion and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost-effectiveness. Different BMPs may be needed at different times during construction since construction activities are constantly changing site conditions. Thus the SWPPP may include a set of BMPs suitable for different stages of the project. Refer to Table 3.1 to match the BMP objective to the appropriate category of BMPs in Chapter 5. The remainder of this section discusses how each BMP objective in Table 3.1 should be met to address the dynamics of a typical construction project.

MINIMIZE DISTURBED AREAS

The first step for selecting BMPs is to compare the project layout and schedule with on-site management measures that where appropriate can limit the exposure of the project site to erosion and sedimentation. Scheduling and

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planning considerations are generally discussed in Section 2, with each site planning BMP described in detail in the first section of Chapter 5. These BMPs all have a similar goal, which is to minimize the amount of the site subject to erosion. Consider the following BMPs:

1. Do not disturb any portion of the site unless an improvement is to be constructed there.

2. The staging and timing of construction can minimize the size of exposed areas and the length of time the areas are exposed and subject to erosion.

3. The staging of grading operations should limit the amount of areas exposed to erosion at any one time. Only the areas that are actively involved in cut and fill operations or are otherwise being graded should be exposed. Exposed areas should be stabilized as soon as grading is complete in that area.

4. Retain existing vegetation and ground cover where feasible, especially along watercourses and along the downstream perimeter of the site.

5. Do not clear any portion of the site until active construction begins.

6. Quickly complete construction on each portion of the site.

7. Install landscaping and other improvements that permanently stabilize each part of the site immediately after the land has been graded to its final contour.

8. Minimize the amount of denuded areas and any new grading activities during the wet months of October through April.

9. Construct post-construction storm water control facilities (e.g., detention basins) early in the project and use for sediment trapping, slope stabilization, velocity reduction, etc. during the construction period.

Site Stabilization BMPs

Vegetative Stabilization
- Seeding and Planting (ESC10)
- Mulching (ESC11)

Physical Stabilization
- Geotextiles and Mats (ESC20)
- Dust Control (ESC21)
- Temporary Stream Crossing (ESC22)
- Construction Road Stabilization (ESC23)
- Stabilized Construction Entrance (ESC24)

STABILIZE DISTURBED AREAS

The purpose of site stabilization BMPs is to prevent erosion by covering disturbed soil. This covering may be vegetative, chemical, or physical (see box, above). Any exposed soil is subject to erosion--either by rainfall striking the ground, runoff flowing over the soil, wind blowing across the soil, and vehicles driving on the soil. Thus all exposed soils should be stabilized except where active construction is in progress. Locations on a construction site which are particularly subject to erosion and should be stabilized as soon as possible include:

- Slopes
- Highly erosive soils
- Construction entrances
- Stream channels
- Soil stockpiles

Stabilize disturbed areas keeping in mind the following:

1. As a rule, native vegetation in undisturbed areas represents the "baseline" for erosion control. The Subdivision Map Act provides language to limit erosion to pre-development levels. Thus, retaining native vegetation in undisturbed areas provides the first and best line of defense against erosion and sedimentation and does so at least cost to the contractor, while minimizing the requirement to revegetate or provide structural controls.

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2. Temporary ground covers (e.g., temporary seeding, mulch, chemical and fabric stabilizers) protect the soil from erosion until permanent vegetation can be established or permanent construction is installed.

3. Timing of revegetation efforts is critical in arid regions. Revegetation should be performed just before or during the rainy season unless an irrigation system exists on-site.

4. Certain relative non-toxic chemicals, such as magnesium chloride or lignum sulfate may be used for soil stabilization where revegetation is not practicable (see ESC21, Dust Control, Chapter 5). These two chemicals do not have an adverse impact on plant life and are a low-cost stabilization treatment.

5. Ground cover of gravel, decomposed granite, wood chips, or mulch may be used.

6. Oil treatment or sodium chloride is unacceptable.

PROTECT SLOPES AND CHANNELS

The next step is to provide slope protection in disturbed areas. Consider the following BMPs:

1. Avoid constructing steep slopes. Increasing slope length and steepness increases the velocity of runoff, which greatly increases its erosive energy. If slope steepness is doubled while other factors are held constant, soil loss potential is increased 2½ times. If both slope steepness and length are doubled, soil loss potential is nearly 4 times greater.

2. Divert or intercept storm water before it reaches long and/or steep slopes using temporary dikes, swales, or pipe slope drains.

3. Long or steep slopes should be terraced at regular intervals (per local requirements). Terraces will slow down the runoff and provide a place for small amounts of sediment to settle out.

4. Slope benches may be constructed with either ditches along them or back-sloped at a gentle angle toward the hill. These benches and ditches intercept runoff before it can reach an erosive velocity and divert it to a stable outlet.

5. Slope stability for cuts and fills should conform to local agency grading ordinances, Uniform Building Code requirements, and/or soil report recommendations.

6. Overland flow velocities can be reduced by creating a rough surface for runoff to cross. Driving a bulldozer up and down a slope (called trackwalking) creates tread marks parallel to slope contours. These miniature terraces both slow runoff velocity and provide flat places for vegetation to hold.

7. Raking or disking the soil surface before seeding also keeps runoff velocities down and increases plant establishment rates. Vegetation, once established, will further reduce runoff rates.

8. Build check dams or other energy dissipation structures in unlined drainage channels to slow runoff velocity and encourage settlement of sediments.

9. Construct velocity reducing structures or riprap linings as soon as storm water outfalls are constructed.

CONTROL SITE PERIMETER

Perimeter control establishes barriers along the perimeter of the project site. Several strategies

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for using BMPs for perimeter control may be considered.

1. Divert upstream runoff around or though the construction site (according to local drainage policies) with no contact with exposed soils or construction activities (i.e., the diversion of runoff BMP category);

2. Runoff from areas upslope of those that have been denuded should not be allowed to cross the exposed soils, particularly when the denuded areas are on slopes (i.e., the diversion of runoff BMP category);

3. Leave a vegetative barrier along the property boundary and interior water courses (i.e., the site planning BMP category); and

4. Trap and remove sediment in runoff from the construction site before it leaves the property (i.e., the sediment trapping BMP category).

Perimeter controls should be placed everywhere runoff enters or leaves the site. They are usually installed just before clearing, grubbing and rough grading begin. Perimeter controls for all but the smallest projects will become overloaded by both runoff and sediment, and should be supplemented by additional controls within the interior of the construction site once rough grading is complete.

Runoff which is free of excessive sediment should be diverted around disturbed areas of the construction site and other locations highly susceptible to erosion. If possible, the runoff should be diverted to stabilized areas where the runoff can be retained and allowed to soak into the ground, or into stabilized drainage ways with sufficient hydraulic capacity to convey any increases in flow. Major flow diversions (i.e., from areas greater than 1 acre) should be designed according to local design standards, and approved by the local municipality as part of the project approval process. This avoids potential flood damage to the construction site or downstream areas. When possible, permanent drainage structures should be built early in the construction project to collect and convey flow diversions.

Runoff Diversion BMPS

- Earth Dike (ESC30)
- Temporary Drains/ Swales/Drains (ESC31)
- Slope Drain (ESC32)

Note: Runoff diversions from areas greater than 1 acre should be constructed according to local drainage design criteria.

Several types of temporary runoff diversions are described in this Handbook (see box, above). Runoff diversions should be considered in the following situations:

1. Divert upslope water around unvegetated areas of the construction site with dikes, swales, or temporary storm drains.

2. Divert runoff to soils able to absorb water (areas which are vegetated, mulched, or where surface roughening exists.

3. Dikes and ditches are the two most common BMPs to divert upland runoff away from a disturbed area; to intercept runoff on cut or fill slopes; and to prevent runoff from entering a disturbed area, such as a group of building pads.

4. Upstream, off-site flow can be taken to the downstream area of the project site and released (according to local drainage policies) back into the natural drainage pattern. A spreading basin or other temporary form of energy dissipator may be needed for large diverted flows or at the base of steep slopes.

5. Perimeter channel or berm to divert flow should not flood, cause erosion or otherwise adversely impact surrounding properties. While structures designed for

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sediment control are temporary and are designed to remove sediment from frequent storms (e.g., less than 2-year storm), they must be designed to safely detain and/or carry major floods without increased risk of property damage.

CONTROL INTERNAL EROSION

Once all other erosion and sediment control BMPs have been exhausted, excessive sediment should be removed from the storm water both within and along the perimeter of the project site. The appropriate controls work on the same principle: the velocity of sediment-laden runoff is slowed by temporary barrier basins which pond the storm water to allow sediments to settle out (see box, this page). Appropriate strategies for implementing sediment trapping controls include:

1. Direct sediment-laden storm water to temporary sediment traps.

2. Locate sediment basins and traps at low points below disturbed areas.

3. Protect all existing or newly-installed storm drainage structures from sediment clogging by providing inlet protection for area drains and curb inlets.

4. Direct off-site and/or sediment-free storm water away from denuded areas and away from temporary sediment traps.

5. Construct temporary sediment traps or basins at the drainage outlet for the site. The discharge from one basin should not enter the inlet of another basin.

6. Excavate post-construction storm water detention basins early in the project, use them as sedimentation basins during construction, remove accumulated sediment, and landscape the basin when the upstream drainage area is stabilized.

7. Temporary sediment barriers such as:

   - Silt Fences
   - Straw Bale Barriers
   - Sand Bag Barriers
   - Brush or Rock Filter

   should only be used in areas where sheet flow runoff occurs. They are ineffective if the runoff is concentrated into rill or gully flow (see Figure 1.1). Temporary sediment barriers should only be installed along a contour line on relatively flat slopes where sufficient area for ponding sediment-laden water exists. These barriers are not appropriate for large drainage areas unless the drainage area is split and additional barriers are placed upstream so that the incremental drainage area to each barrier is less than one acre.

8. Protect all existing or newly-installed storm drainage structures from sediment clogging by providing inlet protection for area drains and curb inlets.

Sediment Trapping BMPs

- Silt Fence Barrier (ESC50)
- Straw Bale Barrier (ESC51)
- Sand Bag Barrier (ESC52)
- Brush or Rock Filter (ESC53)
- Storm Drain Inlet Protection (ESC54)
- Sediment Trap (ESC55)
- Sediment Basin (ESC56)

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SELECTION OF POST-CONSTRUCTION BMPS

Most post-construction BMPs will be proposed by the developer early in the planning stage of a project. Usually, these BMPs will be oriented toward municipal requirements established in a master plan or by ordinance. For most projects, there will be no single BMP which addresses all the post-construction storm water quality problems. Instead, a multi-level strategy will be worked out with the local municipality which incorporates source controls, on-site treatment controls, and community-wide treatment controls. This section provides a brief discussion of selecting post-construction BMPs from the owner/developers perspective. A more thorough discussion may be found in Chapters 3, 4, and 5 of the Municipal Handbook.

SOURCE CONTROL BMPs

The following six categories of source control BMPs are described in Chapter 4 of the Municipal Handbook:

- Planning Management: Municipalities may regulate through zoning ordinances, subdivision ordinances, or buffer/setback requirements the amount of runoff from a site. The municipality may discourage development in environmentally sensitive areas. For a specific project, the developer may achieve these goals by minimizing the impervious area that is directly connected to the drainage system, and by incorporating setbacks from surface waters.

- Materials Management: The objective of these BMPs is to minimize the opportunity for rainfall or runoff to come into contact with pollutants. Commercial and industrial project designs should be adopted to keep pollutant storage/use/disposal areas out of floodplains, away from drainage paths, under cover, and/or in containment areas.

- Spill Prevention: Spill prevention BMPs should be incorporated into project design by using containments, leak-resistent materials, and accessways for proper cleanup.

- Illegal Dumping: Signs may be installed at inlets or along drainageways, and brochures may be distributed to residents/tenants of new facilities to increase awareness about illegal dumping.

- Illegal Connections: Most municipalities will have ordinances, and may require inspection of construction sites, to prevent connections to the storm water system from non-storm water sources. This includes connections of floor drains, washdown areas, septic tank overflows, and the like.

- Street/Storm Drain Maintenance: Infrastructure maintenance after construction will be required and may be performed by the municipality or property owner. Such BMPs would include street sweeping, catch basin cleaning, and drainage structure cleanouts. Maintenance considerations (e.g., easements, access, disposal) should be integrated into the infrastructure when designed.

TREATMENT CONTROL BMPs

When are treatment control BMPs needed? No clear answer to this question exists in the regulations or general permits. The decision to provide a treatment control BMP should be made during the planning/design phase for a project. The municipality may have conducted a master plan (or equivalent planning procedures) to determine where on-site and community-wide facilities are appropriate. Where on-site facilities are needed, the municipality would most likely define the performance standards through ordinances or policies. Typical performance standards include holding peak flow and/or runoff volume after construction equal to runoff peak flow/volume before development, or capture of a specific amount of runoff. Where community-wide facilities are desired, the developer may need to

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construct these facilities (for larger development projects), or pay a share of these facilities' cost through an equitable fee-in-lieu of method.

Thus it is important that the construction site owner/developer and municipality establish the overall performance standard. This will allow the developer to select the appropriate treatment control BMPs given site conditions, costs, and performance standards.

The treatment control BMPs presented in the Municipal Handbook include:

Infiltration
Wet Ponds
Constructed Wetlands
Biofilters
Extended Detention Basins
Media Filtration
Oil/Water Separators and
Water Quality Inlets
Multiple-Systems

Using the site characteristic and the design guidance provided in Chapter 5 of the Municipal Handbook, potential applicable BMPs can be sized and their cost estimated.

In most cases treatment control BMPs can be implemented most effectively when they can be integrated into other aspects of the project design.

- Is a detention/retention facility useful for flood control? Often, facilities needed to maintain peak runoff at predevelopment levels are either required by the local municipality or desired to reduce downstream conveyance system costs. Most treatment control BMPs can be incorporated into flood control detention/retention facilities with modest design refinements, and limited increasing land and cost. This alternative should be reviewed by the local flood control agency to check that both flood control and pollution control objectives are met.

- Are open space/parkland requirements a condition of development? Planned open space which will be relatively flat (e.g., final grade slopes less than 5 percent) may be merged with storm water quality/quantity facilities. Such integrated, multi-use areas may achieve several objectives a modest cost.

- Is water conservation an issue? Storm water runoff can be used to supplement other water resources. Infiltration BMPs may serve as groundwater recharge facilities, detention/retention areas may be created in landscaped areas of the project, and vegetated swales/filters may be used as roadside/median vegetated areas to reduce water demand.

- Is habitat/wetland preservation/mitigation needed? Project EIRs and other regulatory reviews may require that these issues be addressed. Treatment control BMPs like constructed wetlands and wet detention ponds are also excellent habitat. However, regulatory issues will likely exist and require early negotiations.

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BMP CATEGORY	BMP OBJECTIVES						
	Practice Good Housekeeping	Contain Waste	Minimize Disturbed Areas	Stabilize Disturbed Areas	Protect Slope & Channels	Control Site Perimeter	Control Internal Erosion
BMPs FOR CONTRACTOR ACTIVITIES (Chapter 4)							
Construction Practices (CA 1 to 10)	✓			✓	✓	✓	✓
Material Management (CA 10 to 19)	✓						
Waste Management (CA 20 to 29)		✓	✓	✓			
Vehicle & Equipment Management (CA 30 to 39)	✓					✓	✓
Contractor Training (CA40)	✓	✓					
BMPs FOR EROSION & SEDIMENT CONTROL (Chapter 5)							
Site Planning Considerations (ESC 01 to ESC 10)	✓	✓	✓	✓	✓	✓	✓
Vegetative Stabilization (ESC 10 to ESC 19)				✓	✓		
Physical Stabilization (ESC 20 to ESC 29)	✓		✓	✓	✓	✓	
Diversion of Runoff (ESC 30 to ESC 39)		✓			✓	✓	✓
Velocity Reduction (ESC 40 to ESC 49)				✓	✓		
Sediment Trapping/Filtering (ESC 50 to ESC 59)					✓	✓	✓
POST CONSTRUCTION BMPs (See Municipal BMP Handbook)				✓	✓	✓	✓

TABLE 3.1 CATEGORIES OF BMPs AND THE BMP OBJECTIVES MET BY EACH

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4. BMPs FOR CONTRACTOR ACTIVITIES

INTRODUCTION

This chapter describes specific Best Management Practices (BMPs) for common construction activities that may pollute storm water. Chapter 2 led you through the steps of identifying activities at your site that can pollute storm water, while Chapter 3 provided guidance on BMP selection. This chapter will provide a list of BMPs that can be used to fit your site's needs.

BMP fact sheets are provided for each of the contractor's activities, noted in the box, are consistent with Worksheet 4 in Chapter 2.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Costs, including capital costs, and operation and maintenance (O&M) costs
  - Maintenance (including administrative and staffing)
- Limitations
- References

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. For some BMPs, further information is provided in additional sheets.

Contractor Activities

Construction Practices
- CA1 Dewatering Operations
- CA2 Paving Operations
- CA3 Structure Construction and Painting

Material Management
- CA10 Material Delivery and Storage
- CA11 Material Use
- CA12 Spill Prevention and Control

Waste Management
- CA20 Solid Waste Management
- CA21 Hazardous Waste Management
- CA22 Contaminated Soil Management
- CA23 Concrete Waste Management
- CA24 Sanitary/Septic Waste Management

Vehicle and Equipment Management
- CA30 Vehicle and Equipment Cleaning
- CA31 Vehicle and Equipment Fueling
- CA32 Vehicle and Equipment Maintenance

Contractor Training
- CA40 Employee/Subcontractor Training

These BMP fact sheets are suitable for inclusion in many storm water pollution prevention plans for typical contractor activities. The BMPs listed are not an exhaustive list, nor will every BMP be appropriate for every situation. Therefore, suggested BMPs which are inappropriate may be deleted and additional BMPs for specific site conditions should be added. In addition, your selection and implementation of BMPs should be reviewed on a regular basis to match the changing conditions at construction sites.

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TABLE 4.1 CONTRACTOR ACTIVITIES AND BMP OBJECTIVES

	BMP CATEGORY	BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Construction Practices							
CA01	Dewatering Operations	✓				✓	✓	✓
CA02	Paving Operations	✓						
CA03	Structure Construction and Painting	✓			✓			
	Material Management							
CA10	Material Delivery and Storage	✓						
CA11	Material Use	✓						
CA12	Spill Prevention and Control	✓						
	Waste Management							
CA20	Solid Waste Management		✓					
CA21	Hazardous Waste Management		✓					
CA22	Contaminated Soil Management		✓	✓	✓			
CA23	Concrete Waste Management		✓					
CA24	Sanitary/Septic Waste Management		✓					
	Vehicle and Equipment Management							
CA30	Vehicle and Equipment Cleaning	✓					✓	✓
CA31	Vehicle and Equipment Fueling	✓						
CA32	Vehicle and Equipment Maintenance	✓						
	Contractor Training							
CA40	Employee/Subcontractor Training	✓	✓					

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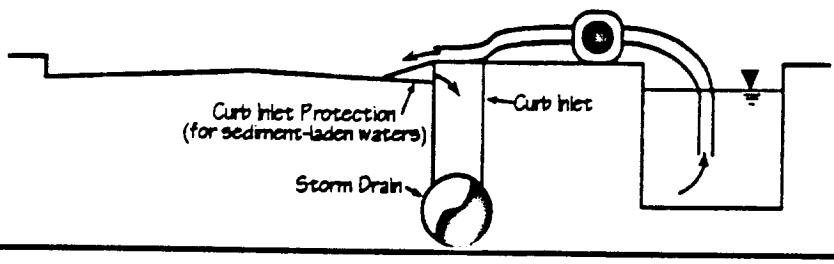
ACTIVITY: DEWATERING OPERATIONS



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls and by testing the groundwater for pollution.

APPROACH

There are two general classes of pollutants that may result from dewatering operations; sediment, and toxics and petroleum products. A high sediment content in dewatering discharges is common because of the nature of the operation. On the other hand, toxics and petroleum products are not commonly found in dewatering discharges unless, the site or surrounding area has been used for light or heavy industrial activities, or the area has a history of groundwater contamination. The following steps will help reduce storm water pollution from dewatering discharges:

Sediment

- Use sediment controls to remove sediment from water generated by dewatering (See Sediment Trap (ESC 55) and Sediment Basin (ESC 56) in Chapter 5).
- Use filtration to remove sediment from a sediment trap or basin. Filtration can be achieved with:
  - Sump pit and a perforated or slit standpipe with holes and wrapped in filter fabric. The standpipe is surrounded by stones which filters the water as it collects in the pit before being pumped out. Wrapping the standpipe in filter fabric may require an increased suction inlet area to avoid clogging and unacceptable pump operation.
  - Floating suction hose to allow cleaner surface water to be pumped out.

Toxics and Petroleum Products

- In areas suspected of having groundwater pollution, sample the groundwater near the excavation site and have the water tested for known or suspected pollutants at a certified laboratory. Check with the Regional Water Quality Control Board and the local wastewater treatment plant for their requirements for dewatering, additional water quality tests, and disposal options.
- With a permit from the Regional Water Quality Control Board, you may be able to recycle/reuse pumped groundwater for landscape irrigation, or discharge to the storm sewer. With a permit from the local agency, you may be able to treat pumped groundwater and discharge it to the municipal wastewater treatment plant via the sanitary sewer.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA1

Best Management Practices

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CONTRACTOR ACTIVITY: DEWATERING OPERATIONS (Continue)

REQUIREMENTS

- Costs (Capital, O&M)
  - Sediment controls are low cost measures.
  - Treatment and/or discharge of polluted groundwater can be quite expensive.
- Maintenance
  - Maintain sediment controls and filters in good working order. (See Chapter 5 for details)
  - Inspect excavated areas daily for signs of contaminated water as evidenced by discoloration, oily sheen, or odors.

LIMITATIONS

- The presence of contaminated water may indicate contaminated soil as well. See CA22 (Contaminated Soil Management) in this chapter for more information.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA1

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1053

R0034389

ACTIVITY: PAVING OPERATIONS

Graphic: North Central Texas COG, 1993

Objectives

- (Housekeeping Practices)
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

APPROACH

- Avoid paving during wet weather.
- Store materials away from drainage courses to prevent storm water runon (see CA10 Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or trap/filter sediment (see Chapter 5).
- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See CA32 (Vehicle and Equipment Maintenance) and CA12 (Spill Prevention and Control) in this chapter.
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.
- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- If paving involves portland cement concrete, see CA23 (Concrete Waste Management) in this chapter.
- If paving involves asphaltic concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks by sweeping. Properly dispose of this waste by referring to CA20 (Solid Waste Management) in this chapter.
  - Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.
  - If paving involves on-site mixing plant, follow the storm water permitting requirements for industrial activities.
- Train employees and subcontractors.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect employees and subcontractors to ensure that measures are being followed.
  - Keep ample supplies of drip pans or absorbent materials on-site.

LIMITATIONS

- There are no major limitations to this best management practice.

Targeted Pollutants

- ◒ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA2

Best Management Practices

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R0034390

CONTRACTOR ACTIVITY: PAVING OPERATIONS (Continue)

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Hot-mix Asphalt Paving Handbook, U.S. Army Corps of Engineers, AC 150/5370-14, Appendix I, July 1991.

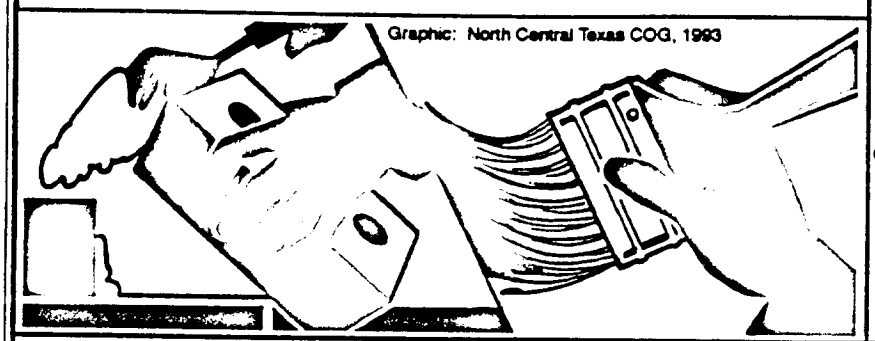
CA2

VOL 12

1055

R0034391

ACTIVITY: STRUCTURE CONSTRUCTION AND PAINTING



Graphic: North Central Texas COG, 1993

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from structure construction and painting by enclosing or covering or berming building material storage areas, using good housekeeping practices, using safer alternative products, and training employees and subcontractors.

APPROACH

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Use soil erosion control techniques if bare ground is exposed (See Chapter 5).
- Buy recycled or less hazardous products to the maximum extent practicable.
- Conduct painting operations consistent with local air quality and OSHA regulations.
- Properly store paints and solvents. See CA10 (Material Delivery and Storage) in this chapter.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs (CA20 to CA24) in this chapter.
- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Clean the storm drain system in the immediate construction area after construction is completed.
- Educate employees who are doing the work.
- Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - These BMPs are generally of low to moderate cost.
- Maintenance
  - Maintenance should be minimal.

LIMITATIONS

- Safer alternative products may not be available, suitable, or effective in every case.
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ● *Floatable Materials*
- ● *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

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ACTIVITY: STRUCTURE CONSTRUCTION AND PAINTING (Continue)

- Be certain that actions to help storm water quality are consistent with Cal- and Fed-OSHA and air quality regulations.

Construction and painting activities can generate pollutants that can reach storm water if proper care is not taken. The sources of these contaminants may be solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos insulation. For specific information on some of these wastes see the following BMPs in this chapter:

CA20 Solid Waste,
CA21 Hazardous Waste, and
CA23 Concrete Waste.

More specific information on structure construction practices is listed below.

Erosion and Sediment Control
If the work involves exposing large areas of soil or if old buildings are being torn down and not replaced in the near future, employ the appropriate soil erosion and control techniques described in Chapter 5.

Storm/Sanitary Sewer Connections
Carefully install all plumbing and drainage systems. Cross connections between the sanitary and storm drain systems, as well as any other connections into the drainage system from inside a building, are illegal. Color code or flag pipelines on the project site to prevent such connections, and train construction personnel.

Painting
Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect storm water quality. These regulations may require that painting operations be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Application equipment that minimizes overspray also helps. When using sealants on wood, pavement, roofs, etc, quickly clean up spills. Remove excess liquid with absorbent material or rags.

If painting requires scraping or sand blasting of the existing surface, use a drop cloth to collect most of the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste. Refer to the waste management BMPs in this chapter for more information.

Mix paint indoors, in a containment area, or in a flat unpaved area not subject to significant erosion. Do so even during dry weather because cleanup of a spill will never be 100% effective. Dried paint will erode from sloped surfaces and be washed away by storms. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer or in a containment area where the dried paint can be readily removed. Properly store leftover paints if they are to be kept for the next job, or dispose of properly.

Roof work
When working on roofs, if small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is lined tight, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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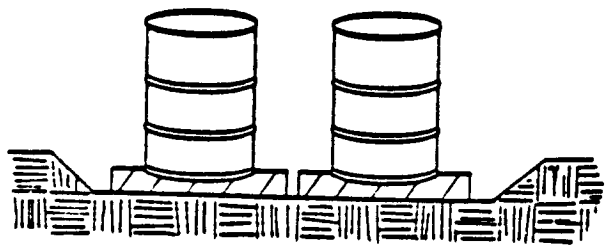
ACTIVITY: MATERIAL DELIVERY AND STORAGE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see CA11 (Material Use), or CA12 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following materials are commonly stored on construction sites:

- Soil,
- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster or other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Designate areas of the construction site for material delivery and storage.
  - Place near the construction entrances, away from waterways
  - Avoid transport near drainage paths or waterways
  - Surround with earth berms (see ESC30, Earth Dike.)
  - Place in an area which will be paved
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.
- Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
- Keep your inventory down.

Targeted Pollutants

- ◒ Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ◒ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA10

Best Management Practices

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ACTIVITY: MATERIAL DELIVERY AND STORAGE (Continue)

- Minimize hazardous materials on-site storage.
- Handle hazardous materials as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as an earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil (See CA22). If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

REQUIREMENTS

- Cost (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep the designated storage area clean and well organized.
  - Conduct routine weekly inspections and check for external corrosion of material containers.
  - Keep an ample supply of spill cleanup materials near the storage area.

LIMITATIONS

- Storage sheds often must meet building and fire code requirements.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA10

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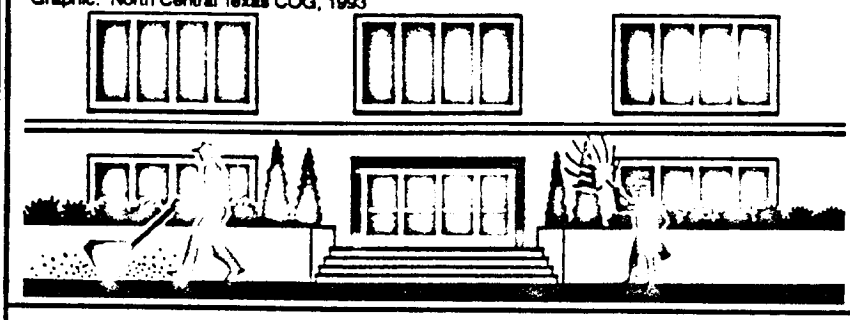
ACTIVITY: MATERIAL USE

Graphic: North Central Texas COG, 1993



Objectives

- (Housekeeping Practices)
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material use by using alternative products, minimizing hazardous material use on-site, and training employees and subcontractors.

APPROACH

The following materials are commonly used on construction sites:

- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster and other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Use of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Use less hazardous, alternative materials as much as possible.
- Minimize use of hazardous materials on-site.
- Use materials only where and when needed to complete the construction activity.
- Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.

Targeted Pollutants

- ○ Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ◒ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA11

Best Management Practices

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REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Maintenance of this best management practice is minimal.

LIMITATIONS

- Alternative materials may not be available, suitable, or effective in every case.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA11

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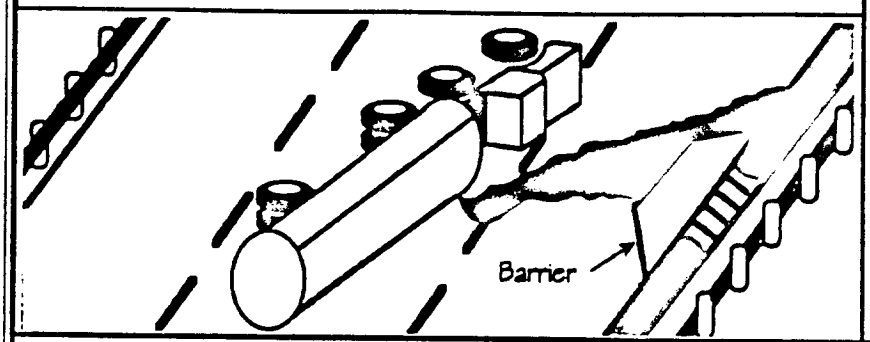
R0034397

ACTIVITY: SPILL PREVENTION AND CONTROL



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA12

Best Management Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, CA10 (Material Delivery and Storage) and CA11 (Material Use), also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following steps will help reduce the storm water impacts of leaks and spills:

Define "Significant Spill"

- Different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this chapter for specific information.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

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ACTIVITY: SPILL PREVENTION AND CONTROL (Continue)

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur on-site, use a designated area and/or a secondary containment, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and pollute storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.
- Maintenance
  - Keep ample supplies of spill control and cleanup materials on-site, near storage, unloading, and maintenance areas.
  - Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals on-site.

LIMITATIONS

- If necessary, use a private spill cleanup company.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA12

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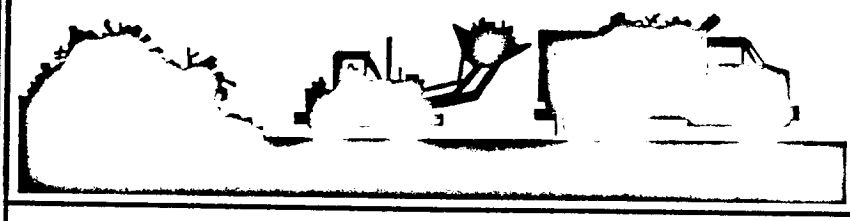
1063

R0034399

ACTIVITY: SOLID WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

APPROACH

Solid waste is one of the major pollutants resulting from construction. Construction debris includes:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction;
- Packaging materials including wood, paper and plastic;
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products; and
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, and plastic wrappers, and cigarettes.

The following steps will help keep a clean site and reduce storm water pollution:

- Select designated waste collection areas on-site.
- Inform trash hauling contractors that you will accept only water-tight dumpsters for on-site use. Inspect dumpsters for leaks and repair any dumpster that is not water tight.
- Locate containers in a covered area and/or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it's windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier (see ESC53), or converted into wood chips, then used as mulch on graded areas (see ESC11).
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.
- Arrange for regular waste collection before containers overflow.

Targeted Pollutants

- ◒ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ● *Floatable Materials*
- ● *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA20

Best Management Practices

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R0034400

ACTIVITY: SOLID WASTE MANAGEMENT (Continue)

- If a container does spill, clean up immediately.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper solid waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Collect site trash daily.
  - Inspect construction waste area regularly.
  - Arrange for regular waste collection.

LIMITATIONS

- There are no major limitations to this best management practice.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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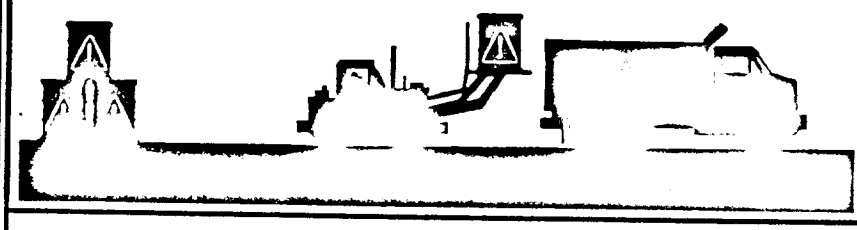
R0034401

ACTIVITY: HAZARDOUS WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993



Objectives

- Housekeeping Practices
- (Contain Waste)
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

APPROACH

Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Herbicides and pesticides;
- Acids for cleaning masonry; and
- Concrete curing compounds.

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints;
- Asbestos; and
- PCBs (particularly in older transformers).

The following steps will help reduce storm water pollution from hazardous wastes:

Material Use

- Use all of the product before disposing of the container.
- Do not remove the original product label, it contains important safety and disposal information.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and re-use thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

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Waste Recycling/Disposal

- Select designated hazardous waste collection areas on-site.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, make recycling impossible, and complicate disposal.
- Recycle any useful material such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g. excess oil-based paint and sludges) is collected, removed, and disposed of only at authorized disposal areas.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

Training

- Train employees and subcontractors in proper hazardous waste management.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect hazardous waste receptacles and area regularly.
  - Arrange for regular hazardous waste collection.

LIMITATIONS

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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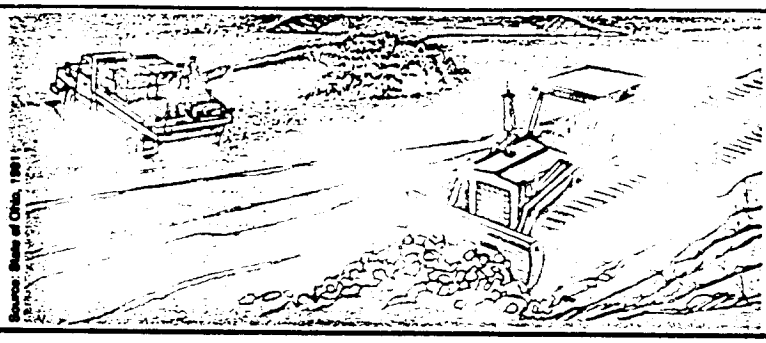
ACTIVITY: CONTAMINATED SOIL MANAGEMENT



Objectives

- Housekeeping Practices
- (Contain Waste)
- (Minimize Disturbed Areas)
- (Stabilize Disturbed Areas)
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ◒ Sediment
- ○ Nutrients
- ● Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

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Best Management Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

APPROACH

Contaminated soils may occur on your site for several reasons including:

- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline-forming elements.

Most developers conduct pre-construction environmental assessments as a matter of routine. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil, highlight the need for contractors to confirm that a site assessment is completed before earth moving begins.

The following steps will help reduce storm water pollution from contaminated soil:

- Conduct thorough site planning including pre-construction geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- Test suspected soils at a certified laboratory.
- If the soil is contaminated, work with the local regulatory agencies to develop options for treatment and/or disposal.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil can be quite expensive.
- Maintenance
  - Inspect excavated areas daily for signs of contaminated soil.
  - Implement CA12, Spill Prevention and Control, to prevent leaks and spills as much as possible.

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LIMITATIONS

- Contaminated soils that cannot be treated on-site must be disposed of off-site by a licensed hazardous waste hauler.
- The presence of contaminated soil may indicate contaminated water as well. See CA1 (Dewatering Operations) in this chapter for more information.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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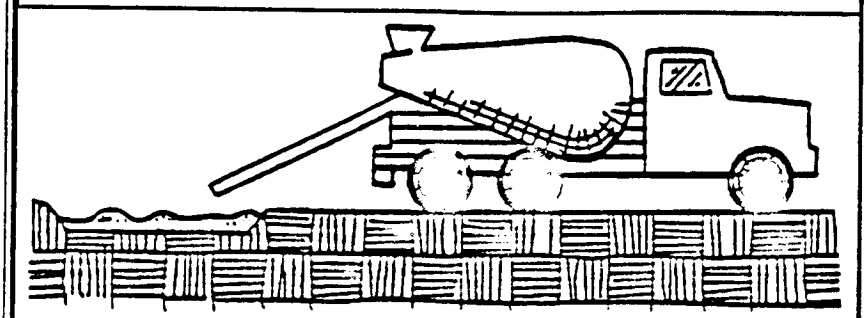
R0034405

ACTIVITY: CONCRETE WASTE MANAGEMENT



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from concrete waste by conducting washout off-site, performing on-site washout in a designated area, and training employees and subcontractors.

APPROACH

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete or cement on-site.
- Perform washout of concrete trucks off site or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated areas.
- For on-site washout:
  - locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste;
  - wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed of properly.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a bermed or level area.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stock pile, or dispose in the trash.
- Train employees and subcontractors in proper concrete waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect subcontractors to ensure that concrete wastes are being properly managed.
  - If using a temporary pit, dispose hardened concrete on a regular basis.

LIMITATIONS

- Off-site washout of concrete wastes may not always be possible.

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ◒ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

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REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, July 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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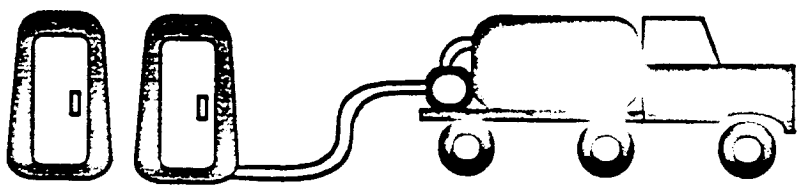
R0034407

ACTIVITY: SANITARY/SEPTIC WASTE MANAGEMENT



Objectives

- Housekeeping Practices
- (Contain Waste)
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from sanitary/septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

APPROACH

Sanitary or septic wastes should be treated or disposed of in accordance with State and local requirements. These requirements may include:

- Locate sanitary facilities in a convenient location.
- Untreated raw wastewater should never be discharged or buried.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an on-site disposal system (OSDS), such as a septic system, comply with local health agency requirements.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- If discharging to the sanitary sewer, contact the local wastewater treatment plant for their requirements.
- Sanitary/septic facilities should be maintained in good working order by a licensed service.
- Arrange for regular waste collection by a licensed hauler before facilities overflow.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect facilities regularly.
  - Arrange for regular waste collection.

LIMITATIONS

- There are no major limitations to this best management practice.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ◒ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA24

Best Management Practices

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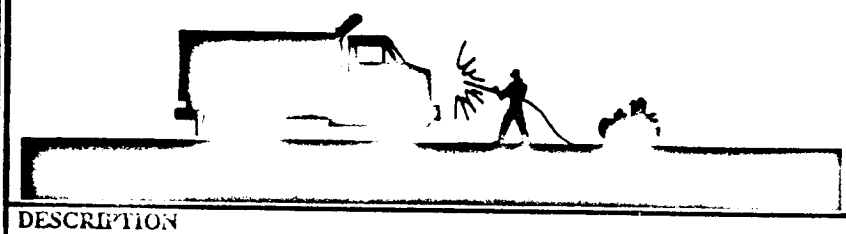
R0034408

ACTIVITY: VEHICLE AND EQUIPMENT CLEANING

Graphic: North Central Texas COG, 1993



Objectives

- (●) Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- (●) Control Site Perimeter
- (●) Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning by using off-site facilities, washing in designated, contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and/or training employees and subcontractors.

APPROACH

- Use off-site commercial washing businesses as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute storm water. If you wash a large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area.
- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Minimal, some berm repair may be necessary.

LIMITATIONS

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades.
- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

REFERENCE

Swisher, R.D., 1987. Surfactant Biodegradation, Marcel Decker Corporation

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA30

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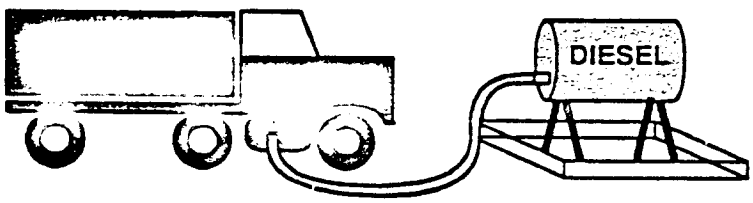
R0034409

ACTIVITY: VEHICLE AND EQUIPMENT FUELING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

APPROACH

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off" of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above measures are low cost, except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA31

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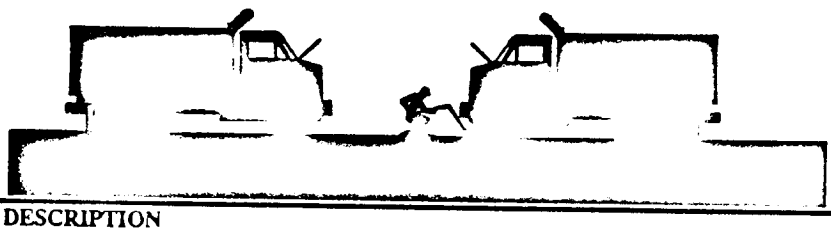
R0034410

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE

Graphic: North Central Texas COG, 1993



Objectives

- (●) Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance by running a "dry site". This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

APPROACH

- Keep vehicles and equipment clean, don't allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute storm water. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.2, CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect maintenance areas on a regular schedule.

Targeted Pollutants

- ( ) Sediment
- ( ) Nutrients
- (◒) Toxic Materials
- (◒) Oil & Grease
- ( ) Floatable Materials
- ( ) Other Construction Waste

(●) Likely to Have Significant Impact
( ) Probable Low or Unknown Impact

Implementation Requirements

- ( ) Capital Costs
- ( ) O&M Costs
- ( ) Maintenance
- (◒) Training
- ( ) Suitability for Slopes >5%

(●) High ( ) Low

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ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE (Continue)

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

Outdoor vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service, particularly changing or replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see CA30, Vehicle and Equipment Cleaning, and CA31, Vehicle and Equipment Fueling.

Listed below is further information if you must perform vehicle or equipment maintenance on-site.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane, or methylene chloride. Many of these parts cleaners are harmful and must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling/Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Do not bury used tires.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites: Flood Control District of Maricopa County, AZ, September 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

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R0034412

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Employee/subcontractor training, like maintenance or a piece of equipment, is not so much a best management practice as it is a method by which to implement BMPs. This fact sheet highlights the importance of training and of integrating the elements of employee/subcontractor training from the individual source controls into a comprehensive training program as part of a company's Storm Water Pollution Prevention Plan (SWPPP).

The specific employee/subcontractor training aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approach for assuring employee/subcontractor training in storm water pollution prevention. Accordingly, the organization of this fact sheet differs somewhat from the other fact sheets in this chapter.

OBJECTIVES

Employee/subcontractor training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

APPROACH

- Integrate training regarding storm water quality management with existing training programs that may be required for your business by other regulations such as: the Illness and Injury Prevention Program (IIPP) (SB 198) (California Code of Regulations Title 8, Section 3203), the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120), the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112), and the Hazardous Materials Management Plan (Business Plan) (California Health and Safety Code, Section 6.95).
- Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, may use the information in this Handbook to develop a training program to reduce their potential to pollute storm water.
- Use the quick reference on disposal alternatives (Table 4.2) to train employee/subcontractors in proper and consistent methods for disposal.

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R0034413

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING (Continue)

- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employee/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employee/subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employee/subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

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TABLE 4.2 QUICK REFERENCE - DISPOSAL ALTERNATIVES
(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use. **ALTERNATIVES ARE LISTED IN PRIORITY ORDER.**

Key:
- HHW — Household hazardous waste (Government-sponsored drop-off events)
- POTW — Publically Owned Treatment Plant
- Reg.Bd. — Regional Water Quality Control Board (Oakland)

"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance			
Excess paint (oil-based)	1. Recycle/reuse. 2. Dispose as hazardous waste.		1. Recycle/reuse. 2. Take to HHW drop-off.
Excess paint (water-based)	1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, dispose as hazardous waste.		1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, take to HHW drop-off
Paint cleanup (oil-based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste.		Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Take to HHW drop-off.
Paint cleanup (water-based)	Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.		Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.
Empty paint cans (dry)	1. Remove lids, dispose as trash.		1. Remove lids, dispose as trash.
Paint stripping (with solvent)	1. Dispose as hazardous waste.		1. Take to HHW drop-off.
Building exterior cleaning (high-pressure water)	1. Prevent entry into storm drain and remove offsite 2. Wash onto dirt area, spade in 3. Collect (e.g. mop up) and discharge to sanitary sewer	POTW	
Cleaning of building exteriors which have **HAZARDOUS MATERIALS** (e.g. mercury, lead) in paints	1. Use dry cleaning methods 2. Contain and dispose washwater as hazardous waste (Suggestion: dry material first to reduce volume)		

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Table 4.1 (Continued)
Page 2

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Non-hazardous paint scraping/ sand blasting	1. Dry sweep, dispose as trash		1. Dry sweep, dispose as trash
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste		1. Dry sweep, take to HHW drop-off
Soil from excavations during periods when storms are forecast	1. Should not be placed in street or on paved areas 2. Remove from site or backfill by end of day 3. Cover with tarpaulin or surround with hay bales, or use other runoff controls 4. Place filter mat over storm drain Note: Thoroughly sweep following removal of dirt in all four alternatives.		
Soil from excavations placed on paved surfaces during periods when storms are not forecast	1. Keep material out of storm conveyance systems and thoroughly remove via sweeping following removal of dirt		
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud 2. Use silt ponds and/or similar pollutant reduction techniques when flushing pavement		
Soil erosion, sediments	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant immediately.		
Fresh cement, grout, mortar	1. Use/reuse excess 2. Dispose to trash		1. Use/reuse excess 2. Dispose as trash
Washwater from concrete/mortar (etc.) cleanup	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Rinsewater from concrete mixing trucks	1. Return truck to yard for rinsing into pond or dirt area 2. At construction site, wash into pond or dirt area		
Non-hazardous construction and demolition debris	1. Recycle/reuse (concrete, wood, etc.) 2. Dispose as trash		1. Recycle/reuse (concrete, wood, etc. 2. Dispose as trash
Hazardous demolition and construction debris (e.g. asbestos)	1. Dispose as hazardous waste		1. Do not attempt to remove yourself. Contact asbestos removal service for safe removal and disposal 2. Very small amounts (less than 5 lbs) may be double-wrapped in plastic and taken to HHW drop-off
Saw-cut slurry	1. Use dry cutting technique and sweep up residue 2. Vacuum slurry and dispose off-site. 3. Block storm drain or berm with low weir as necessary to allow most solids to settle. Shovel out gutters; dispose residue to dirt area, construction yard or landfill.		
Construction dewatering (Nonturbid, uncontaminated groundwater)	1. Recycle/Reuse 2. Discharge to storm drain		
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1. Recycle/reuse 2. Discharge to sanitary sewer 3. As appropriate, treat prior to discharge to storm drain	POTW Reg. Bd.	
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW	POTW	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair 2. If dumpster is used for liquid waste, use plastic liner		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse)		
Dumpster cleaning water	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer 2. Clean on site and discharge through grease interceptor to sanitary sewer	POTW POTW	
Cleaning driveways, paved areas * (Special Focus = Restaurant alleys Grocery dumpster areas) * Note: Local drought ordinances may contain additional restrictions	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer). 3. Same as 2 above, but with rinsewater (2c)(no soap) discharged to storm drain.		1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, follow this 3-step process: a. Clean up leaks with rags or absorbents; dispose as hazardous waste. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer.
Steam cleaning of sidewalks, plazas * * Note: Local drought ordinances may contain additional restrictions	1. Collect all water and pump to sanitary sewer. 2. Follow this 3-step process: a. Clean oil leaks with rags or adsorbents b. Sweep (Use dry absorbent as needed) c. Use no soap, discharge to storm drain		
Potable water/line flushing Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching creeks		
Super-chlorinated (above 1 ppm) water from line flushing	1. Discharge to sanitary sewer 2. Complete dechlorination required before discharge to storm drain		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Landscape/Garden Maintenance			
Pesticides	1. Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash 2. Dispose unused pesticide as hazardous waste		1. Use up. Rinse containers, use rinsewater as pesticide. Dispose rinsed container as trash. 2. Take unused pesticide to HHW drop-off
Garden clippings	1. Compost 2. Take to Landfill		1. Compost 2. Dispose as trash.
Tree trimming	1. Chip if necessary, before composting or recycling		1. Chip if necessary, before composting or recycling
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.	POTW	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.
Acid or other pool/spa/fountain cleaning	1. Neutralize and discharge to sanitary sewer	POTW	
Swimming pool, spa filter backwash	1. Reuse for irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer		1. Use for landscape irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer
Vehicle Wastes			
Used motor oil	1. Use secondary containment while storing, send to recycler.		1. Put out for curbside recycling pickup where available 2. Take to Recycling Facility or auto service facility with recycling program 3. Take to HHW events accepting motor oil
Antifreeze	1. Use secondary containment while storing, send to recycler.		1. Take to Recycling Facility
Other vehicle fluids and solvents	1. Dispose as hazardous waste		1. Take to HHW event
Automobile batteries	1. Send to auto battery recycler 2. Take to Recycling Center		1. Exchange at retail outlet 2. Take to Recycling Facility or HHW event where batteries are accepted
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer		1. Use holding tank, dispose to sanitary sewer.

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Vehicle Wastes (cont'd)			
Vehicle Washing	1. Recycle 2. Discharge to sanitary sewer, never to storm drain	POTW	1. Take to Commercial Car Wash. 2. Wash over lawn or dirt area 3. If soap is used, use a bucket for soapy water and discharge remaining soapy water to sanitary sewer.
Mobile Vehicle Washing	1. Collect washwater and discharge to sanitary sewer.	POTW	
Rinsewater from dust removal at new car fleets	1. Discharge to sanitary sewer 2. If rinsing dust from exterior surfaces from appearance purposes, use no soap (water only); discharge to storm drain.	POTW	
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags or absorbents 2. Sweep, using granular absorbent material (cat litter) 3. Mop and dispose of mopwater to sanitary sewer.		
Other Wastes			
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer	POTW	1. Dispose to sanitary sewer
Roof drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer 2. If no contamination is present, discharge to storm drain		
Cooling water Air conditioning condensate	1. Recycle/reuse 2. Discharge to sanitary sewer	POTW	
Pumped groundwater, infiltration/ foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer 3. Treat and discharge to storm drain	Reg. Bd. POTW Reg. Bd.	
Fire fighting flows	If contamination is present, Fire Dept. will attempt to prevent flow to stream or storm drain		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Other Wastes (cont'd)			
Kitchen Grease	1. Provide secondary containment, collect, send to recyler. 2. Provide secondary containment, collect, send to POTW via hauler.	POTW	1. Collect, solidify, dispose as trash
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer. 2. Clean outside in container or bermed area with discharge to sanitary sewer.		
Clean-up wastewater from sewer back-up	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer. (no rinse-water may flow to storm drain)		

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Chapter 5

R0034422

5. BMPs FOR EROSION AND SEDIMENTATION CONTROL

INTRODUCTION

This chapter describes specific Best Management Practices (BMPs) for common construction activities that result in erosion of the construction site and the generation of sediment which impacts waterways and off-site property. Chapter 2 led you through the steps of identifying activities at your site that can cause erosion, while Chapter 3 provided guidance with BMP selection. This chapter will provide you with the BMPs that best fit your site's needs.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Suitable Applications
- Installation/Application Criteria
- Requirements
  - Costs, including capital costs, and operations and maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. The remainder of the fact sheet provides further information on some or all of these topics, and provides references for additional guidelines.

Sizing and design criteria for erosion and sedimentation control may be standardized for each local area. This handbook cannot develop specific sizing criteria for all topographies and climates in California. Many local agencies have developed such criteria and should be consulted before sizing specific BMPs. A common design storm for sizing temporary erosion and sedimentation controls is a two-year, 24-hour storm. Sizing criteria given in this handbook assume that such a storm would result in 0.042 ac-ft/ac. of runoff (0.5 inches of runoff). This should be appropriate for sizing controls in most areas. Keep in mind that these controls must also be able to safely contain or

BMPs for Erosion and Sedimentation Control

Site Planning Considerations
- ESC1 Scheduling
- ESC2 Preservation of Existing Vegetation

Vegetative Stabilization
- ESC10 Seeding and Planting
- ESC11 Mulching

Physical Stabilization
- ESC20 Geotextiles and Mats
- ESC21 Dust Control
- ESC22 Temporary Stream Crossing
- ESC23 Construction Road Stabilization
- ESC24 Stabilized Construction Entrance

Diversion of Runoff
- ESC30 Earth Dike
- ESC31 Temporary Drains and Swales
- ESC32 Slope Drain

Velocity Reduction
- ESC40 Outlet Protection
- ESC41 Check Dams
- ESC42 Slope Roughening/Terracing

Sediment Trapping/Filtering
- ESC50 Silt Fence
- ESC51 Straw Bale Barrier
- ESC52 Sand Bag Barrier
- ESC53 Brush or Rock Filter
- ESC54 Storm Drain Inlet Protection
- ESC55 Sediment Trap
- ESC56 Sediment Basin

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convey storms larger than the design storm for erosion and sediment control.

These BMP fact sheets are suitable for inclusion in many SWPPPs for erosion and sedimentation control. They may be used to supplement and provide details for erosion and sedimentation controls shown on the project site map. In all cases, however, local erosion and sedimentation criteria and standards supersede the suggested criteria on these fact sheets.

BMPs fact sheets are provided for each of the following BMP categories, and are consistent with Worksheet 5 in Chapter 2.

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TABLE 5.1 EROSION AND SEDIMENT CONTROL AND BMP OBJECTIVES

	BMP CATEGORY	BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Site Planning Considerations							
ESC1	Scheduling	✓	✓	✓	✓	✓	✓	✓
ESC2	Preservation of Existing Vegetation			✓	✓	✓	✓	
	Vegetative Stabilization							
ESC10	Seeding and Planting				✓	✓		
ESC11	Mulching				✓	✓		
	Physical Stabilization							
ESC20	Geotextiles and Mats				✓	✓		
ESC21	Dust Control	✓		✓	✓		✓	
ESC22	Temporary Stream Crossing	✓		✓	✓	✓		
ESC23	Construction Road Stabilization	✓		✓	✓	✓		
ESC24	Stabilized Construction Entrance	✓		✓	✓		✓	
	Diversion of Runoff							
ESC30	Earth Dike		✓			✓	✓	✓
ESC31	Temporary Drains and Swales					✓	✓	✓
ESC32	Slope Drain					✓		
	Velocity Reduction							
ESC40	Outlet Protection					✓		
ESC41	Check Dams (see ESC 53 also)					✓		
ESC42	Slope Roughening/Terracing				✓	✓		

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	BMP CATEGORY	BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Sediment Trapping/Filtering							
ESC50	Silt Fence						✓	✓
ESC51	Straw Bale Barrier						✓	✓
ESC52	Sand Bag Barrier					✓	✓	✓
ESC53	Brush or Rock Filter					✓	✓	✓
ESC54	Storm Drain Inlet Protection						✓	✓
ESC55	Sediment Trap							✓
ESC56	Sediment Basin							✓

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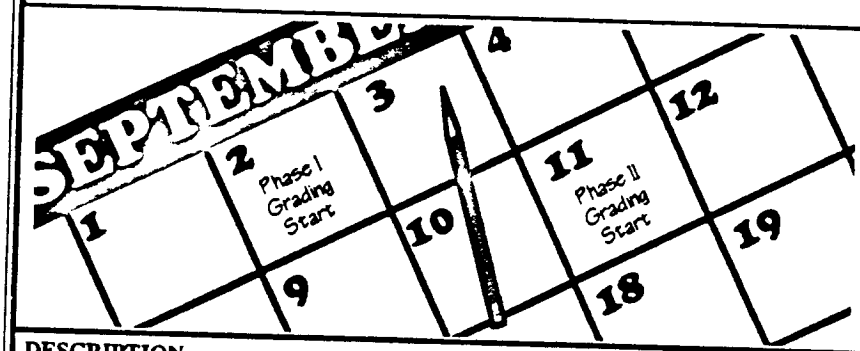
BMP: SCHEDULING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ○ Suitibility for Slopes >5%

● High ○ Low

ESC1

Best Management Practices

DESCRIPTION

Sequencing the construction project to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

SUITABLE APPLICATIONS

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project. Use of other, more costly yet less effective, erosion and sedimentation controls, may often be reduced through proper construction sequencing.

APPROACH

- Project design considerations: Design project to integrate into existing land contours. Significant regrading of a site will require more costly erosion and sedimentation control measures and may require that on-site drainage facilities be installed.
- Incorporate existing, natural areas: Inventory and evaluate the existing site terrain and vegetation. Disturbance of highly erosive natural areas (e.g., steep, unstable slope areas, watercourses) should be minimized, while protecting other areas may enhance site aesthetics. Construction should not disturb these areas (see ESC2).
- Avoid rainy periods: Schedule major grading operations during dry months. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means (see ESC 10 to 24) or to install temporary sediment trapping devices (see ESC 50 to 56).
- Practice erosion and sediment control year round: Erosion may be caused during dry seasons by "freak" rainfall, wind and vehicle tracking. Therefore, keep the site stabilized year-round, and retain wet season sediment trapping devices.
- Minimize soil exposed at one time: Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding—revegetate cut and fill slopes as the work progresses.
- Trenching: Close and stabilize open trenches as soon as possible. Sequence trenching projects so that most open portions of the trench are closed before new trenching is begun.

REQUIREMENTS

- Cost
  - Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost-effectiveness of scheduling techniques should be compared with the other, less effective erosion and sedimentation controls to achieve a cost-effective balance.

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LIMITATIONS

There are no significant limitations to the use of this BMP.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona - 1992.

Erosion and Sediment Control Guidelines for Developing Areas in Texas, U.S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas - 1976.

Storm Water Management for Construction Activites. Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water (EPA 832-R-92-005) - September, 1992.

Virginia Erosion and Sediment Control Handbook, Third Edition, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation - 1992.

ESC1

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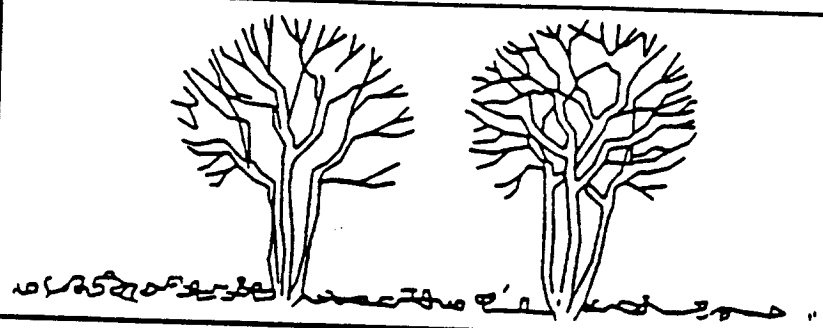
BMP: PRESERVATION OF EXISTING VEGETATION



Objectives

- Housekeeping Practices
- Contain Waste
- (Minimize Disturbed Areas)
- (Stabilize Disturbed Areas)
- (Protect Slopes/Channels)
- (Control Site Perimeter)
- Control Internal Erosion

GENERAL DESCRIPTION

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls.

SUITABLE APPLICATIONS

- Areas within site where no construction activity occurs, or occurs at a later date.
- Sensitive areas where natural vegetation exist and should be preserved, such as: steep slopes, watercourses, and building sites in wooded areas.
- Areas where local, state and federal government requires preservation, such as: vernal pools, wetlands, marshes, certain oak trees, etc.

INSTALLATION/APPLICATION CRITERIA

- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much existing vegetation as possible and state proper care of this vegetation both during and after construction.
- Define and protect with berms, fencing, signs, etc., a setback area from vegetation to be preserved. Setback area size should be based on the location, species, size, age and potential impact of adjacent construction activities or permanent improvements.
- Proposed landscaping plans which do not include plant species that compete with the existing vegetation.
- Do not locate construction traffic routes, spoil piles, etc., where significant adverse impact on existing vegetation may occur.

REQUIREMENTS

- Maintenance
  - Inspection and maintenance requirements for protection of vegetation are low.
  - During construction the limits of grading or disturbance should be clearly marked at all times.
  - Irrigation or maintenance of native trees or vegetation should conform to specifications on the Landscape Plan.
- Cost
  - There is little cost associated with preserving existing vegetation if properly planned during the project design, and may yield aesthetic benefits which enhance property values.

LIMITATIONS

- Requires forward planning by the owner/developer, contractor and design staff.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactorily for the planned development.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ● Suitability for Slopes >5%

● High ○ Low

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Additional Information — Preservation of Existing Vegetation

The best way to prevent excessive erosion is to not disturb the land. On a construction site, where extensive land disturbance is necessary, a reasonable BMP would be to not disturb land in sensitive areas of the site which need not be altered for the project to be viable (e.g., natural watercourses, steep slopes), and to design the site to incorporate particularly unique or desireable existing vegetation into the site landscaping plan. Clearly marking and leaving a buffer area around these unique areas will both help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping in naturally vegetated areas.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to insure the survival of desirable vegetation for shade, beautification, and erosion protection. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. Also, vegetation helps to keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

The following criteria may be used for deciding which vegetation will remain on the site:

- Aesthetic values: Consideration should be given to foliage, flowering habits, bark and crown characteristics (for trees).
- Freedom from disease and rot.
- Life span of trees: Short-lived trees need not be preserved.
- Environmental values: Habitat; screening; and buffers.
- Sudden exposure: Save vegetation which grows in direct sunlight and is able to withstand radiated heat from proposed buildings and pavement.
- Space needed: Sufficient space must be provided between the vegetation and any structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees and shrubs with bright paint or ribbon so there is no doubt as to which trees and shrubs are to be left and protected from damage during construction.

Saving existing vegetation and mature trees on-site, beautifies the area and may save money by reducing new landscaping requirements. Mature trees also increase property values and satisfy consumer aesthetic needs.

Preserving and protecting existing vegetation can often result in more stable soil conditions during construction. Careful site planning and identification of plantings to preserve can provide erosion and sedimentation controls during construction, and contribute to the aesthetics of the development. For example, in Sacramento County a tree ordinance has been adopted that protects the native California Oak tree. Provisions to protect the tree and its root system during construction must be specified in the project plans, and an area must be provided where the soil stability may not be disturbed. No grading or construction storage within the tree dripline is allowed.

Installation/Application

Building sites may be planned to integrate existing vegetation and trees. Construction impacts must be considered. Trench width for pipe construction projects and the location of permanent structures, such as buildings, needs to be considered when preserving existing vegetation, including mature trees and their root system. Native vegetation should be preserved since it is able to adapt to the climate. The USDA Soil Conservation Service should be contacted about existing vegetation for sites throughout California. Mature trees are generally preferable to newly planted trees because of the greater soil stabilization provided by the extensive root system of a mature tree.

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Additional Information — Preservation of Existing Vegetation

Methods for protecting existing vegetation and trees:

- Stake off root system limits (drip line of tree). Some counties limit construction within 5 feet of the tree drip line.
- Fence off the area to be preserved or along the tree drip line.
- Flag or mark trees to remain in place.
- Tree wells and retaining walls (permanent) help preserve existing vegetation, but must be large enough to protect the root system (see below).
- For the California Oak tree, no trenching or irrigation should be allowed within the driplines of the tree, since both these activities are detrimental to the preservation of the tree.
- Where grading under trees is necessary, excavation and fill should be limited to 1 foot within the driplines.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

County of Sacramento Tree Preservation Ordinance - September 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC2

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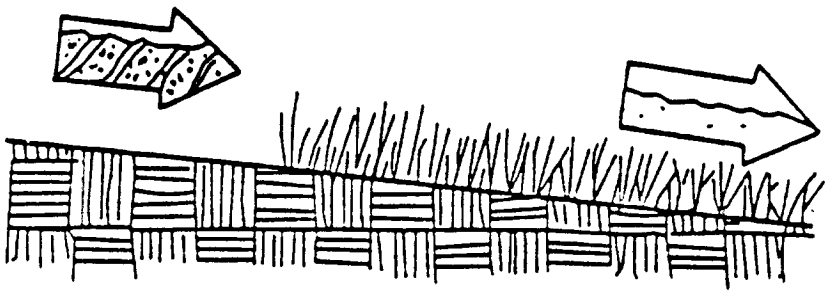
BMP: SEEDING AND PLANTING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Seeding of grasses and plantings of trees, shrubs, vines and ground covers provide long-term stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

SUITABLE APPLICATIONS

- Appropriate for site stabilization both during construction and post-construction.
- Any graded/cleared areas where construction activities have ceased.
- Open space cut and fill areas.
- Steep slopes.
- Spoil piles.
- Vegetated swales.
- Landscape corridors.
- Stream banks.

INSTALLATION/APPLICATION CRITERIA

Type of vegetation, site and seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

Grasses:

- Ground preparation: fertilize and mechanically stabilize the soil.
- Tolerant of short-term temperature extremes and waterlogged soil conditions.
- Appropriate soil conditions: shallow soil base, good drainage, slope 2:1 or flatter.
- Develop well and quickly from seeds.
- Mowing, irrigating, and fertilizing are vital for promoting vigorous grass growth.

Trees and Shrubs:

- Selection Criteria: vigor, species, size, shape & wildlife food source.
- Soil conditions: select species appropriate for soil,drainage & acidity.
- Other Factors: wind/exposure, temperature extremes, and irrigation needs.

Vines and Ground Covers:

- Ground preparation: lime and fertilizer preparation.
- Use proper seeding rates.
- Appropriate soil conditions: drainage, acidity, slopes.
- Generally avoid species requiring irrigation.

Targeted Pollutants

- ● Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

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BMP: SEEDING AND PLANTING (Continue)

REQUIREMENTS

- Maintenance
  - Shrubs and trees must be adequately watered and fertilized and if needed pruned.
  - Grasses may need to be watered and mowed.
- Cost: Average annual cost for installation and maintenance (2 year useful life, source: EPA, 1992)
  - Seeding: $300 per acre, appropriate for flat slopes and stable soils.
  - Seeding with Mulching: $1,100 per acre, appropriate for moderate to steep slopes and/or erosive soils.
  - Trees, shrubs, vines, and ground cover: Cost, applicability based on species used and terrain features.

LIMITATIONS

- Permanent and temporary vegetation may not be appropriate in dry periods without irrigation.
- Fertilizer requirements may have potential to create storm water pollution if improperly applied.

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Additional Information — Seeding and Planting

Permanent seeding of grasses, sodding, and planting of trees, shrubs, vines and ground covers can provide long-term stabilization of soil. Permanent seeding and planting contributes to long-term site aesthetics and helps reduce erosion by reducing the velocity of runoff, allowing infiltration to occur, filtering sediments, and by holding soil particles in place.

Seeding and planting should be applied as soon as final grading is done to all graded and cleared areas of the construction site where plant cover is ultimately desired. For example, vegetation may be established along landscaped corridors and buffer zones where they may act as filter strips (see TC6 in Chapter 5 of the Municipal Handbook). Additionally, vegetated swales, steep and/or rocky slopes and stream banks can also serve as appropriate areas for seeding and plantings.

Installation/Application Criteria

Application of appropriate vegetation must consider: the seedbed or plantbed, proper seasonal planting times, water requirements fertilizer requirements and availability of the selected vegetation within the project's region. Permanent plantings during the construction stage of projects require careful coordination between the local agency inspectors, project managers, construction managers, and landscape contractor. Protocols for coordination and implementation procedures regarding site access, construction staging, and short- and long-term planting areas should be developed prior to the construction bid process. Where possible, these protocols should be established by and remain the responsibility of the site owner.

Because of the many available types of plants and ground covers and because site conditions and land use vary so widely within California, a set of general guidelines is included for installation/application of grasses, trees and shrubs, vines and ground covers. However, your local municipality, Soil Conservation Service, agricultural extention, or other resources should be consulted on appropriate species, planting requirements, and maintenance needs for your climate and soils.

Grasses

Grasses, depending on the type, provide short-term soil stabilization during construction or can serve as long- term/ permanent soil stabilization for disturbed areas. In general, grasses provide low maintenance to areas that have been cleared, graded and mechanically stabilized.

Selection:

The selection of the grass type is determined by the climate, irrigation, mowing frequency, maintenance effort and soil-bed conditions. Although grasses provide quick germination and rapid growth, they also have a shallow root system and are not as effective in stabilizing deep soils, where trees, shrubs and deep rooted ground covers may be more appropriate. Several grasses are adaptable to the various California climates. The figure at the end of these fact sheets shows appropriate grasses for regions within California. Blue grass is well adapted throughout California except for in the valley regions. The blue grass is found on dry, sandy soils that have good drainage. Bermuda grass, on the other hand is well adapted in the valley region where soils are dry, coarse and heavier. Specific seed mix and/or varieties for each site should be provided by an approved/qualified plant materials specialist.

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Additional Information — Seeding and Planting

Planting:
The following steps should be followed to ensure established growth:

1. Select the proper grass for the site.
2. Prepare the seedbed; soil should be fertilized and contain good topsoil or soil at least a 2:1 or flatter slope.
3. Broadcast the seedings in the late fall or early spring. In the late fall, seedings should be planted by mid- September to have established grass by the October rainy season.
4. Initial irrigation will be required often for most grasses, with follow-up irrigation and fertilization as needed. Mulching may be required in dry climates or during drought years.

Trees & Shrubs

Selection:
Trees and shrubs, when properly selected, are low maintenance plantings that stabilize adjacent soils, moderate the adjacent temperatures, filter air pollutants, and serve as a barrier to wind. Some desirable characteristics to consider in selecting trees and shrubs include: vigor, species, age, size and shape, and use as a wildlife food source and habitat.

Trees and shrubs to be saved should be clearly marked so that no construction activity will take place within the dripline of the plant. The sites for new plantings should be evaluated. Consider the prior use of the land: adverse soil conditions such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting and traffic problems.

Transplanting:
Time of Year - Late fall through winter (November to February) is the preferred time for transplanting in most of California.

Preparation - Proper digging of a tree/shrub includes the conservation of as much of the root system as possible. Soil adhering to the roots should be damp when the tree is dug, and kept moist until re-planting. The soil ball should be 12 inches in diameter for each inch of diameter of the trunk.

Site preparation - Refer to landscape plans and specifications for site and soil preparation, and for ability to coordinate construction strategy with permanent vegetation.

Supporting the trunk - Many newly planted trees/shrubs need artificial support to prevent excessive swaying.

Watering - Soil around the tree should be thoroughly watered after the tree is set in place. When the soil becomes dry, the tree should be watered deeply, but not often. Mulching around the base of the tree is helpful in preventing roots from drying out.

Vines & Ground Covers

Selection:
Vines, ground covers, and low growing plants, that can quickly spread, come in many types, colors, and growth habits. Some are suitable only as part of a small maintained landscape area, while some can stabilize large areas with little maintenance. Flowers, which provide little long-term erosion control may be planted to add color and varietal appearances.

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Additional Information — Seeding and Planting

Caution should be exercised in the non-native vegetation because of impacts to native vegetation on adjacent lands. For example, species that may be planted at the construction site can quickly spread and compete with originally undisturbed vegetation such as the California Poppy and California buckwheat, both of which complete poorly with introduced grasses (e.g., planting wild oats is illegal in California). In addition to stabilizing disturbed soil, vines and ground covers can perform the following functions:

1. Provide attractive cover that does not need mowing.
2. Help to define traffic areas and control pedestrian movement.

Site Preparation:
Ground covers are plants that naturally grow very close together, causing severe competition for space nutrients and water. Soil for ground covers should be well prepared. The entire area should be spaded, disced, or rototilled to a depth of six to eight inches. Two to three inches of organic material, such as good topsoil or peat, should be spread over the entire area.

Planting:
The following steps will help ensure good plant growth.

1. Make the plantings following the contours of the land.
2. Dig the holes 1/3 larger than the plant root ball.
3. Know what depth to place the plants.
4. Use good topsoil or soil mixture with a lot of organic matter.
5. Fill hole 1/3 to 1/2 full, shake plants to settle soil among roots, then water.
6. Leave saucer-shaped depression around the plant to hold water.
7. Water thoroughly and regularly.
8. Space plants according to the type of plant and the extent of covering desired.

Materials:
There are many different species of vines and ground covers from which to choose, but care must be taken in their selection. It is essential to select planting materials suited to both the intended use and specific site characteristics. The plants discussed in this handbook are those which are known to be adapted to California, and commonly available from commercial nurseries. Additional information can be obtained from local nurserymen, landscape architects, and extension agents. An approved low water use plant list may be obtained from the State Department of Water Resources or the Soils Conservation Service.

Requirements
Maintenance

General requirements include:

- Grass maintenance should be minimal to none. Irrigation and regular fertilizing may be required for some types of grasses. Mowing is only required in areas where aesthetics or fire hazards are a concern.
- Young trees should receive an inch of water each week for the first two years after planting. The tree should be watered deeply, but not more often than once per week.
- Transplanted trees should be fertilized on an annual basis.
- Proper pruning, watering, and application of fertilizer is necessary to maintain healthy and vigorous shrubs. A heavy layer of mulch applied around the shrubs reduces weeds and retains moisture.
- Trim old growth as needed to improve the appearance of ground covers. Most covers need once-a-year trimming to promote growth.

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Additional Information — Seeding and Planting

Limitations

- Construction activities are likely to injure or kill trees unless adequate protective measures are taken. Direct contact by equipment is the most obvious problem, but damage is also caused by root stress from filling, excavation, or compacting too close to trees.
- Temporary seeding can only be viable when adequate time is available for plants to grow and establish.
- Over fertilizing of plants may cause pollution of storm water runoff.
- Irrigation source and supply may be limiting.

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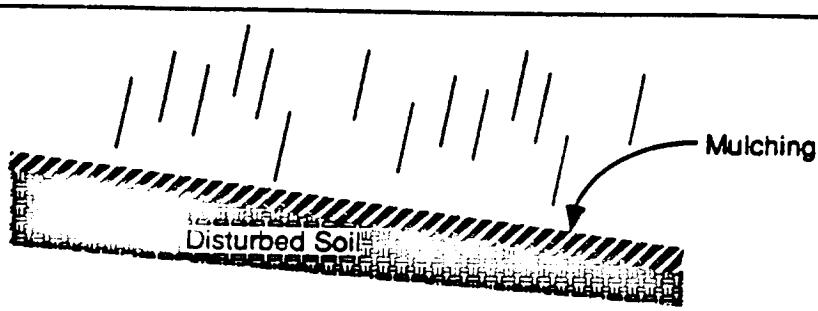
BMP: MULCHING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- (Stabilize Disturbed Areas)
- (Protect Slopes/Channels)
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ● Sediment
- ◒ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ● Suitability for Slopes >5%

● High ○ Low

ESC11

Best Management Practices

GENERAL DESCRIPTION

Mulching is used to temporarily and permanently stabilize cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, and gravel.

SUITABLE APPLICATIONS

- Temporary stabilization of freshly seeded and planted areas.
- Temporary stabilization during periods unsuitable for growing vegetation.
- Temporary stabilization of areas that cannot be seeded or planted (e.g., insufficient rain, steep slope).
- Mulches such as gravel and decomposed soils may be used as post-construction BMPs, particularly in arid regions.

INSTALLATION/APPLICATION CRITERIA

Mulch prevents erosion by protecting the soil surface and fostering growth of new seedings that do not stabilize by themselves.

- May be used with netting to supplement soil stabilization.
- Apply to planting areas where slopes are 2:1 or greater.
- Binders may be required for steep areas, or if wind and runoff is a problem.
- Type of mulch, binders, and application rates should be recommended by manufacturer/contractor.

REQUIREMENTS

- Maintenance
  - Must be inspected weekly and after rain for damage or deterioration.
- Cost: Average annual cost for installation and maintenance (3-4 month useful life, source: EPA, 1992)
  - Straw Mulch: $7,500 per acre.
  - Wood Fiber Mulch: $3,500 per acre.
  - Jute Netting: $12,500 per acre.

LIMITATIONS

- Wood fiber mulches should be used only in areas with over 20 inches annual precipitation.
- Organic mulches are not permanent erosion control measures.
- Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.
- Permanent mulches for arid regions should include gravel and decomposed soils.

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Additional Information — Mulching

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedings; prevents compaction and cracking of soil; and aids plant growth for seedings and plantings by holding the seeds, fertilizers and topsoil in place until growth occurs. Mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite and gravel. A variety of nettings or mats of organic or non-organic materials and chemical soil stabilization are practices that may be used conjunctively with mulching.

Mulching may be applied to all graded and cleared areas of the construction site:

- Areas which have been permanently seeded to assist in retaining moisture, and to hold seedings;
- Areas which need temporary soil surface protection because seeding cannot occur due to the season;
- Areas between trees, shrubs and certain ground covers;
- Areas where climatic conditions require a soil moisture retention aid to avoid cracking of the soil and associated compaction, and require soil temperature modification.

Installation/Application Criteria

Only a set of general guidelines is included for application and installation of mulching on disturbed lands because of the various climates, soil conditions and land uses in California. Installation of mulch consists of furnishing all materials, preparing the soil surface and applying the mulch to all soil surface areas designated on the project plans or established by the site engineer.

Materials

Organic mulch materials, such as straw, wood chips, bark and wood fiber, have been found to be most effective where re-vegetation will be provided by reseeding. The choice of mulch should be based on the size of the area, site slopes, surface conditions such as hardness and moisture; weed growth and availability of mulch materials.

Wood Fiber Mulches: Wood fiber mulches consist of specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch should be from virgin wood, and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The fiber lengths should be as long as possible to increase the effectiveness for erosion control. Wood fiber mulching should not be used in areas of extremely hot summer and late fall seasons because of fire danger. When used as a tackifier with straw mulch, wood fiber mulches are good for steep slopes and severe climates. The California Office of the Soils Conservation Service recommends a non-toxic mulch green dye be used to provide a visual aid in metering applications.

Wood Chips and Bark Chips: Wood and bark chips are suitable for application in landscaped areas that will not be closely mowed. Wood chips do not require tacking, but do require nitrogen treatment (12 pounds/ton) to prevent nutrient deficiency. Bark chips do not require additional nitrogen fertilizer. When the wood source is near the project site, wood and bark chips can be very inexpensive. Caution must be used in areas of steep slopes, since both wood and bark chips tend to wash down slopes exceeding 6 percent.

Straw Mulch: Straw mulch is a good short-term protection most commonly used with seeding. The mulch should be from the current season's crop. A letter of certification from the supplier should be required to show that the straw was baled less than 12 months from the delivery date. Wheat or oat straw is recommended.

Emulsified Asphalt: Asphalt is used to adhere the mulch to the ground surface, preventing the mulch from blowing or washing off. The type and quantity of asphalt used should not result in a storm water pollution problem.

Binder: Binder should be free flowing, noncorrosive powder produced from natural plant gum such as those marketed under M-Binder, M145 Binder, or AZ-TAC. Synthetic, spray-on materials are not recommended since they tend to create an impervious surface, and may enter the stormwater sewer system via discharge runoff.

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Additional Information — Mulching

Preparations/Methods and Equipment

Straw Mulch: Should be applied in an even, uniform manner, either by hand or by mulch blowing equipment. Straw mulches must be anchored to prevent the mulch from being blown or washed off the site. Anchoring is achieved in two ways:

- Crimping: The mulch is anchored by running a heavy disc with flat, dull, serrated, closely-spaced blades over the mulched soil. Effective crimping embeds the mulch about 2 inches into the soil without completely covering it. The disc should be run once or twice across the soil. About 2 1/2 tons of straw mulch per acre should be applied if the mulch is anchored by crimping.
- Tacking: Achieved using a emulsified asphalt or binder either independently or followed by crimping. If tacked, straw mulch may be applied at a rate of 1 3/4 ton per acre, and tacked with emulsified asphalt at a rate of 500 gallons per acre.

Wood Fiber Mulch: Typically applied with a hydroseeder at a rate of about 1000 to 1500 pounds per acre, or as a slurry consisting of at least 150 pounds of binder, 400 pounds of wood fiber mulch, and 200 gallons of water per acre.

Requirements

Maintenance: Mulched areas require frequent inspection for damage and deterioration. Requirements will vary greatly based on the type of mulch used and the type of vegetation to be established. Vegetative mulches are usually not intended to be permanent; but are extended only as a base for re-seeding or re-vegetation. Where a permanent anchor for vegetation is required, along steep slopes or areas of higher velocity flows, then a geotextile mat or net is recommended (see ESC20).

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Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, September 1992.

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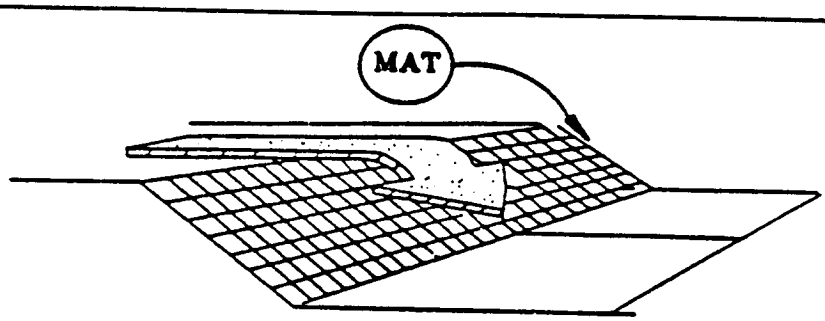
BMP: GEOTEXTILES AND MATS



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Mattings made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

SUITABLE APPLICATIONS

Typically suited for post-construction site stabilization, but may be used for temporary stabilization of highly erosive soils.

- Channels and streams.
- Steep slopes.

INSTALLATION/APPLICATION CRITERIA

Mattings may be applied to disturbed soils and where existing vegetation has been removed. The following organic matting materials provide temporary protection until permanent vegetation is established, or when seasonal circumstances dictate the need for temporary stabilization until weather or construction delays are resolved.

- Jute mattings.
- Straw mattings.

The following synthetic mattings may be used for either temporary or post-construction stabilization, both with and without vegetation

- Excelsior matting.
- Glass fiber matting.
- Staples.
- Mulch nettings.

REQUIREMENTS

- Maintenance
  - Inspect monthly and after significant rainfall.
  - Re-anchor loosened matting and replace missing matting and staples as required.
- Cost
  - Relatively high compared to other BMPs.

LIMITATIONS

- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g., channels, steep slopes).
- May delay seed germination, due to reduction in soil temperature.
- Installation requires experienced contractor to ensure soil stabilization and erosion protection.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ● Suitability for Slopes >5%

● High ○ Low

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Best Management Practices

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Additional Information — Geotextiles and Mats

Mattings are used to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, mattings may be used to stabilize soils until vegetation is established. This practice may be used alone or with a mulch during the establishment of protective cover on critical slopes (see ESC11, Mulching).

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 fps and 6 fps is likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive.

The following natural or synthetic mattings are commonly used:

Jute Mat - should be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48" in width, and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus five (5) percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn should be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than its normal diameter.

Straw Mat - should be a machine produced mat consisting of 70% (±3%) agricultural straw and 30% (±3%) coconut fiber. The blanket should be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. The blanket should be covered on the top side with polypropylene netting having an approximate 5/8" x 5/8" mesh containing ultraviolet additives to resist breakdown, and on the bottom with a polypropylene netting with an approximate " x " mesh. The blanket should be sewn together with cotton thread.

Excelsior Mat - should be wood excelsior, 48 inches in width plus or minus one inch and weighing 0.8 pound per square yard plus or minus ten percent. The excelsior material should be covered with a netting to facilitate handling and to increase strength.

Glass Fiber Matting - should be of bonded textile glass fibers with an average fiber diameter of eight to twelve microns, two to four inch strands of fiber bonded with phenol formaldehyde resin. Mat should be roll type, water permeable, minimum thickness inch, maximum thickness inch, density not less than three pounds per cubic foot.

Staples for anchoring soil stabilizing materials should be Number 11 gauge wire or heavier. Their length should be six to ten inches, with longer staples used in loose, unstable soils.

Other Mulch Netting - such as paper, plastic, cotton or fiber glass matting should be installed according to the manufacturer's recommendations.

Installation/Application Criteria

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness and moisture; weed growth and availability of materials. Matting strengths and uses vary, therefore, manufacturer's specifications must be followed. Proper installation of mattings is critical in order to obtain firm, continuous contact with the soil.

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Additional Information — Geotextiles and Mats

Site Preparation: After the site has been shaped and graded to the approved design, prepare a friable seed bed relatively free from clods and rocks more than 1 inches in diameter and any foreign material that will prevent contact of the protective mat with the soil surface.

Planting: Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Erosion Stops: Erosion stops are made of glass fiber strips, excelsior matting strips or tight-folded jute matting blanket or strips for use on steep, highly erodible watercourses. The stops are placed in narrow trenches six to twelve inches deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting: Before laying the matting, all erosion stops should be installed and the friable seed bed made free from clods, rocks, and roots. The surface upon which the separation fabric will be placed should be compacted and finished according to the requirements of the manufacturer's recommendations.

Most matting comes with the manufacturer's recommendations for installation. Most channels will require multiple widths of matting, and the matting should be unrolled starting at the upper end of the channel, allowing a four inch overlap of mattings along the center of the channel. To secure, bury the top ends of the matting in a narrow trench, a minimum of six inches deep. Backfill trench and tamp firmly to conform to channel cross section. Secure with a row of staples about four inches down slope from the trench with staples twelve inches apart.

Where matting crosses erosion stops, reinforce with a double row of staples at six inch spacing, using a staggered pattern on either side of the erosion stop. When the matting is overlapped, the discharge end of the matting liner should be similarly secured with a double row of staples.

Mechanical or manual laydown equipment should be capable of handling full rolls of fabric, and laying the fabric smoothly, without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Final Check: Check the following after the mating is installed:

- Make sure matting is uniformly in contact with the soil.
- All lap joints are secure.
- All staples are flush with the ground.
- All disturbed areas seeded.

Limitations

Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.

Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs, otherwise the material will not stabilize the soil and erosion will occur beneath the material. Ultraviolet protection may be required on some geotextiles. Matting strengths and uses vary; the manufacturer's specifications should be followed.

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Additional Information — Geotextiles and Mats

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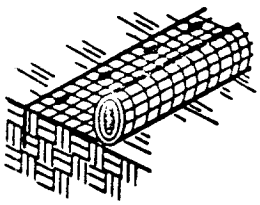
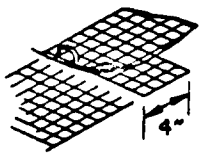
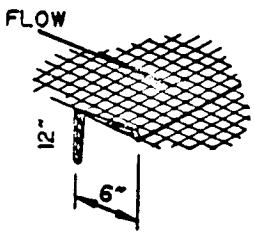
Additional Information — Geotextiles and Mats



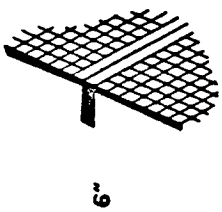
ANCHOR SLOT: BURY THE UP-CHANNEL END OF THE NET IN A 12" DEEP TRENCH. TAMP THE SOIL FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET.



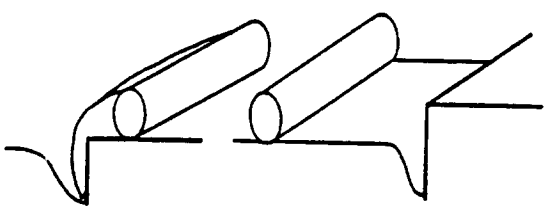
OVERLAP: OVERLAP EDGES OF THE STRIPS AT LEAST 4". STAPLE EVERY 12" DOWN THE CENTER OF THE STRIP.



JOINING STRIPS: INSERT THE NEW ROLL OR NET IN A TRENCH, AS WITH THE ANCHOR SLOT. OVERLAP THE UP-CHANNEL END OF THE PREVIOUS ROLL 18" AND TURN THE END OF THE PREVIOUS ROLL JUST BELOW THE ANCHOR SLOT, LEAVING 6" OVERLAP.



CHECK SLOTS: ON ERODIBLE SOILS OR STEEP SLOPES, CHECK SLOTS SHOULD BE MADE EVERY 15 FEET. INSERT A FOLD OF THE NET INTO A 6" TRENCH AND TRAMP FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET. LAY THE NET SMOOTHLY ON THE SURFACE OF THE SOIL - DO NOT STRETCH THE NET, AND DO NOT ALLOW WRINKLES.



ANCHORING ENDS AT STRUCTURES: PLACE THE END OF THE NET IN A 12" SLOT ON THE UP-CHANNEL SIDE OF THE STRUCTURE. FILL THE TRENCH AND TAMP FIRMLY. ROLL THE NET UP THE CHANNEL. PLACE STAPLES AT 12" INTERVALS ALONG THE ANCHOR END OF THE NET.

INSTALLATION OF NETTING AND MATTING

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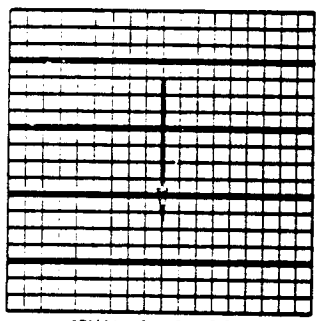
Additional Information — Geotextiles and Mats

ON SHALLOW SLOPES, STRIPS OF NETTING MAY BE APPLIED ACROSS THE SLOPE.

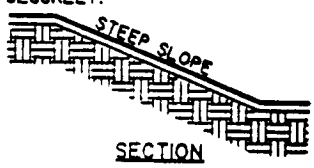
SECTION



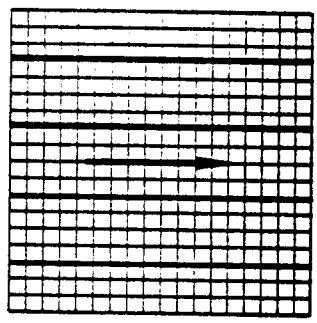
(SHALLOW SLOPES)

PLAN

ON STEEP SLOPES, APPLY STRIPS OF NETTING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.



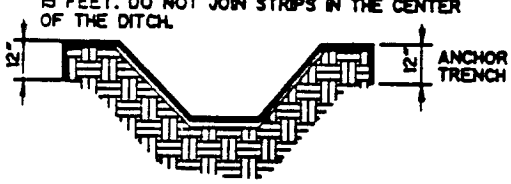
SECTION



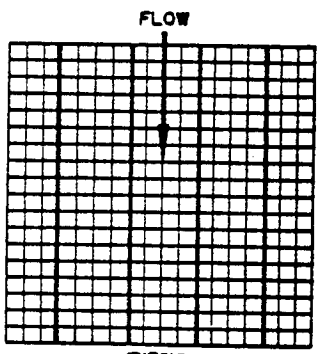
(STEEP SLOPE)

PLAN

IN DITHCHES, APPLY NETTING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS EVERY 15 FEET. DO NOT JOIN STRIPS IN THE CENTER OF THE DITCH.

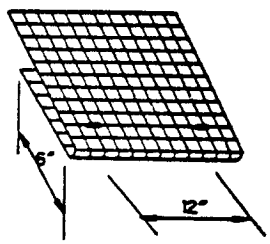


SECTION

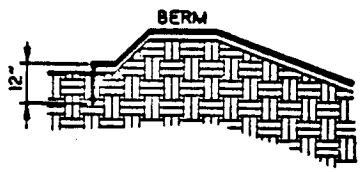


(DITCH)

PLAN



BRING NETTING DOWN TO A LEVEL BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 6" AND STAPLE AT 12" INTERVALS.



WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATTING OVER THE BERM AND ANCHOR IT BEHIND THE BERM WITH A 12" ANCHOR TRENCH.

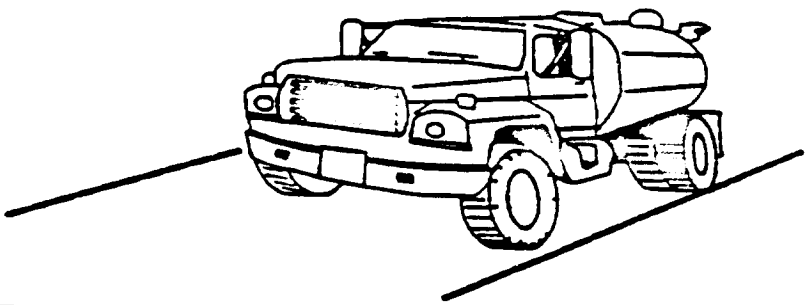
ESC20

ORIENTATION OF NETTING AND MATTING

R0034446

VOL 12

BMP: DUST CONTROLS



Objectives

- (●) Housekeeping Practices
- Contain Waste
- (●) Minimize Disturbed Areas
- (●) Stabilize Disturbed Areas
- Protect Slopes/Channels
- (●) Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

GENERAL DESCRIPTION

Dust control measures are used to stabilize soil from wind erosion, and reduce dust generated by construction activities.

SUITABLE APPLICATIONS

- Clearing and grading activities.
- Construction vehicle traffic on unpaved roads.
- Drilling and blasting activities.
- Sediment tracking onto paved roads.
- Soil and debris storage piles.
- Batch drop from front end loaders.
- Areas with unstabilized soil.
- Final grading/site stabilization usually is sufficient to control post-construction dust sources.

INSTALLATION/APPLICATION CRITERIA

- Schedule construction activities to minimize exposed area (See ESC 1).
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering (See ESC 10 and 11).
- Identify and stabilize key access points prior to commencement of construction (See ESC 24).
- Minimizing the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site (See ESC 23).

REQUIREMENTS

- Maintenance
  - Most dust control measures require frequent, often daily, attention.
- Cost
  - Installation costs for water/chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

LIMITATIONS

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Overwatering may cause erosion.
- Oil should not be used for dust control because the oil may migrate into drainageway and/or seep into the soil.
- Certain chemically-treated subgrades may make soil water repellant, increasing runoff.

ESC21

Best Management Practices

R0034447

VOL 12

Additional Information — Dust Controls

California's mediterranean climate, with short wet seasons and long hot dry seasons, allow the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbance and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities. Los Angeles, the North Coast and Sacramento, among others have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line. Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). 90% of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and/or public health departments are in place in some regions within California. For jurisdictions that have no formal dust control regulations and/or standards, Sections 10, 17 and 18 of CalTrans' Standard Specifications provide detailed provisions for dust control practices.

Many local agencies require dust control in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. The following are measures that local agencies may have already implemented as requirements for dust control from contractors:

- Construction & Grading Permits: Require provisions for dust control plans;
- Opacity Emission Limits: Enforce compliance with California air pollution control laws;
- Increase overall enforcement activities: Priority given to cases involving citizen complaints;
- Maintain Field Application Records: Require records of dust control measures from contractor;
- Stormwater Pollution Prevention Plan: (SWPPP): Integrate dust control measures into SWPPP.

Dust Control Practices

Dust control BMP's generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. Table ESC21.1 shows which Dust Control BMPs apply to site conditions which cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel or asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching and sand fences can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting on-site vehicle traffic to 15 miles per hour, and controlling the number and activity of vehicles on a site at any given time.

Many of the reasonably available control measures for controlling dust from construction sites can also be implemented as BMPs for storm water pollution prevention. Those BMPs include:

- Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid clean-up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize unpaved haul roads, parking and staging areas. Reduce speed and trips on unpaved roads.
- Implement dust control measures for material stockpiles.
- Prevent drainage of sediment laden storm water onto paved surfaces.
- Stabilize abandoned construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For the chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. The types of chemicals available and recommendations for their use are tabulated in Table ESC 21.2, Commonly Used Chemicals for Dust Control.

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Additional Information — Dust Controls

In addition, there are many other BMPs identified in this handbook that provide dust control including:

- Seeding and Plantings (ESC 10)
- Mulching (ESC 11)
- Construction Road Stabilization (ESC 23)
- Stabilized Construction Entrances (ESC 24)

Limitations

- Oil treated subgrades should not be used because the oil may migrate into drainageways and/or seep into the soil.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration, and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24 hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

California Air Pollution Control Laws, California Air Resources Board, 1992.

CalTrans, Standard Specifications, Sections 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative".

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Sacramento County, Winterization Ordinance & Dust Control Ordinance (example).

USDA Soil Conservation Service, "Guides for Erosion and Sediment Control".

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TABLE ESC 21.1 DUST CONTROL BMPs FOR GIVEN SITE CONDITIONS

SITE CONDITION	DUST CONTROL BMPs								
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt Surfacing	Sand Fences	Temporary Gravel Construction Entrances/Equipment Wash Down	Haul Truck Covers	Minimize Extent of Area Disturbed
Disturbed Areas not Subject to Traffic	X	X	X	X	X				X
Disturbed Areas Subject to Traffic			X	X	X				X
Material Stock Pile Stabilization			X	X		X			X
Demolition			X				X	X	
Clearing/Excavation			X	X					X
Truck Traffic on Unpaved Roads			X	X	X			X	
Mud/Dirt Carry-Out					X		X		

R0034450

TABLE ESC 21.2 COMMONLY USED CHEMICALS FOR DUST CONTROL

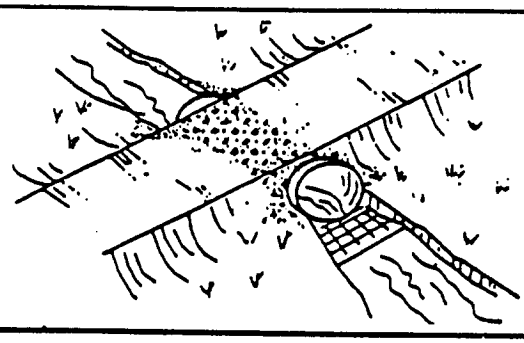
	SALTS	ORGANIC, NON PETROLEUM-BASED	PETROLEUM BASED PRODUCTS[1]
CHEMICAL TYPES	• Calcium Chloride[2] • Magnesium Chloride • Natural Brines	• Calcium Lignosulfonate • Sodium Lignosulfonate • Ammonium Lignosulfonate	• Bunker Oil • Asphalt Primer • Emulsified Asphalt
LIMITATIONS	Can lose effectiveness in dry periods with low humidity. Leaches from road in heavy rain Not recommended for gravel road surfaces with low fines. Recommended 10-20% fines.	Not affected by dry weather and low humidity. Leached from road in heavy rain if not sufficiently cured. Best performance on gravel roads with high surface fines (10-30%) and dense compact surface with loose gravel.	Generally effective regardless of climatic conditions may pothole in wet weather. Best performance on gravel roads with 5-10% fines.
COMMENTS	Calcium Chloride is popular. May become slippery when wet on gravel surfaces with high fines.	Ineffective on gravel surfaces low in fines. May become slippery when wet on gravel surfaces with high fines content.	Creates a hardened crust.

[1] Motor oils and oil treatments are not recommended due to adverse effects on plant life and groundwater.

[2] Not recommended due to adverse effects on plant life.

R0034451

BMP: TEMPORARY STREAM CROSSING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

A temporary access stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to be used to maintain traffic for the general public.

SUITABLE APPLICATIONS

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels which may be significantly eroded by construction traffic.

INSTALLATION/APPLICATION CRITERIA

Requires knowledge of stream flows and soil strength and should be designed under the direction of a California registered engineer with knowledge of both hydraulics and construction loading requirements for structures.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each significant rainfall, including assessment of foundations.
  - Periodically remove silt from crossings.
  - Replace lost aggregate from inlets and outlets of culverts.
- Cost
  - CalTrans Construction Cost Index for temporary bridge crossing is $45-$95 per square feet.

LIMITATIONS

- May be an expensive for a temporary improvement.
- Requires other BMPs to minimize soil disturbance during installation and removal.
- Fords should only be used in dry weather.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC22

Best Management Practices

R0034452

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Additional Information — Temporary Stream Crossing

A temporary access stream crossing is a culvert, ford, or bridge placed across a waterway to provide access for construction for a period of less than one year. Temporary access crossings are not intended to be used for general public traffic.

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in California. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light-duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Installation/Application

Temporary access stream crossings should be sized and installed according to the drainage design criteria of the local municipality. Design criteria should be based on standard engineering practices for culvert design with provisions for minimizing impacts on disturbed crossing areas. Three types of temporary access stream crossings may be considered:

Temporary Access Culvert: A temporary access culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.

Temporary Access Ford: A temporary access ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate during the dry season and in arid areas of California.

Temporary Access Bridge: With the appropriate materials and designs, a temporary access bridge causes the least erosion of the stream channel crossing during its installation and removal.

During the long summer construction season in California, rainfall is infrequent and many streams are dry. Under these conditions, a temporary access ford may be sufficient. A ford is not appropriate if construction will continue through the winter rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary access culverts and bridges should then be considered and, if used, should be sized to pass a significant design storm (i.e., at least a 10-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing (and, consequently, costly construction delays).

Limitations

Special care must be taken when crossing an environmentally sensitive waterway. Oils or other potentially hazardous materials shall not be used for surface treatments. Street runoff should not be allowed to spill down crossing sideslopes. Construction in watercourses should be at or near the natural elevation of the stream bed to prevent any potential flooding upstream of the crossing. In addition, the following limitations may apply:

ESC22

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Additional Information — Temporary Stream Crossing

- May be expensive temporary cost
- Increased soil disturbance upon installation and removal
- Temporary culverts need regular maintenance and can cause erosion if the culvert becomes clogged.
- A temporary ford offers little if any erosion control in flowing streams and can often make erosion worse. Fords should only be used in the dry season on dry streams.

Construction in waterways is subject to additional permit requirements. Contact the local municipal storm water agency for additional information.

REFERENCES

Bank and Shore Protection, CalTrans - November 1970.

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September, 1992.

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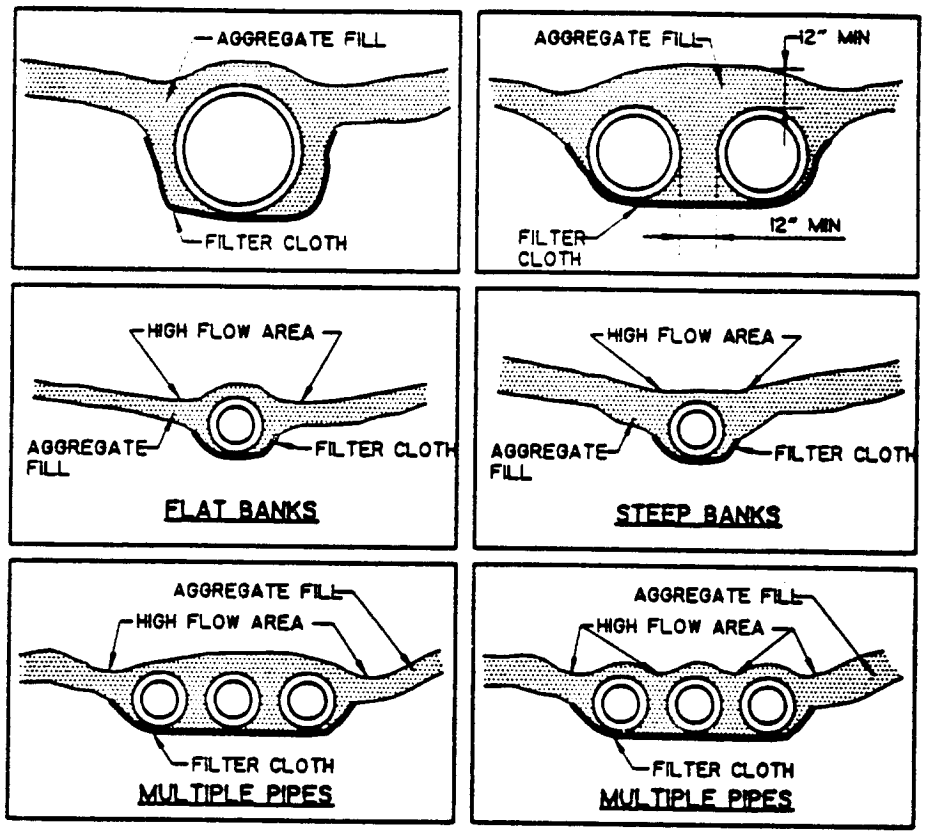
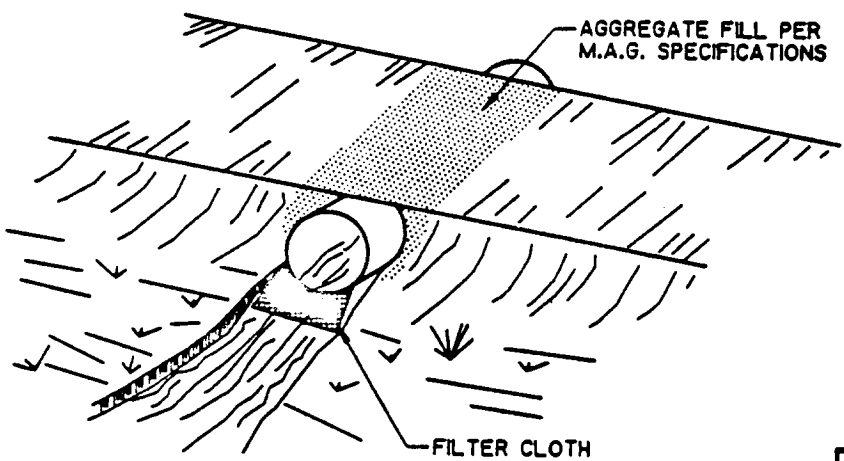
Additional Information — Temporary Stream Crossing





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TEMPORARY ACCESS CULVERT

R0034455

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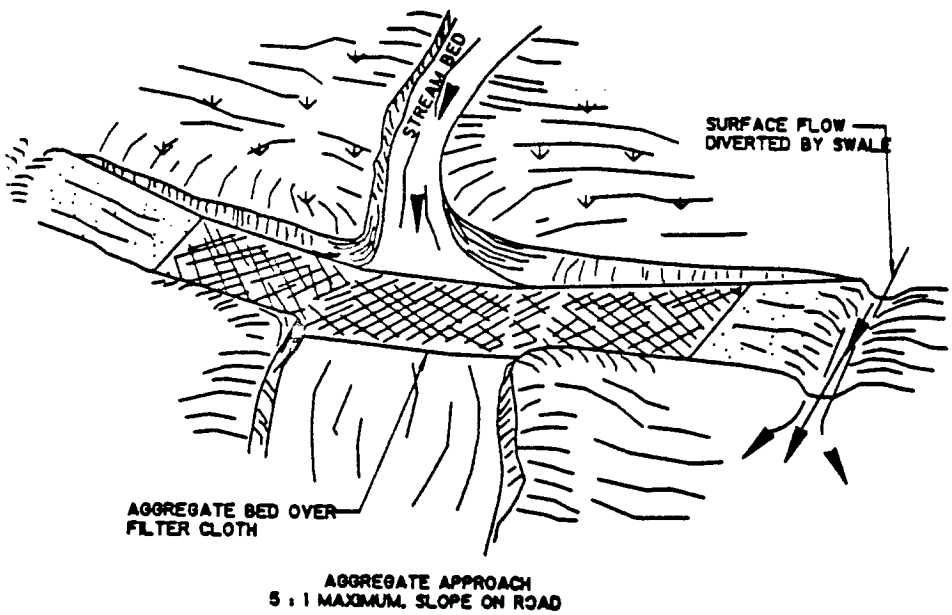
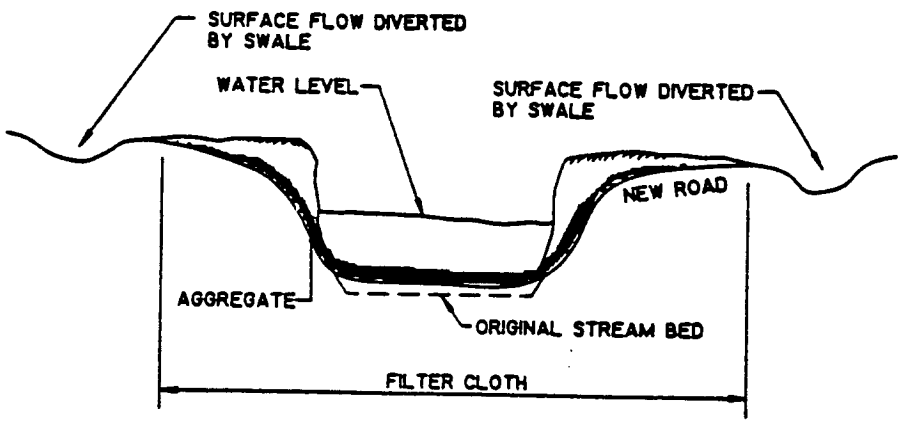
Additional Information — Temporary Stream Crossing





TEMPORARY ACCESS FORD

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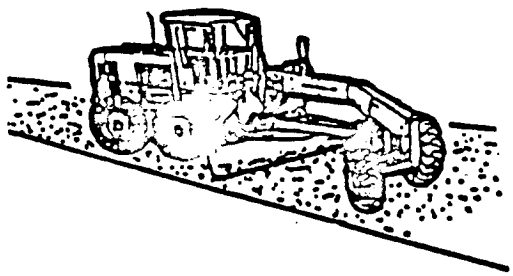
BMP: CONSTRUCTION ROAD STABILIZATION



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC23

Best Management Practices

GENERAL DESCRIPTION

Access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes should be stabilized immediately after grading and frequently maintained to prevent erosion and control dust.

SUITABLE APPLICATIONS

- Temporary construction traffic.
- Phased construction projects and off-site road access.
- Detour roads.
- Construction during wet weather.

INSTALLATION/APPLICATION CRITERIA

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15 percent.
- Gravel roads should be a minimum 4-inch thick, 2-3 inch coarse aggregate base applied immediately after grading, or as recommended by soils engineer.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (see Dust Control ESC 21).

REQUIREMENTS

- Maintenance
  - Periodically apply additional aggregate on gravel roads.
  - Active dirt construction roads are commonly watered three or more times per day during the dry season.
  - Inspect weekly, and after each rain.
  - Repair any eroded areas immediately.
- Cost
  - Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay.
  - No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

LIMITATIONS

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause storm water or soil pollution and should not be used (see Dust Control ESC 21).
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.

R0034457

VOL 12 1121

Additional Information — Construction Road Stabilization

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces on-site erosion but can significantly speed on-site work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Installation/Application Criteria

Where feasible, alternative routes should be made for construction traffic; one for use in dry condition, the other for wet conditions which incorporate the measures listed for this BMP. Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and/or on slopes greater than 5 percent.

When gravel road is needed, apply a minimum 4-inch course of 2 to 4-inch crushed rock, gravel base, or crushed surfacing base course immediately after grading or the completion of utility installation within the right-of-way. Chemical stabilization may also be used upon compacted native sub-grade (see the Dust Control BMP ESC 21). These chemical controls should be applied per the manufacturer's directions.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15 percent. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of super-elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment-laden water from entering the storm sewer system (see "Storm Drain Inlet Protection" ESC 54).

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June1981.

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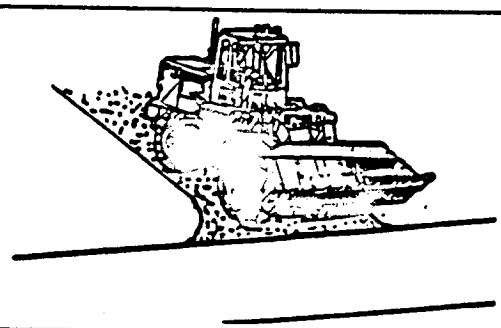
ESC23

VOL 12

1122

R0034458

BMP: STABILIZED CONSTRUCTION ENTRANCE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

The construction entrance practice is a stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. Stabalizing the construction entrance significantly reduces the amount of sediment (dust, mud) tracked off-site, especially if a washrack incorporated for removing caked on sediment.

SUITABLE APPLICATIONS

- All points of construction ingress and egress.
- Unpaved areas where sediment tracking occurs from site onto paved roads.

INSTALLATION/APPLICATION CRITERIA

- Construct on level ground where possible.
- Stones should be 1-3 inches.
- Minimum depth of stones should be 6 inches or as recommended by soils engineer.
- Length should be 50-foot minimum, and 30-foot minimum width.
- Provide ample turning radii as part of entrance.

REQUIREMENTS

- Maintenance
  - Inspect monthly and after each rainfall.
  - Replace gravel material when surface voids are visible.
  - Remove all sediment deposited on paved roadways within 24 hours.
  - Remove gravel and filter fabric at completion of construction
- Cost: Average annual cost for installation and maintenance (Source: EPA, 1992)
  - Without Wash Rock: $1500 each.
  - With Wash Rock: $2200 each.

LIMITATIONS

- Requires periodic top dressing with additional stones.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.

Targeted Pollutants

- ◒ Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC24

Best Management Practices

R0034459

VOL 12 1123

Additional Information — Stabilized Construction Entrance

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing trackout of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving, a stabilized construction entrance should be used at all points of construction ingress and egress. NPDES permits require that appropriate measures be implemented to prevent trackout of sediments onto paved roadways, which is a significant source of sediments derived from mud and dirt carryout from the unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be build on the level ground. Advantages of the Stabilized Construction Entrance is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance.

The aggregate for a stabilized construction entrance aprons should be 1 to 3 inches in size, washed, well-graded gravel or crushed rock. Minimum apron dimensions of 30 ft. x 50 ft. and 6 inches deep is adequate for two-way ingress/egress traffic.

The entrance must be properly graded to prevent runoff from leaving the construction site.
When wash areas are provided, washing is done on a reinforced concrete pad (if significant washing is necessary) or in an area stabilized with crushed stone which drains into a properly constructed sediment trap or basin (ESC 55 and 56). Sediment barriers are provided to prevent sediments from entering into the stormwater sewer system, ditch, or waterway.

Limitations

- Construct on level ground.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.
- Requires periodic top dressing with additional stones.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

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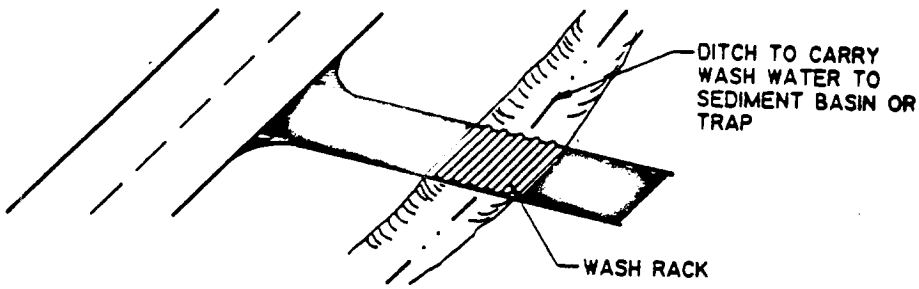
ESC24

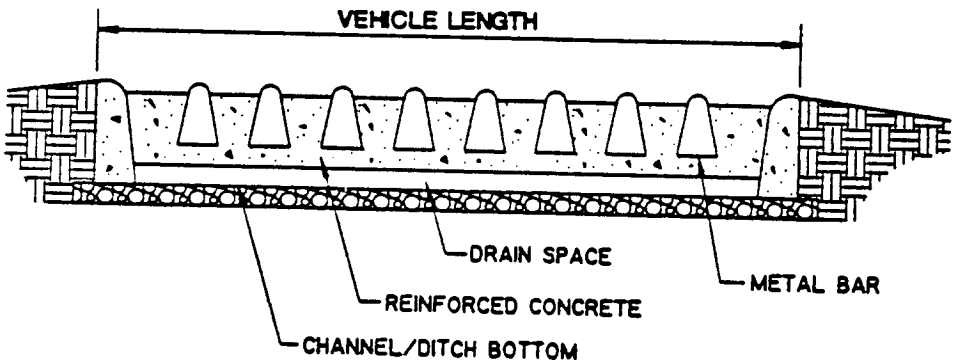
R0034460

VOL 12

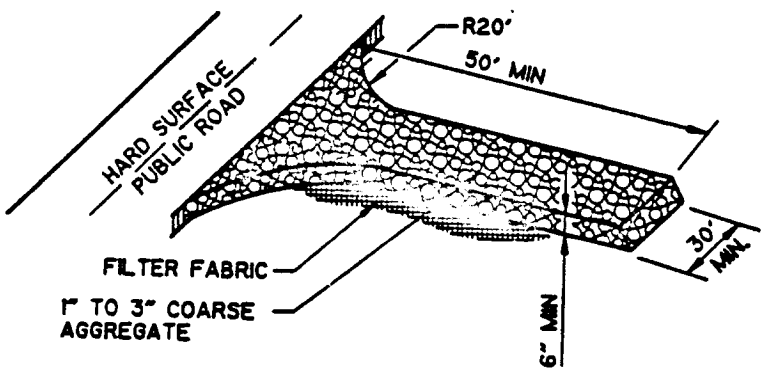
1124

Additional Information — Stabilized Construction Entrance





WASH RACK (SCHEMATIC)



STABILIZED CONSTRUCTION ENTRANCE

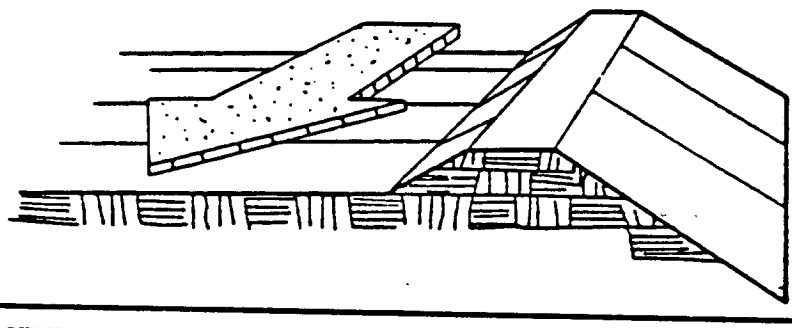
ESC24

R0034461

VOL 12

1125

BMP: EARTH DIKE



Objectives

- Housekeeping Practices
- (Contain Waste)
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- (Protect Slopes/Channels)
- (Control Site Perimeter)
- (Control Internal Erosion)

GENERAL DESCRIPTION

The temporary earth dike is a temporary berm or ridge of compacted soil, used to divert runoff or channel water to a desired location.

SUITABLE APPLICATIONS

Earth dikes are typically used to divert concentrated runoff through disturbed areas into another BMP (e.g., sediment basins), to divert runoff away from disturbed or unstable slopes, to divert runoff from off-site and undisturbed areas around disturbed areas, and as a containment for construction materials and wastes. The dikes should remain in place until the disturbed areas are permanently stabilized. The dikes must be on-site and must safely convey anticipated flood flows.

INSTALLATION/APPLICATION CRITERIA

- All dikes should be compacted by earth-moving equipment.
- All dikes should have positive drainage to a stabilized outlet.
- Top width may be wider and side slopes may be flatter at crossings for construction traffic.
- Dikes should direct sediment-laden runoff into a sediment trapping device.
- Dikes should be stabilized with vegetation, chemicals, or physical devices.

REQUIREMENTS

- Maintenance
  - Inspect periodically and after every significant rainfall; repair as necessary.
- Cost
  - Cost ranges from $15 to $55 per foot for both earthwork and stabilization and depends on availability of material, site location, and access.

LIMITATIONS

Dikes should not be used for drainage areas greater than 10 acres, or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted storm water may cause downstream flood damage.
- Dikes should not be constructed of soils which may be easily eroded.
- Regrading the site to remove the dike may add additional cost.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ◒ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC30

Best Management Practices

VOL 12

1126

R0034462

Additional Information — Earth Dike

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert storm water to a sediment trapping device or stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off-site and from undisturbed areas away from disturbed areas, and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff; a dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

- The advantages of the temporary earth dike include the ability to handle flows from large drainage areas.
- Once stabilized, earth dikes require relatively little maintenance. Additionally, the earth dikes are relatively inexpensive to install since the soil material required for construction may be available on-site, and can be constructed as part of the initial grading operations, while the equipment is on-site.
- Uses on-site materials.

Installation/Application Criteria

Temporary earth dikes are a practical, inexpensive BMP used to divert storm water runoff. Temporary diversion dikes should be installed in the following manner:

1. All dikes should be compacted by earth-moving equipment.
2. All dikes should have positive drainage to an outlet.
3. All dikes should have 2:1 side slopes, 18 inches minimum height, and a minimum top width of 24 inches. Top width may be wider and side slopes may be flatter at crossings for construction traffic.
4. The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a sediment trap (ESC 55) or sediment basin (ESC 56) when either the dike channel or the drainage area above the dike are not adequately stabilized.
5. Temporary stabilization may be achieved using seed and mulching for slopes less than 5%, and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
6. If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

CHANNEL GRADE	RIPRAP STABILIZATION
0.5-1.0%	4" Rock
1.1-2.0%	6" Rock
2.1-4.0%	8" Rock
4.1-5.0%	8-12" Riprap

7. The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
8. Filter cloth may be used to cover dikes in use for long periods.
9. Construction activity on the earth dike should be kept to a minimum.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

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ESC30

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1127

R0034463

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ESC30

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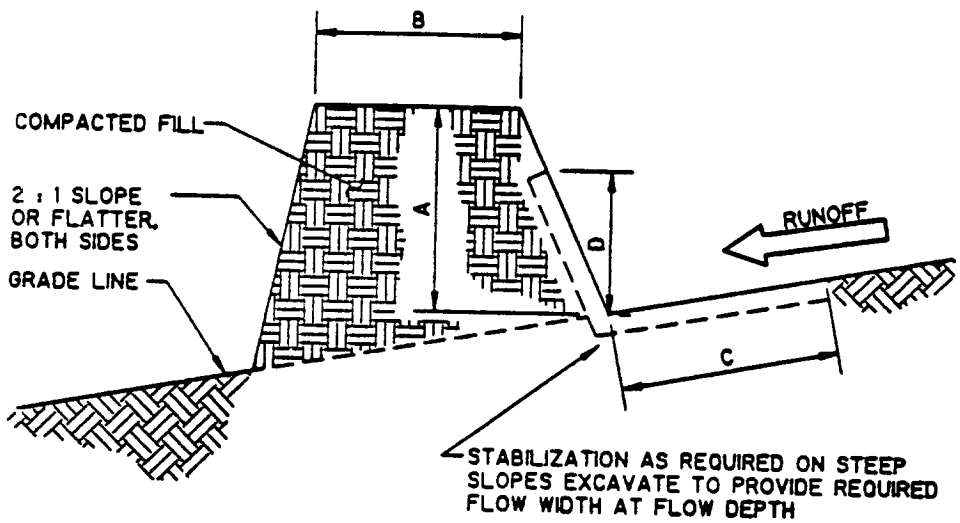
1128

R0034464

Additional Information — Earth Dike



REQUIREMENTS BASED ON UPSTREAM DRAINAGE AREA

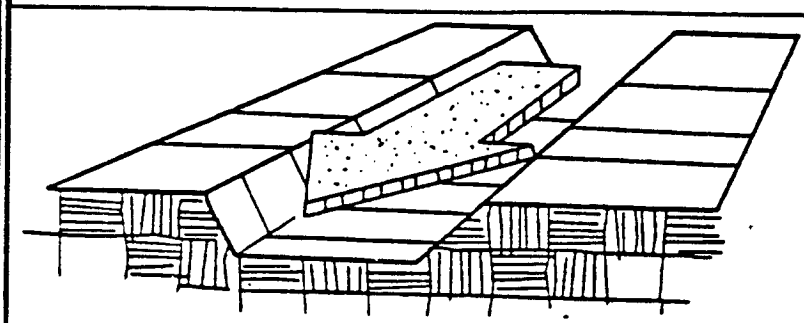
	DIKE 1 (5 ACRES OR LESS)	DIKE 2 (5-10 ACRES)
A-DIKE HEIGHT	18"	36"
B-DIKE WIDTH	24"	36"
C-FLOW WIDTH	4'	6'
D-FLOW DEPTH	8"	15"

TEMPORARY DIVERSION DIKE

ESC30

VOL 12
1129
R0034465

BMP: TEMPORARY DRAINS AND SWALES



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- (Protect Slopes/Channels)
- (Control Site Perimeter)
- (Control Internal Erosion)

GENERAL DESCRIPTION

Temporary drains and swales are used to divert off-site runoff around the construction site, divert runoff from stabilized areas around disturbed areas, and direct runoff into sediment basins or traps.

SUITABLE APPLICATIONS

Temporary drains and swales are appropriate for diverting any upslope runoff around unstabilized or disturbed areas of the construction site:

- Prevent slope failures.
- Prevent damage to adjacent property.
- Prevents erosion and transport of sediments into water ways.
- Increases the potential for infiltration.
- Diverts sediment-laden runoff into sediment basins or traps.

INSTALLATION/APPLICATION CRITERIA

Temporary drainage swales will effectively convey runoff and avoid erosion if built properly:

- Size temporary drainage swales using local drainage design criteria.
- A permanent drainage channel must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drain/swale should conform to predevelopment drainage patterns and capacities.
- Construct the drain/swale with an uninterrupted, positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drain or swale can reach an erosive velocity.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Repair any erosion immediately.
  - Remove sediment which builds up in the swale and restricts its flow capacity.
- Cost
  - The cost of a drainage swale increases with drainage area and slope. Typical. swales for controlling internal erosion are inexpensive.

LIMITATIONS

- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC31

Best Management Practices

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R0034466

Additional Information — Temporary Drains and Swales

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike (see ESC30) at the top of a slope can safely divert runoff to a location where it can safely be brought to the bottom of the slope (see Pipe Slope Drain ESC32). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded, and remain in place until post-construction BMPs are installed and/or the slopes are stabilized.

Diversion practices concentrate the volume of surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. A swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization, if significant erosion will occur. Any drain or swale which conveys sediment-laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

Installation/Application Criteria

Diversion drains or swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost-effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drains or swales should be designed as follows:

- No more than 5 acres may drain to a temporary drain or swale
- Place the drain or swale above, not on, a cut and fill slope
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 inches
- Side slopes should be 2:1 or flatter
- Drain or swale should be layed at a grade of at least 1 percent, but not more than 15 percent
- The swale must not be overtopped by the 10-year, 24-hour storm, irrespective of the design criteria stated above
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built
- Compact any fill material along the path of the swale
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- The cost of swales and other diversion devices is generally included in the earthwork cost, as a separate item under the grading budget of the project construction contract.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

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R0034467

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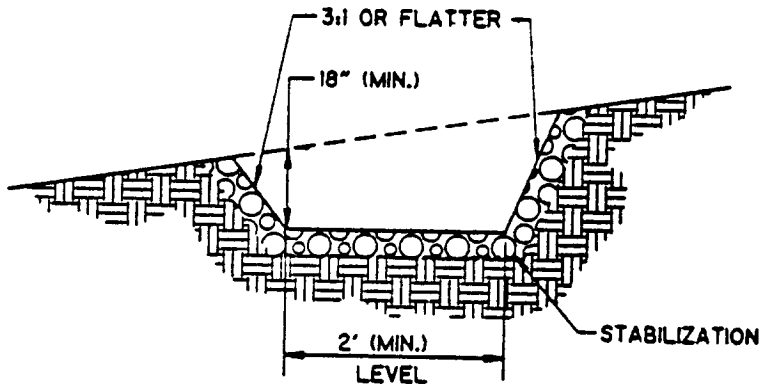
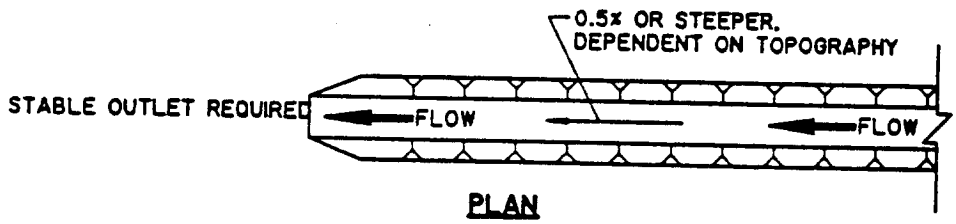


CROSS SECTION



PLAN

TEMPORARY DRAINAGE SWALE

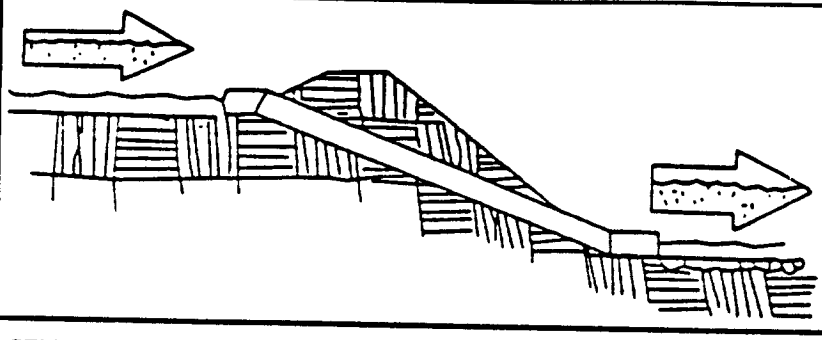
ESC31

R0034468

VOL 12

1132

BMP: SLOPE DRAIN



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

A temporary pipe or lined channel to drain the top of a slope to a stable discharge point at the bottom of a slope without causing erosion.

SUITABLE APPLICATIONS

- Where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where water can accumulate.

The types of slope drain can include:

- Pipe drops.
- Flexible downdrains.
- Sectional downdrains.
- Lined terrace drains.

INSTALLATION/APPLICATION CRITERIA

- Secure inlet and surround with dikes to prevent gully erosion, and anchor pipe to slope.
- Size to convey at least the peak of a 10-year, 24-hour storm (See local flood control agency for requirements).
- Stabilize outlet.

REQUIREMENTS

- Maintenance
  - Structure must be inspected regularly and after storms.
  - Inlet must be free of undercutting and no water should circumvent the entry.
  - Outlet should not produce erosion; velocity dissipators must be maintained.
  - Pipe anchors must be checked to ensure that the pipe remains anchored to the slope.
- Cost
  - CalTrans Cost Schedule gives regional cost ranges.

LIMITATIONS

- Maximum drainage area per slope drain is 5 acres. (For large areas use a paved chute, rock lined channel or additional pipes.)
- Clogged slope drains will force water around the pipe and cause slope erosion.
- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.
- Failure can result in flooding and severe erosion.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC32

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Additional Information — Slope Drain

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of a slope. The drain conveys concentrated runoff down to the bottom of the slope. The BMP typically is used in combination with a diversion control, such as a temporary dike or swale, at the top of the slope, and serves as a temporary BMP to reduce or eliminate slope erosion until permanent BMPs are installed and the slope is stabilized.

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the stormwater from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent storm water collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion. Typical uses include:

- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where storm water can accumulate and must be conveyed down the slope.

Installation/Application Criteria

Temporary slope drains are highly effective in eliminating slope erosion. Installation and maintenance requirements are small, especially when flexible pipe is used. General criteria:

- Gully erosion is the major problem with slope drains. Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- The drain must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- The outlet must be stabilized with rip-rap, concrete or other type of energy dissipator, or directed into a stable sediment trap or basin.
- A debris rack is recommended at the inlet, and should be encouraged for larger pipes and at the outlet as a safety device to prevent small children from entering the pipe.

Materials:

Material selection and criteria for the pipe slope drain is often established by the local municipality. Soil type, rainfall patterns, construction schedule, and available supply are some of the factors to be considered. The following types of slope drains are commonly used:

- Rigid Pipe: This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured into the slope. One foot minimum cover is required on the pipe, and concrete thrust blocks must be used when required by the municipality or warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars.
- Flexible Pipe: The flexible pipe slope drain consists of a flexible conduit of heavy duty material. The conduit material is securely anchored into the slope and connections are watertight. The conduit should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or water tight collars.
- Sectional Downdrains: The sectional downdrain consists of pre-fabricated, sectional conduit of half-round or third-round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.
- Concrete-lined Terrace Drain: This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are after permenant structures which should be designed according to local drainage design criteria.

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R0034470

Additional Information — Slope Drain

Design:
Unless specified by the local municipality, the capacity for temporary drains should be sufficient to handle the peak runoff from a 10-year, 24-hour rainfall event. The pipe size may be computed using the Rational Method or a method established by the local municipality. Higher flows must be safely stored or routed to prevent any offsite concentration of flow, and any erosion of the slope.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

MINIMUM PIPE DIAMETER	MAXIMUM DRAINAGE AREA (ACRES)
12"	0.5
18"	1.5
21"	2.5
24"	3.5
30"	5.0

Permanent improvements must be designed and installed if the drainage area is greater than 5 acres.

The following additional design criteria should be considered:

- Construct the pipe slope drain entrance of a standard flared end section with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance is usually at least 3 percent.
- Thoroughly compact the soil around and under the pipe and entrance section.
- Securely fasten the slope drain sections together, have gasketed watertight fittings, and securely anchored into the soil.
- Secure the flared inlet section to the slope drain and have watertight connecting bands.
- Use interceptor dikes to direct runoff into a slope drain. The height of the dike should be at least 1 foot higher at all points than the top of the inlet pipe.
- If the pipe slope drain is conveying sediment-laden water, direct all flows into a sediment trap (ESC55) or sediment basin (ESC56).
- Unless the pipe directly enters a sediment trap/basin, stabilize the area below the outlet with a riprap apron.

Limitations
Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion. Maximum drainage area per pipe slope drain is 5 acres. For larger areas use a paved chute, rock lined channel or additional pipes. (See the local municipality for drainage requirements)

- During large storms, pipe slope drains may become clogged or overcharged, forcing water around the pipe and causing extreme slope erosion.
- Structures for dissipation of high flow velocities at the pipe outlet must be constructed to avoid downstream erosion.
- Failure of this type of temporary structure may result in flooding and severe erosion.
- If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion, and potential failure of the structure.

ESC32

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R0034471

Additional Information — Slope Drain

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

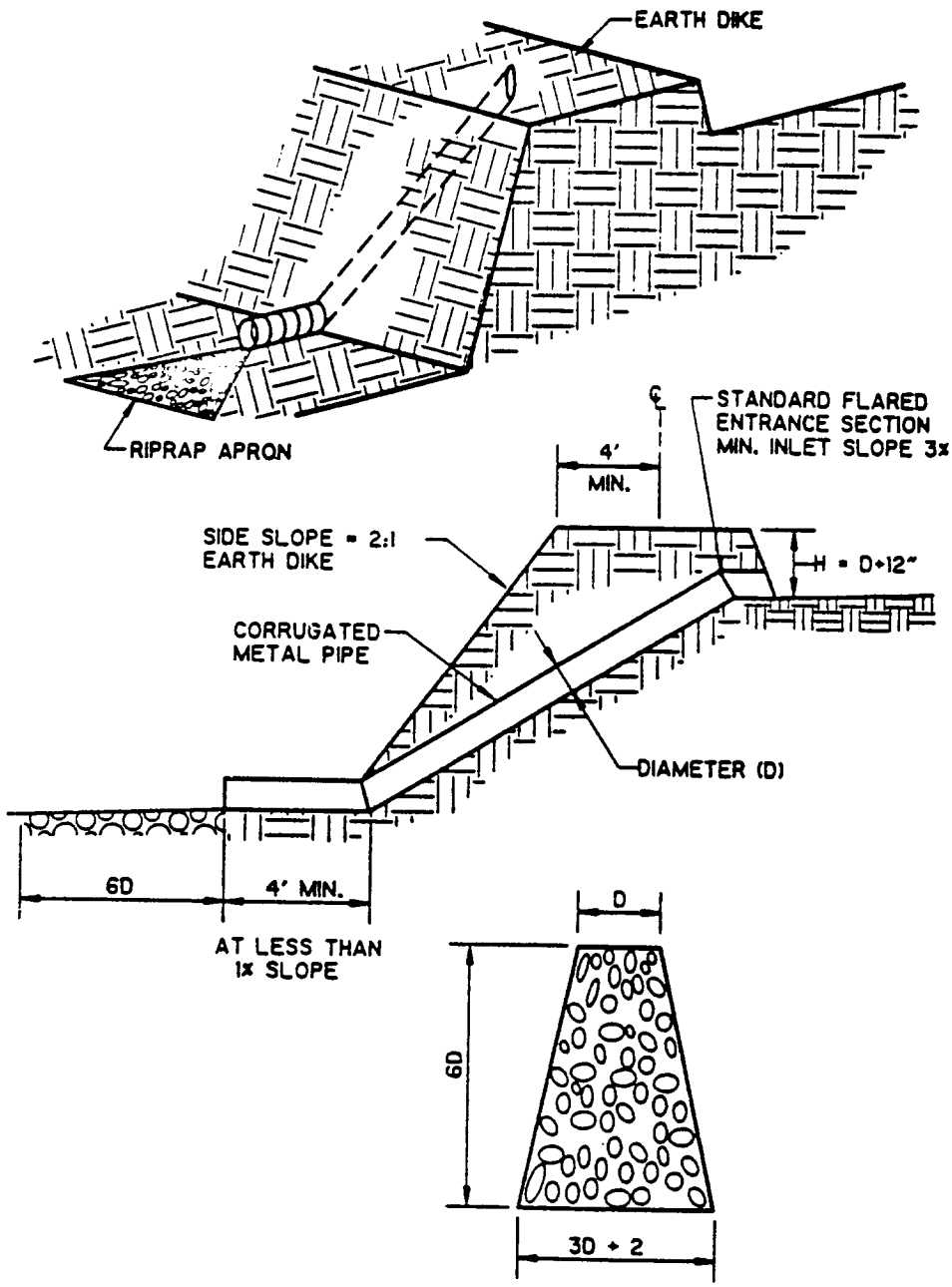
ESC32

VOL 12

1136

R0034472

Additional Information — Slope Drain



RIPRAP SHOULD CONSIST OF 6" DIAMETER STONE PLACED AS SHOWN AND SHOULD BE A MINIMUM OF 12" IN THICKNESS.

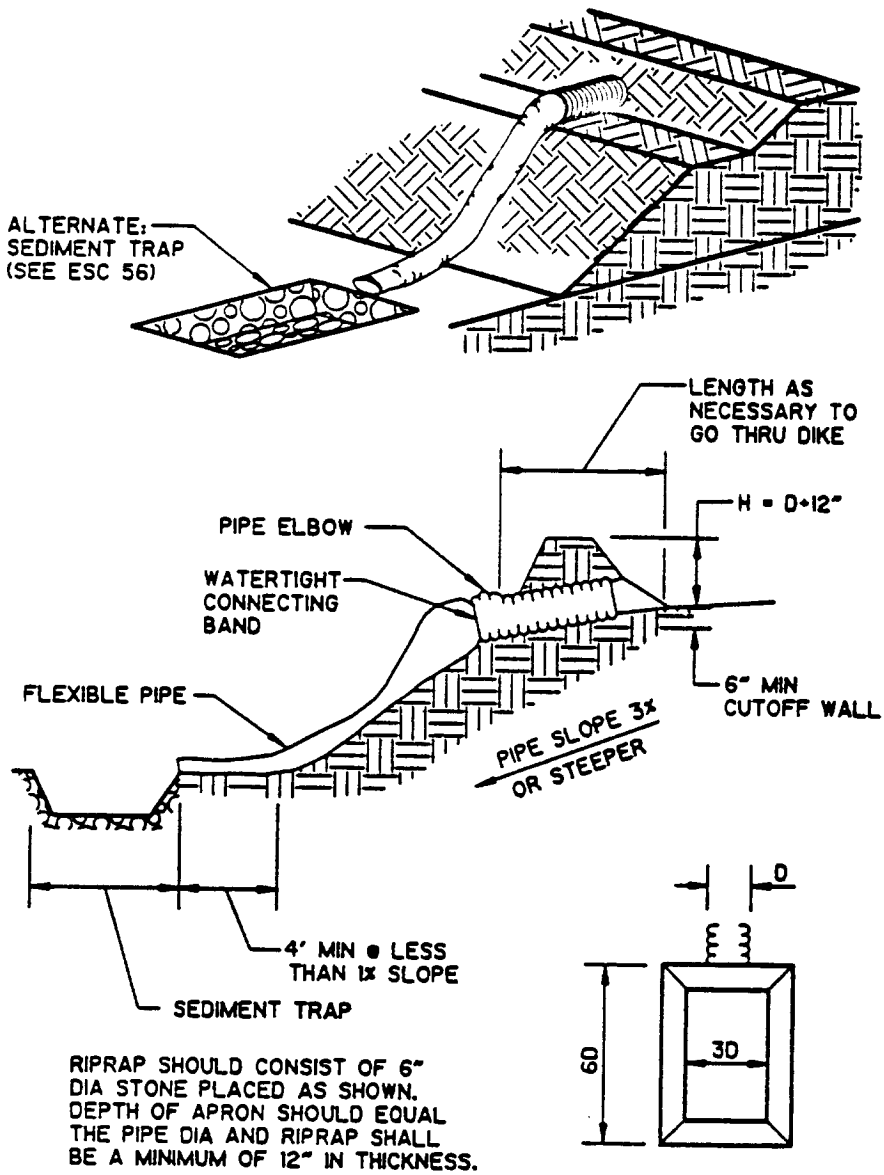
ESC32

PIPE SLOPE DRAIN (RIGID)

R0034473

VOL 12 1137

Additional Information — Slope Drain



RIPRAP SHOULD CONSIST OF 6" DIA STONE PLACED AS SHOWN. DEPTH OF APRON SHOULD EQUAL THE PIPE DIA AND RIPRAP SHALL BE A MINIMUM OF 12" IN THICKNESS.

ALTERNATIVE SEDIMENT TRAP: RIPRAP PLAN

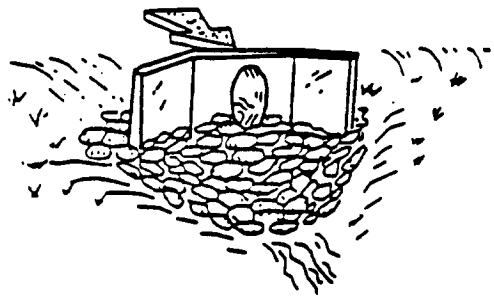
PIPE SLOPE DRAIN (FLEXIBLE)

ESC32

R0034474

VOL 12 1138

BMP: OUTLET PROTECTION



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- (Protect Slopes/Channels)
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Rock outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to absorb flow energy to produce non-erosive velocities.

SUITABLE APPLICATIONS

- Wherever discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the next downstream reach.
- Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or energy dissipators.
- A sediment trap below the pipe outlet is recommended if runoff is sediment laden.
- Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design.
- Grouted riprap should be avoided in areas of freeze and thaw because the grout will break up.

INSTALLATION/APPLICATION CRITERIA

Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. Rock size should be increased for high velocity flows. General recommendations for rock size and length of outlet protection mat are presented in the additional information sheet. Best results are obtained when sound, durable, angular rock is used. CalTrans Standard Specifications or the local municipality can provide additional specifications for constructing outlet protection devices.

REQUIREMENTS

- Maintenance
  - Inspect after each significant rain for erosion and/or disruption of the rock, and repair immediately.
  - Grouted or wire-tied rock riprap can minimize maintenance requirements.
- Cost
  - CalTrans Cost Schedule gives regional cost ranges.

LIMITATIONS

- Large storms often wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC40

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R0034475

Additional Information — Outlet Protection

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the inlet or outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipators. It also serves to trap sediment and reduce flow velocities.

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat is shown in the rock outlet protection figure. Best results are obtained when sound, durable, angular rock is used. Rock depth and outlet protection length are governed by the discharge pipe size, but hydraulic calculations and velocities should be used to determine length. Your local municipality or CalTrans should be consulted for appropriate sizing criteria in your area.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Mariposa County, Arizona, September 1992.

County of Sacramento Improvement Standards, Sacramento County - May 1989.

Environmental Criteria Manual, City of Austin, TX, 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, Jun 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

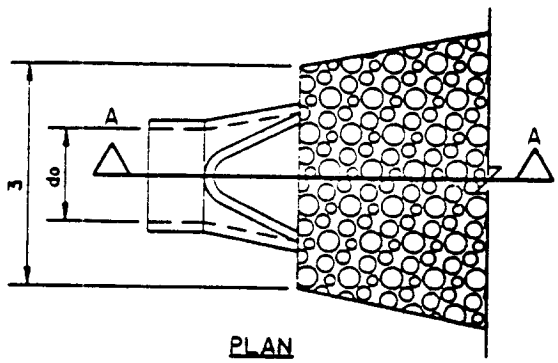
ESC40

VOL 12

1140

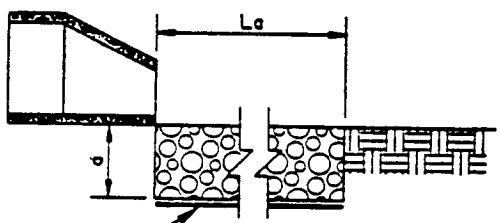
R0034476

Additional Information — Outlet Protection



PLAN

La = LENGTH OF APRON
do = INSIDE PIPE DIAMETER
w = APRON WIDTH
d = APRON THICKNESS

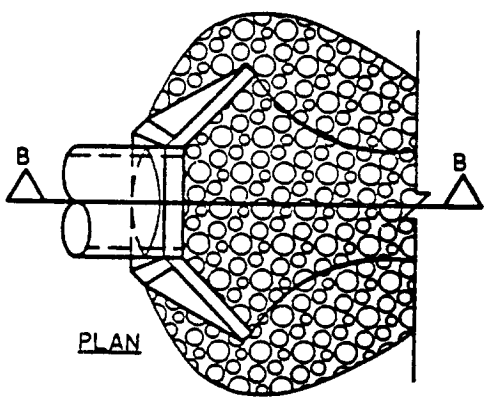


FILTER FABRIC — SECTION A-A

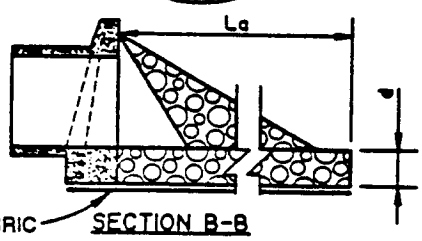
PIPE OUTLET TO FLAT AREA WITH NO DEFINED CHANNEL

NOTES

1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, OR CONCRETE
2. PIPE DIAMETER, APRON DIMENSIONS, AND AVERAGE ROCK SIZE FOR RIPRAP ARE BASED ON THE DESIGN FLOW RATE AND VELOCITY. La AND ROCK SIZE MUST BE SET TO SLOW THE FLOW TO NON-EROSIVE VELOCITIES (e.g., LESS THAN 10 fps). SEE CALTRANS AND LOCAL AGENCY DESIGN CRITERIA FOR APPROPRIATE SIZING CRITERIA.
3. d = 1.5 TIMES THE MAXIMUM ROCK SIZE DIAMETER BUT NOT LESS THAN 6 INCHES.



PLAN



FILTER FABRIC — SECTION B-B

PIPE OUTLET TO WELL-DEFINED CHANNEL

PIPE OUTLET CONDITIONS

ESC40

R0034477

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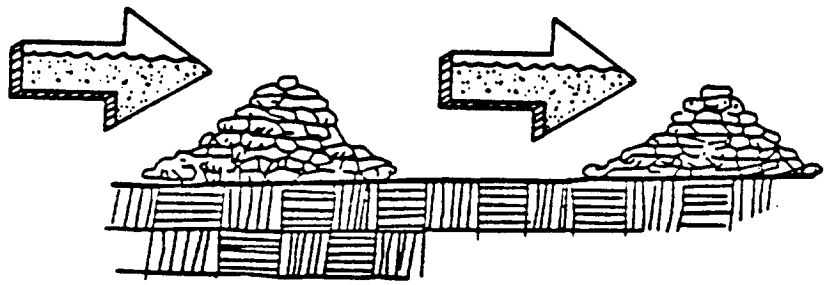
BMP: CHECK DAMS



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- (Protect Slopes/Channels)
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Small temporary dams constructed across a swale or drainage ditch. Check dams reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch, and promoting sedimentation behind the dam. If properly anchored, brush or rock filter berms (ESC53) may be used for check dams.

SUITABLE APPLICATIONS

- Used to prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- May also promote sedimentation behind the dam, but should not be considered to be a primary sediment trapping device because subsequent storms will scour and resuspend much of the trapped sediment.

INSTALLATION/APPLICATION CRITERIA

- Check dams should be placed at a distance and height to allow small pools to form between each one.
- Backwater from a downstream check dam should reach the toe of the upstream check dam.
- Major floods (2 year storm or larger) should safely flow over the check dam without an increase in upstream flooding or destruction of the checkdam.
- Primarily used in small, steep channels where velocities exceed 2 fps.
- Used in steep terrain where velocity reduction is required.
- A deep sump may be provided immediately upstream of the check dam to capture excessive sediment.
- Check dams may be built of rocks or logs, which are secured against damage during significant floods.

REQUIREMENTS

- Maintenance
  - Inspect for sediment buildup behind the check dam and signs of erosion around the check dam after each rain.
  - Remove accumulated sediment whenever it reaches one-half the sump depth.
- Cost
  - See CalTrans Cost Schedule for regional cost data.

LIMITATIONS

- Use only in small open channels which drain 10 acres of less.
- Not to be used in live streams.
- Do not install in lined or vegetated channels.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC41

Best Management Practices

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R0034478

Additional Information — Check Dams

Check dams create small pools in swales and ditches which drain 10 acres or less. These pools reduce the velocity of storm water flows, thus reducing erosion of the swale/ditch. Sedimentation also occurs in these small pools, but probably results in little net sediment removal because of the small detention time and probable scour during longer storms. A sediment trap (ESC55) may be placed immediately upstream of the check dam to increase sediment removal efficiency (but never in a natural stream or channel). Check dams should not be placed in swales/ditches with a base flow during some or all of the year.

Installation/Application Criteria

Check dams must be sized and constructed correctly and maintained properly, or they will be either washed out or cause flooding. Check dams can be constructed of either rock or logs. Use of other natural materials available on-site that can withstand the stormwater flow velocities is acceptable, such as pea-gravel filled in sand bags. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

A sediment trap (ESC55) may be installed immediately upstream of the check dam, but may be of limited effectiveness if channel flows are large enough to scour the trap during moderate to large storms. Maximum velocity reduction is achieved if the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will act like a weir during major floods.

Rock check dams are usually constructed of appropriately 8"-12" rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6-inch diameter logs. The logs should be embedded into the soil at least 18 inches.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swale is greater than 4 percent).

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Mariposa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC41

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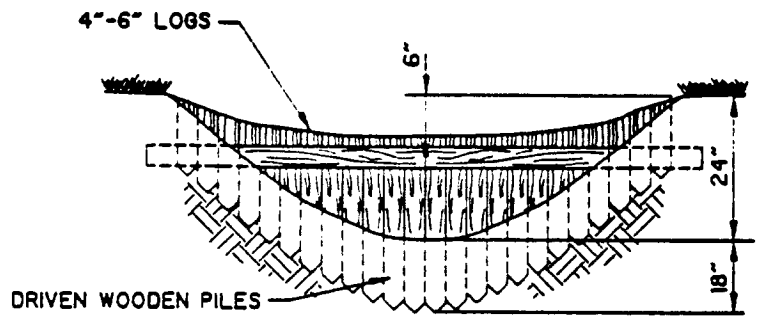
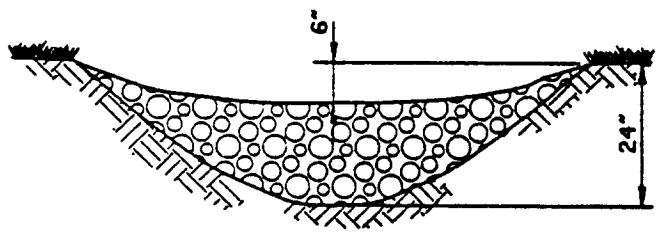
R0034479

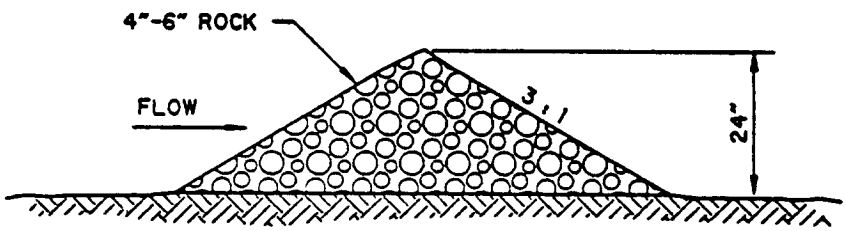
Additional Information — Check Dams



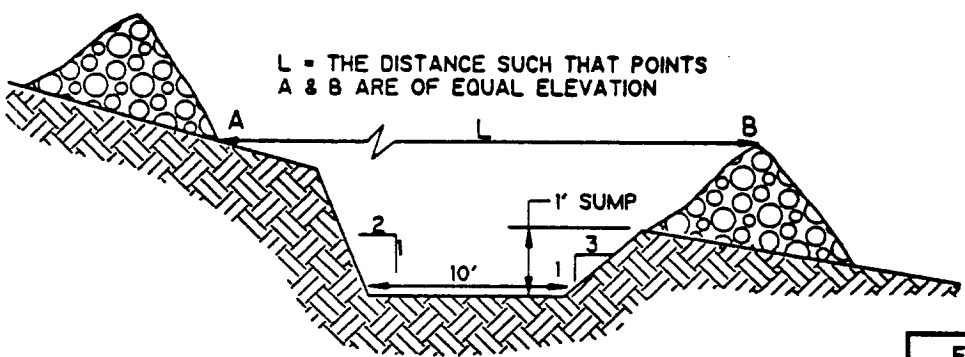
LOG CHECK DAM



ROCK CHECK DAM



ROCK CHECK DAM CROSS-SECTION



SPACING BETWEEN CHECK DAMS

ESC41

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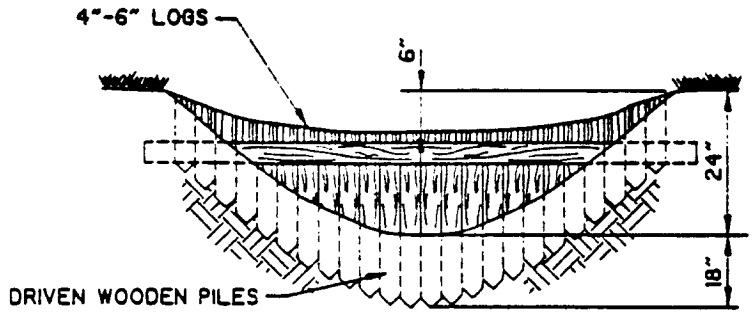
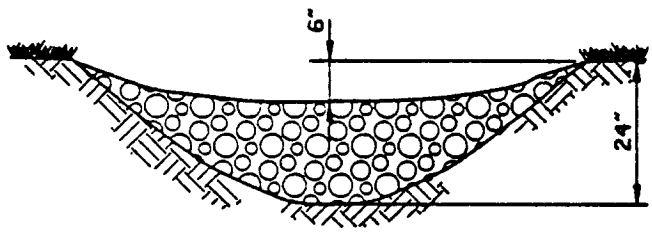
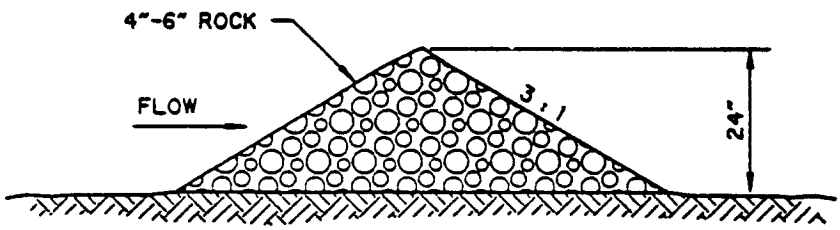
Additional Information — Check Dams



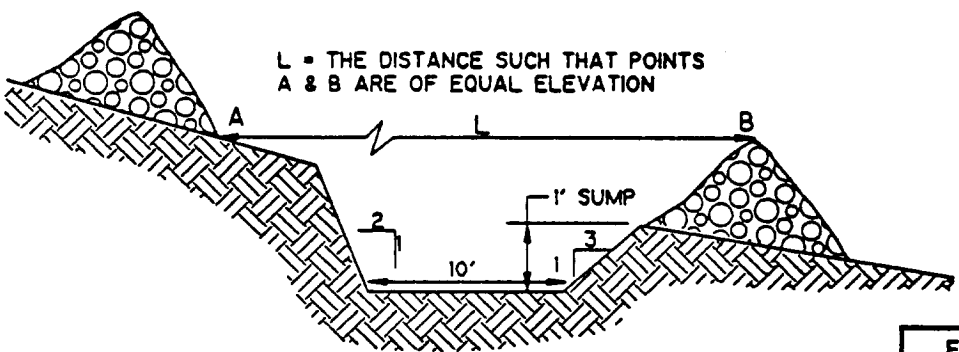
LOG CHECK DAM



ROCK CHECK DAM



ROCK CHECK DAM CROSS-SECTION



SPACING BETWEEN CHECK DAMS

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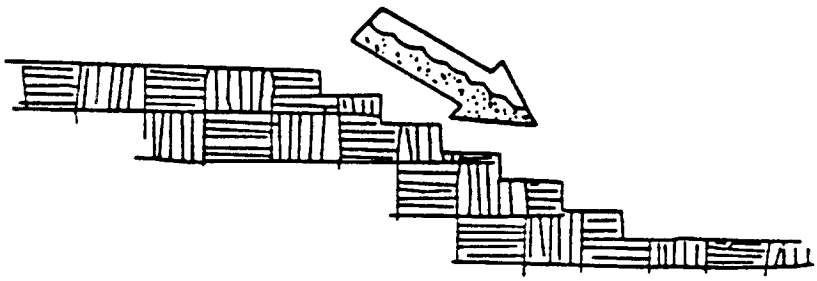
R0034481

BMP: SLOPE ROUGHENING/TERRACING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- (Stabilize Disturbed Areas)
- (Protect Slopes/Channels)
- Control Site Perimeter
- Control Internal Erosion

GENERAL DEFINITION

Slope roughening/terracing creates microclimates for establishing vegetation, reduces runoff velocity, increases infiltration, and provides small depressions for trapping sediment.

SUITABLE APPLICATIONS

- Any cleared area prior to seeding and planting.
- Required for cleared, erodible slopes steeper than 3:1 and higher than 5 feet prior to seeding and planting.

INSTALLATION/APPLICATION CRITERIA

Slope roughening/terracing is performed in several ways:

- Stair-step grading.
- Grooving.
- Furrowing.
- Tracking.
- Rough grading.
- No grading.

REQUIREMENTS

- Maintenance
  - Inspect roughened slopes weekly and after rainfall for excessive erosion.
  - Revegetate as quickly as possible.
- Cost (source: EPA, 1992)
  - Surface Roughening: Performed at no (e.g., rough grading) to low (e.g., tracking) cost.
  - Terracing: Average annual cost is $4 per linear foot (2 year useful life).

LIMITATIONS

- Roughening is of limited effectiveness on its own, but is used to speed revegetation.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ● Suitability for Slopes >5%

● High ○ Low

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Best Management Practices

R0034482

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Additional Information — Slope Roughening/Terracing

Slope roughening/terracing creates uneven depressions, steps or grooves on the soil surface to aid in establishment of vegetation, reduce runoff velocity, increase infiltration, and provide for sediment trapping.

Surface roughening may be applied to all slopes steeper than 3:1, and greater than 5 vertical feet, providing some instant erosion protection on bare soil while vegetative cover is being established. It is an inexpensive, simple and short-term erosion control measure for roadway cut slopes.

Terracing usually is a more permanent measure used to stabilize a steep slope. Terraces should be designed by a registered professional engineer and included in the project construction plans. Local design criteria should be used.

Installation/Application

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decreased runoff velocity. Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Graded areas steeper than 3:1 should be stair-stepped with benches (See figure at end of fact sheet). The stair-steping will help vegetation become attached and also trap soil eroded from the slopes above. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
3. Areas which will be mowed (there areas should have slopes less than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased. Tracking can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, in leaving a pattern of cleat imprints parallel to slope contours.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Handbook of Steel, Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

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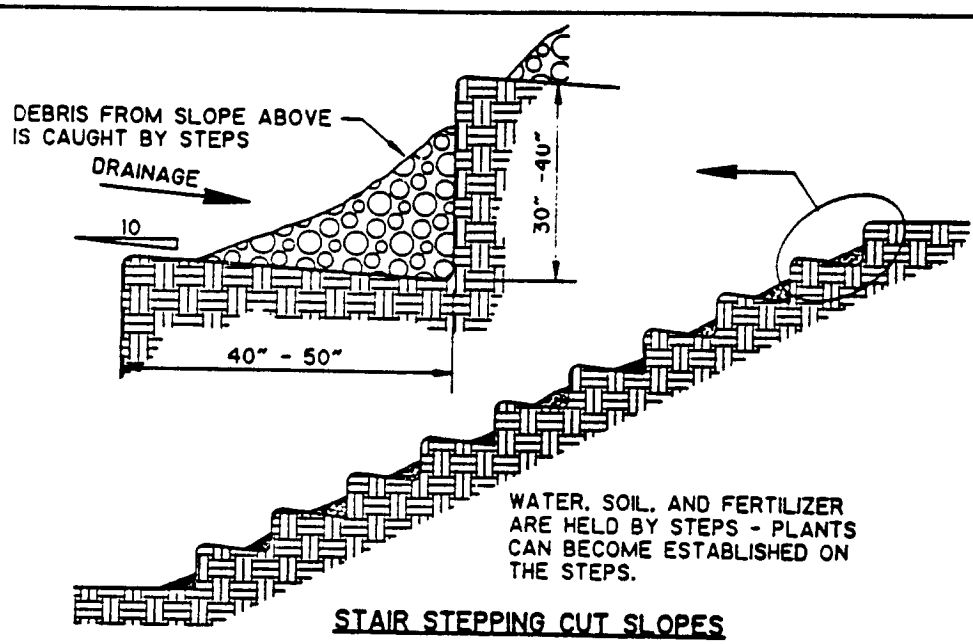
ESC42

VOL 12

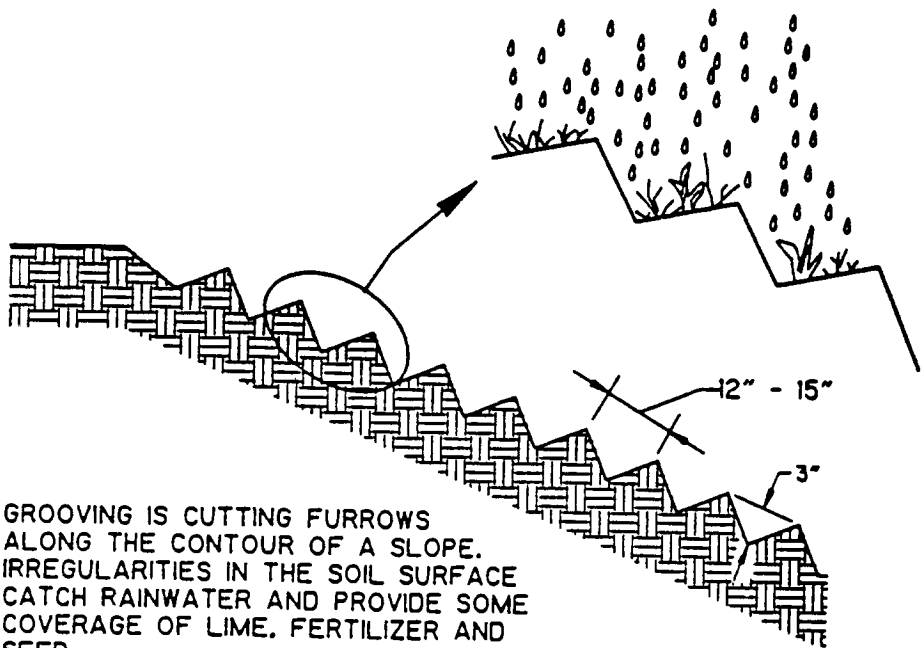
1147

R0034483

Additional Information — Slope Roughening/Terracing



STAIR STEPPING CUT SLOPES



GROOVING IS CUTTING FURROWS ALONG THE CONTOUR OF A SLOPE. IRREGULARITIES IN THE SOIL SURFACE CATCH RAINWATER AND PROVIDE SOME COVERAGE OF LIME, FERTILIZER AND SEED.

GROOVING SLOPES

ESC42

STAIR-STEPPING CUT SLOPES AND GROOVING SLOPES

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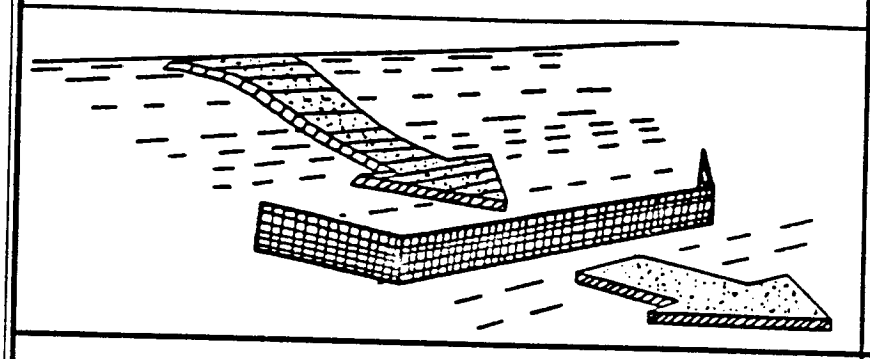
R0034484

BMP: SILT FENCE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- (Control Site Perimeter)
- (Control Internal Erosion)

GENERAL DESCRIPTION

A silt fence is made of a filter fabric which has been entrenched, attached to supporting poles, and sometimes backed by a wire fence for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Below the toe of a cleared slope.
- Along streams and channels.
- Around temporary spoil areas.
- Across swales with catchments less than 1 acre.
- Below other small cleared areas.

INSTALLATION/APPLICATION

- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 feet at any point.
- No more than 1 acre, 100 ft., or 0.5 cfs of concentrated flow should drain to any point along the silt fence.
- Turn ends of fence uphill.
- Provide area behind the fence for runoff to pond and sediment to settle (approx. 1200 sq. ft. per acre draining to the silt fence).
- Select filter fabric which retains 85% of the soil, by weight, based on sieve analysis, but is not finer than an equivalent opening size of 70.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rainfall.
  - Repair wherever fence is damaged.
  - Remove sediment when it reaches 1/3 the height of the fence.
- Cost (source: EPA, 1992)
  - Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre)

LIMITATIONS

- Do not use where 85% of the soil, by weight, passes through a No. 200 sieve because the filter fabric will clog.
- Do not place fence on a slope, or across any contour line.
- Do not use in streams, channels, or anywhere flow has concentrated.
- Do not use in locations where ponded water may cause flooding.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC50

Best Management Practices

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R0034485

Additional Information — Silt Fence

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of the fabric used, supported with wire fence. Silt fences trap sediment in two ways: (1) by intercepting and detaining small amounts of sediment from disturbed areas during construction operations in order to promote sedimentation behind the fence; and (2) by decreasing the velocity of low flows (up to 0.5 cfs) in swales.

Silt fences may be used for perimeter control, placed upstream of the point(s) of discharge of sheet flow from a site. They may also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion, and perpendicular to minor swales or ditch lines for up to one acre contributing drainage areas. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows.

Installation/Application

Planning:

Silt fences are generally most effective when the following placement criteria are followed:

- Limit the upstream drainage area to 1 acre or less when used alone or in combination with sediment basin in a larger site.
- The maximum slope perpendicular to the fence line should be 1:1.
- Limit the maximum sheet or overland flow path length to any point along the fence to 100 feet.
- Limit the concentrated flows reaching the fence to 0.5 cfs.

Silt fences are preferable to straw barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw barriers, there are many instances where silt fences have been improperly installed. The following installation methods can improve performance and should be followed:

- Construct the silt fence along a level contour.
- Silt fences should remain in place until the disturbed area is permanently stabilized.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 sq. ft. of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent storm water from flowing around the fence.
- Leave an undisturbed or stabilized area immediately downslope from the fence.
- Do not place in live streams or intermittently flowing channels.

Design:

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet will have openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. standard sieve No. 200, select the EOS to retain 85 percent of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 [0.0083 in. (0.21 mm.)] except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

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Additional Information — Silt Fence

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100 [0.0059 in. (0.15 mm.)]. If 85 percent or more of a soil, by weight, passes through the openings in a No. 200 sieve [0.0029 in. (0.074 mm.)], filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large, and they would clog the fabric quickly if the EOS was small enough to capture the soil.

The fence should be supported by a wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0° F. to 120° F.

Installation Guidelines:
Filter fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- Posts should be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches.
- A trench should be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.
- When standard strength filter fabric is used, a wire mesh support fence should be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire should extend into the trench a minimum of 4 inches.
- The standard strength filter fabric should be stapled or wired to the fence, and 40 inches of the fabric should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated and the filter fabric stapled or wired directly to the posts.
- Avoid the use of joints. The filter fabric should be purchased in a continuous roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 inch overlap, and both ends securely fastened to the post.
- The trench should be backfilled with compacted native material.

Requirements
Maintenance:

Inspect monthly during dry periods and immediately after each rainfall. Repair as necessary. Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected.

Filter fences should not be removed until the upslope area has been permanently stabilized.

Limitations
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Filter fences are not practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre or less, and flow rates of less than 0.5 cfs.
- Problems may arise from incorrect selection of pore size and/or improper installation.
- Do not allow water depth to exceed 1.5 ft. at any point.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.

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Additional Information — Silt Fence

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Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September1992.

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, Jun 1981.

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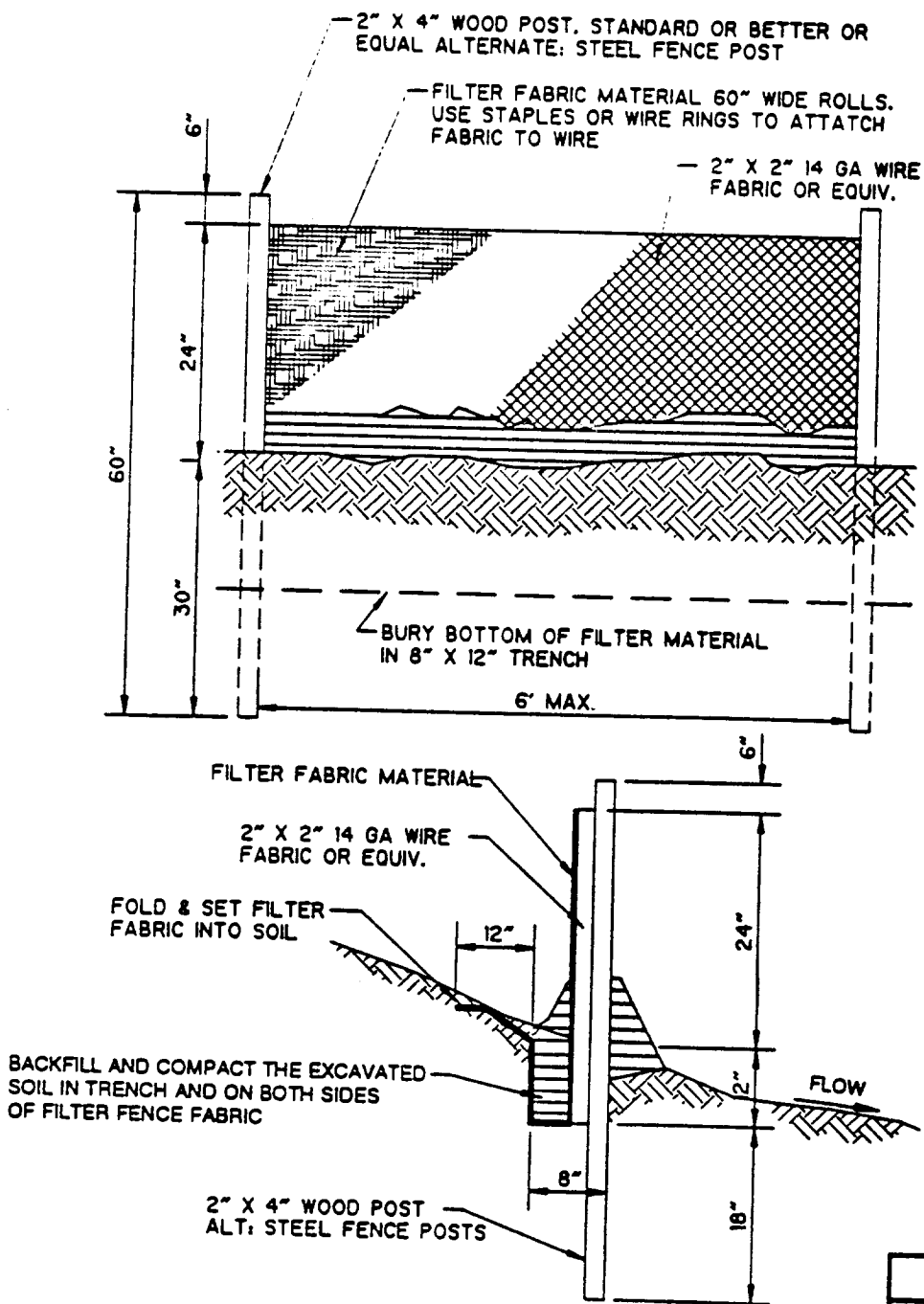
R0034488

Additional Information — Silt Fence



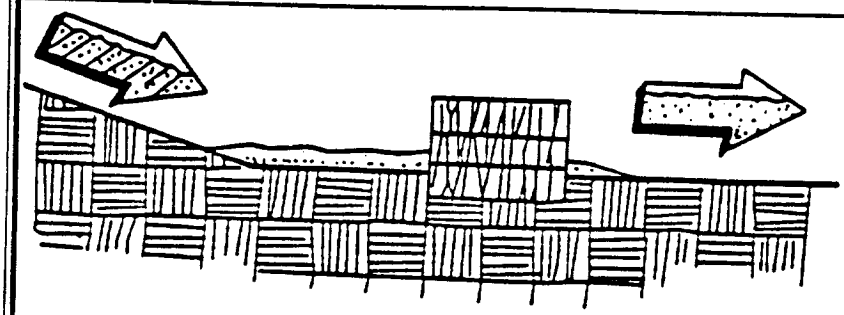
SILT FENCE

ESC50

R0034489

VOL 12 1153

BMP: STRAW BALE BARRIERS



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter* (●)
- *Control Internal Erosion* (●)

GENERAL DEFINITION

A straw bale barrier consists of straw bales placed end to end along a level contour in a shallow trench and staked to hold them in place. The barrier detains runoff, creating a pond behind the barrier where sedimentation occurs.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Along streams and channels.
- Across swales with small catchments.
- Around temporary spoil areas.
- Below other small, cleared areas.

INSTALLATION/APPLICATION CRITERIA

- Use primarily in areas where sheet or rill flow occurs.
- No more than 1/4 acre per 100 feet of barrier should drain to the barrier.
- Install along a level contour.
- Place in a 4-inch deep trench.
- Backfill and compact the excavated soil on the upstream face of the barrier.
- Secure each bale with two stakes.
- Leave enough area (about 1200 sq. ft. per acre) behind the barrier for runoff to pond (no more than 1.5 ft. depth) and sediment to settle.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Replace bales which have decomposed or whose bindings have broken.
  - Remove sediment behind the barrier when it reaches a depth of 6 inches.
- Costs (source: EPA, 1992)
  - Average annual cost for installation and maintenance (assumes 3 month useful life): $17 per lineal foot ($6,800 per drainage acre).

LIMITATIONS

- Straw bale barriers are not to be used for extended periods of time because they tend to rot and fall apart.
- Suitable only for sheet flow on slopes of 2% or flatter.
- Not appropriate for large drainage areas, limit to one acre or less.
- Straw bales lose their effectiveness rapidly due to rotting, thus constant maintenance is required.
- Not recommended for concentrated flow, inlet protection, channel flow, and live streams.
- Bale bindings of jute or cotton not recommended.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ● *Capital Costs*
- ● *O&M Costs*
- ● *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

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Best Management Practices

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BMP: STRAW BALE BARRIERS (Continue)

- Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainageways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow.

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R0034491

Additional Information — Straw Bale Barrier

A straw bale barrier consists of a series of secured anchored bales placed to intercept sediment-laden runoff from small drainage areas of disturbed soil. The barrier ponds runoff and allow sediment to settle. Straw bale dikes should not be used for extended periods of time because they tend to rot and fall apart.

The straw bale barrier is used where there are no concentrations of water in a channel or drainageway, and where erosion would occur from sheet flow. These barriers are typically constructed below disturbed areas subject to sheet flow of runoff.

Installation/Application

Straw bale barriers should be used for drainage areas no more than 1/4 acre per 100 feet of barrier length, with no more than 100 ft upstream of any point along the barrier. The barrier should be placed along a level contour no greater than 2:1. When installed and maintained according to the guidelines on this fact sheet, straw bale dikes remove approximately 67% of the sediment transported in construction site runoff. This optimum efficiency can only be achieved through careful maintenance, with special attention to replacing rotted or broken bales. The barrier should be constructed on a level contour to prevent concentration of flow against a small portion of the barrier.

An effective straw bale barrier should be installed in the following manner:

1. Bales should be placed on the contour and in a row with ends tightly abutting the adjacent bales.
2. Leave area for runoff to pond upstream of the barrier by locating barrier away from the toe of slopes. This also provides access for maintenance.
3. Each bale should be embedded in the soil a minimum of (4) inches and placed so the bindings are horizontal. Bindings placed on soil will soon disintegrate and cause the barrier to fail.
4. Bales should be securely anchored in place by either two stakes or re-bars driven through the bale. The first stake in each bale should be driven toward the previously laid bale at an angle to force the bales together. Stakes should be driven flush with the bale.
5. Backfill and compact the excavated soil along the upstream face of the barrier.
6. Remove the barrier when it has served its usefulness so as not to block or impede storm flow or drainage.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

"Environmental Criteria Manual", City of Austin, Texas.

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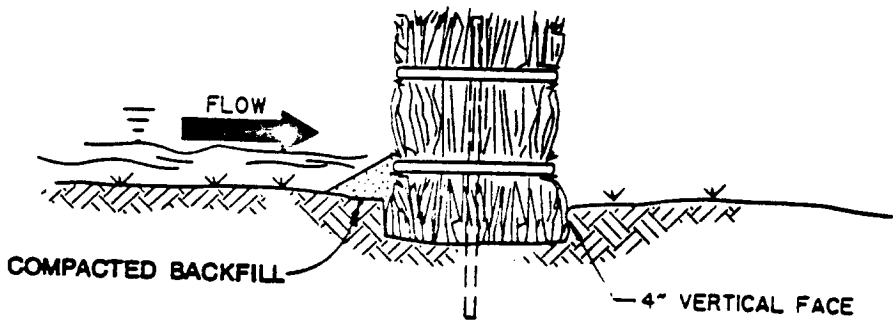
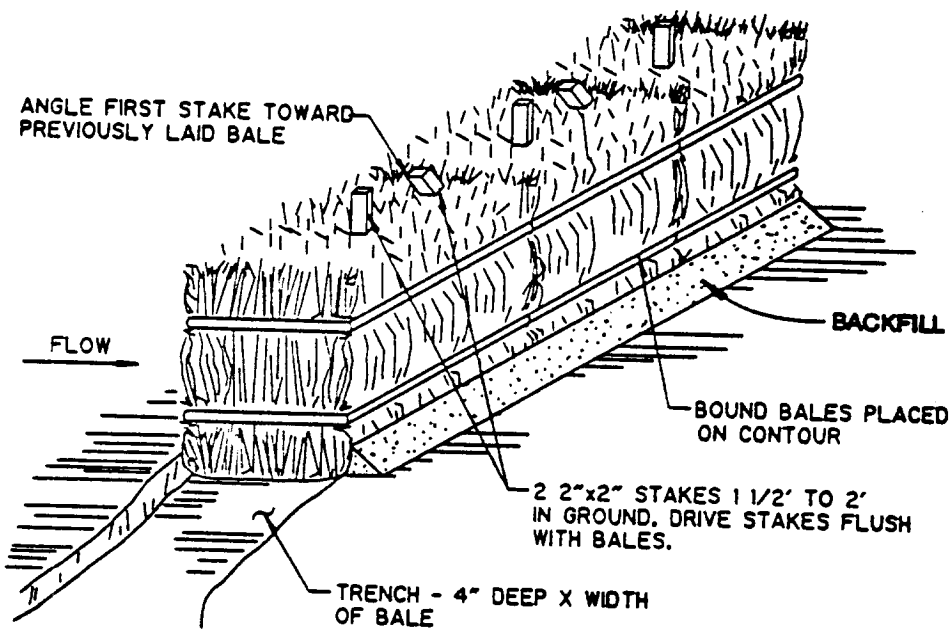
R0034492

Additional Information — Straw Bale Barrier



• PROMOTES ON SITE SEDIMENTATION BY CREATING A TEMPORARY POND.

BEDDING DETAIL



SUBSTITUTION OF STEEL BARS FOR WOODEN STAKES IS NOT RECOMMENDED DUE TO POTENTIAL FOR DAMAGING CONSTRUCTION EQUIPMENT

ANCHORING DETAIL

STRAW BALE BARRIERS

ESC51

R0034493

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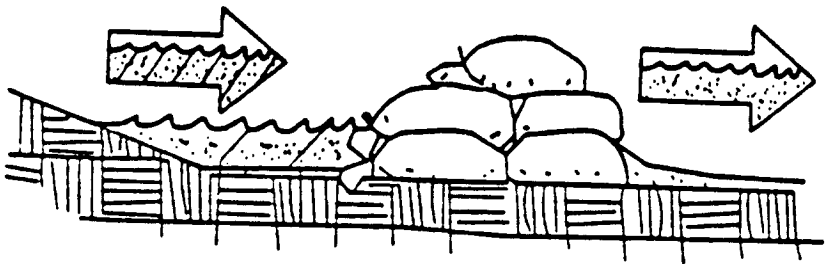
BMP: SAND BAG BARRIER



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DEFINITION

Stacking sand bags along a level contour creates a barrier which detains sediment-laden water, ponding water upstream of the barrier and promoting sedimentation.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Check dams across streams and channels.
- Along streams and channels.
- Barrier for utility trenches in a channel.
- Across swales with small catchments.
- Division dike or berm.
- Below the toe of a cleared slope.
- Create a temporary sediment trap.
- Around temporary spoil areas.
- Below other small cleared areas.

INSTALLATION/APPLICATION CRITERIA

- May be used in drainage areas up to 5 acres.
- Install along a level contour.
- Base of sand bag barrier should be at least 48 inches wide.
- Height of sand bag barrier should be at least 18 inches high.
- 4 inch PVC pipe may be installed between the top layer of sand bags to drain large flood flows.
- Provide area behind barrier for runoff to pond and sediment to settle, size according to sediment trap BMP criteria (ESC55).
- Place below the toe of a slope.
- Use sand bags large enough and sturdy enough to withstand major flooding.

REQUIREMENTS

- Maintenance
  - Inspect after each rain.
  - Reshape or replace damaged sand bags immediately.
  - Remove sediment when it reaches six inches in depth.
- Cost
  - Sand bag barriers are more costly, but typically have a longer useful life than other barriers.

LIMITATIONS

- Sand bags are more expensive than other barriers, but also more durable.
- Burlap should not be used for sand bags.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

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Best Management Practices

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Additional Information — Sand Bag Barrier

Suitable Applications

Sand bag berms may be used during construction activities in stream beds and utility construction in channels, temporary channel crossing for construction equipment, etc. Sand bag berms may also be installed parallel to roadway construction. Sand bag berms may also be used to create temporary sediment traps, retention basins and in place of straw bales or silt fences. Examples of applications include:

- Check dams across stream channels.
- Barriers for utility trenches or other construction in a stream channel.
- At temporary channel crossings.
- May be used on a slope where straw bales and silt fences are not appropriate.
- As a diversion dike.
- Embankment for a temporary sediment basin or retention basin.
- Sediment barriers near the toe of slopes.
- At construction perimeter.

Advantages

- Provides a semi-permeable barrier in potentially wet areas.
- More permanent than silt fences or straw bales.
- Allows for easy relocation on site to meet changing needs during construction.

Installation/Application

Sand bag barriers may be used for sediment trapping in locations where silt fences and straw bale barriers are not strong enough. In addition, sand bag barriers are appropriate to use when construction of check dams or sumps in a stream is undesirable. The sand bag berms can provide the same function as a check dam without disturbing the stream or vegetation. The sand bag berm will also allow a small sediment retention area to be created prior to construction of final detention basins. For installation of a sand bag berm, the following criteria should be observed:

- Drainage Area - Up to five (5) acres.
- Height of Berm - 18 inches minimum height, measured from the top of the existing ground at the upslope toe to the top of the barrier.
- Width of Berm - 48 inches minimum width measured at the bottom of the barrier; 18 inches at the top.
- Sand bag Size - Length 24 to 30 inches, width 16 to 18 inches and thickness six (6) to eight (8) inches. Weight 90 to 125 pounds.
- Sand bag Material - Polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four (4) ounces per square yard, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent. Use of burlap is discouraged since it rots and deteriorates easily.
- Grade of Sand - Coarse sand, gravel.
- Runoff water should be allowed to flow over the tops of the sand bags or through four (4) inch polyvinyl chloride pipes embedded below the top layer of bags.
- Area behind the sand bag barrier should be established according to sizing criteria for sediment trap BMP (ESC55).

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

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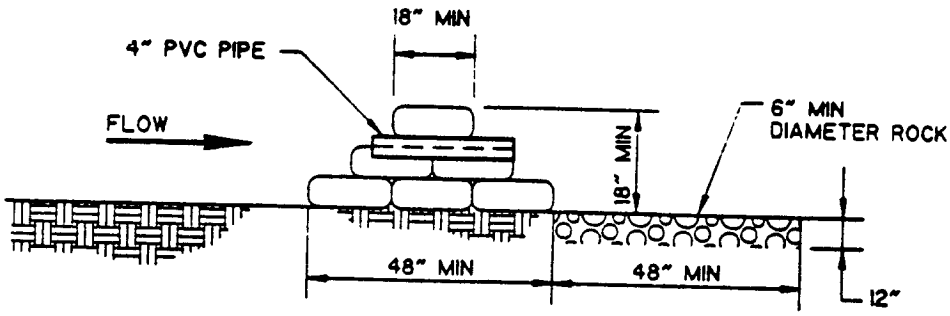
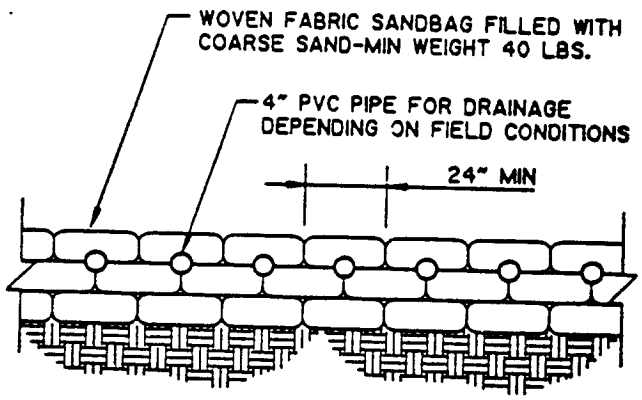
R0034495

Additional Information — Sand Bag Barrier



CROSS-SECTION



FRONT VIEW

SAND BAG BERM

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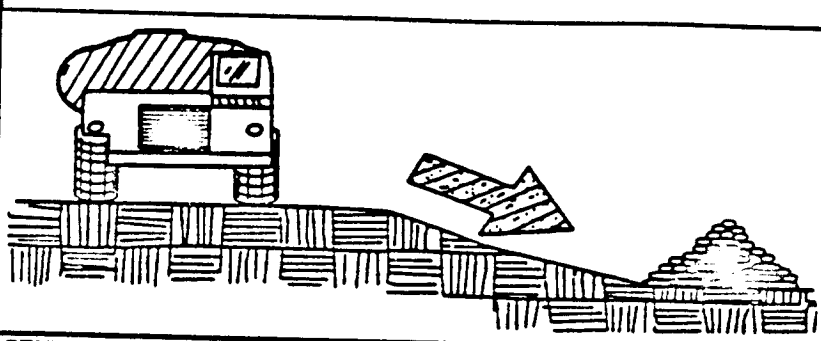
BMP: BRUSH OR ROCK FILTER



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ○ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC53

Best Management Practices

GENERAL DEFINITION

A rock filter berm is made of rock 3/4 to 3 inches in diameter and placed along a level contour where sheet flow may be detained and ponded, promoting sedimentation. A brush barrier is composed of brush (usually obtained during the site clearing) wrapped in filter cloth and anchored to the toe of the slope. If properly anchored brush or rock filters may be used for sediment trapping and velocity reduction. See Check Dam BMP (ESC41) for more information.

SUITABLE APPLICATIONS

- As check dams across mildly sloped construction roads.
- Below the toe of slopes.
- Along the site perimeter.
- Along streams and channels.
- Around temporary spoil areas.
- Below other small cleared areas.
- At sediment traps at culvert/pipe outlets.

INSTALLATION/APPLICATION CRITERIA

- Use principally in areas where sheet or rill flow occurs.
- For rock filter, use larger rock and place in a staked, woven wire sheathing if placed where concentrated flows occur.
- Install along a level contour.
- Leave area behind berm where runoff can pond and sediment can settle.
- Drainage area should not exceed 5 acres.

REQUIREMENTS

- Maintenance
  - Inspect monthly and after each rainfall.
  - If berm damaged, reshape and replace lost/dislodged rock.
  - Remove sediments when depth reaches 1/3 of berm height, or 1 ft.
- Cost
  - Brush filter: Low to moderate cost if debris from on-site clearing and grubbing is used.
  - Rock filter: Expensive, since off-site materials, hand construction and demolition/removal are usually required.

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BMP: BRUSH OR ROCK FILTER (Continue)

LIMITATIONS

- Rock berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Not appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.

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R0034498

Additional Information — Brush or Rock Filter

Rock Filter

A rock filter consists of open graded rock installed at the toe of a slope, along the perimeter of a developing or disturbed area, and as a checkdam across construction roads. Their purpose is to intercept sediment laden runoff from disturbed areas of the site, allow the runoff to pond, promote sedimentation behind the filter, and slowly release the water as sheet flow.

Rock filters are appropriate where a temporary measure is needed to prevent sediments from entering right-of-ways of traffic areas such as near the toe of slopes, incorporated into temporary stabilized construction entrances (ESC 26), or at other locations along the construction site perimeter. Rock filters may also be used as check dams across one or more lanes of construction traffic temporary roads, or unsurfaced rights of way subject to construction traffic.

Advantages of the rock filters are that they may be less costly than other temporary barriers, and are relatively efficient at sediment removal.

Installation/Application:

Planning:

- Rock filters should be placed along a level contour to intercept sheet flow.
- Allow ample room for ponding, sedimentation, and access by sediment removal equipment between the berm and the toes of slopes.
- Flow through the filter should occur as sheet flow into an undisturbed or stabilized area.
- Installation in stream beds requires large rock, staking of woven wire sheathing, and daily inspection.

Design & Sizing Criteria:

The following design criteria are commonly used to construct filters:

- In Non-Traffic Areas:
  - Maximum flow-through rate per square foot of filter = 60 gpm
  - Height = 18 inches minimum
  - Top width = 24 inches minimum
  - Side slopes = 2:1 or flatter
  - Woven wire sheathing (poultry netting) is recommended in areas of concentrated flow. The wire should be 1 inch diameter hexagonal mesh, galvanized 20 gauge.
  - Build the filter along on a level contour.
  - Rock: 3/4 to 3 inches open graded for sheet flow, 3 to 5 inches open graded for concentrated flow.
- In Construction Traffic Areas:
  - Height = 12" maximum
  - Provide multiple filters in series, spaced as shown.
    - Every 300 ft on slopes less than 5 percent
    - Every 200 ft on slopes 5 to 10 percent
    - Every 100 ft on slopes greater than 10 percent.

Brush Filter

Brush filters trap and filter sediments in a manner similar to other barriers in this handbook (e.g., silt fence, straw bale barrier, rock filter), but have the advantage of being constructed from brush cleared from the site and usually disposed off-site at a cost.

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Additional Information — Brush or Rock Filter

Steps in Construction of a Brush Filter:

1. Stack the brush at the toe of a slope or along the perimeter of the site just outside the limits of clearing and grabbing. The brush may be stacked up to 15 ft. high and 15 ft. wide.
2. Construct a trench 1 to 3 ft. deep immediately upslope from the brush.
3. Place filter fabric over the brush filter and in the trench, extending 1 to 2 ft. upslope of the trench.
4. Backfill the trench with aggregate or compacted soil. The trench should be deep enough and backfill material sufficient to hold the barrier in place during a storm.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September1992.

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Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

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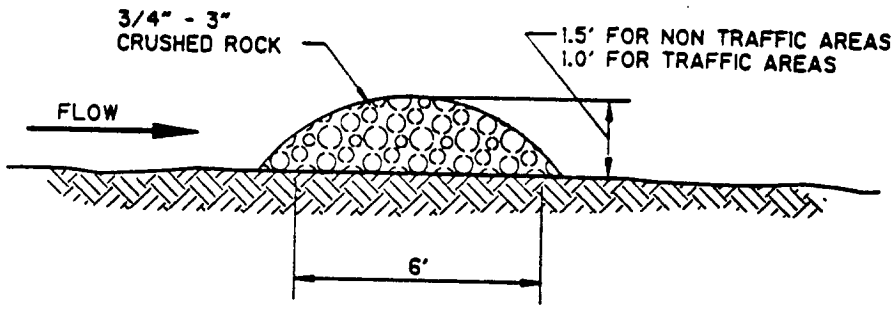
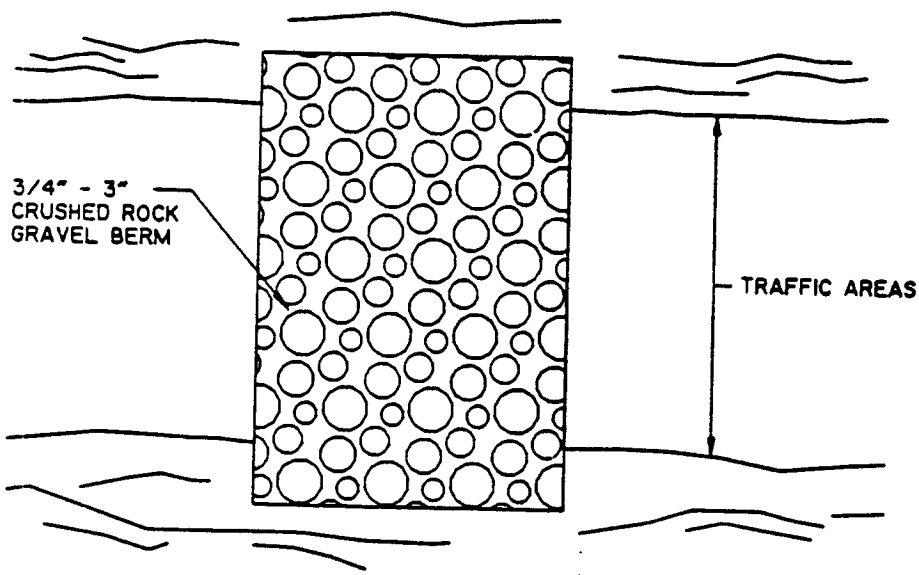
R0034500

Additional Information — Brush or Rock Filter



SECTION



PLAN

GRAVEL FILTER BERM

ESC53

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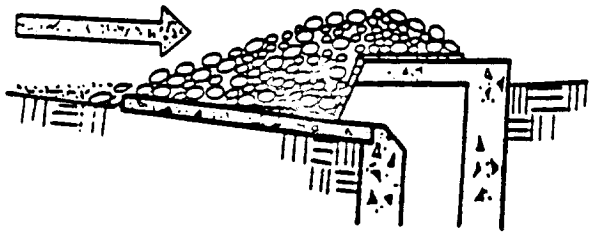
R0034501

BMP: STORM DRAIN INLET PROTECTION



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DEFINITION

Devices of various designs which detain sediment-laden runoff and allow the sediment it to settle prior to discharge into a storm drain inlet or catch basin.

SUITABLE APPLICATIONS

- Every storm drain inlet receiving sediment-laden runoff should be protected, either by covering the inlet or promoting sedimentation upstream of the inlet.

INSTALLATION/APPLICATION

- Five types of inlet protection are presented below, however, it is recognized that other effective methods and proprietary device, exist and may be selected:
  - Filter Fabric Fence: Appropriate for drainage basins less than one acre with less than a 5 percent slope.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  - Gravel and Wire Mesh Filter: Used on curb or drop inlets where construction equipment may drive over the inlet.
  - Sand bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (see Sediment Trap ESC 55).
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Use only for drainage areas smaller than one acre unless a sediment trap first intercepts the runoff.
- Provide area around the inlet for water to pond without flooding structures and property.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Replace clogged filter fabric or stone filters immediately.
  - Remove sediment when depth exceeds half the height of the filter, or half the depth of the sediment trap.
  - Remove as soon as upstream soils are stabilized and streets are swept.
- Cost (source: EPA, 1992)
  - Average annual cost for installation and maintenance (1 year useful life) is $150 per inlet.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ◒ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

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BMP: STORM DRAIN INLET PROTECTION (Continue)

LIMITATIONS

- Drainage area should not exceed 1 acre.
- Runoff will bypass protected inlets on slopes.
- Ponding will occur at a protected inlet, with possible short-term flooding.
- Straw bales are not effective for inlet protection.

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Additional Information — Storm Drain Inlet Protection

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. This erosion and sedimentation control BMP prevents excessive sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

All on-site storm drain inlets should be protected. Off-site, inlets should be protected in areas where construction activity tracks sediment onto paved areas or where inlets receive runoff from disturbed areas.

Installation/Aplication Criteria

Planning

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through a Temporary Sediment Trap (see ESC 56). Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the local storm water management agency.

General Design and sizing criteria:

- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed)1 to 2 feet with 2:1 side slopes around the inlet.

Installation procedures for filter fabric fence:

a. Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. The stakes must be at least 3 feet long.
b. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes.
c. Staple the filter fabric (for materials and specifications, see Silt Fence ESC 50) to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least one inch in length.
d. Backfill the trench with 3/4 inch or less washed gravel all the way around.

Installation procedure for block and gravel filter:

a. Place hardware cloth or comparable wire mesh with one-half inch openings over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
b. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, 8 inches, and 12 inches wide. The row of blocks should be at least 12 inches but no greater than 24 inches high.
c. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with one half inch openings.
d. Pile washed stone against the wire mesh to the top of the blocks. Use 3/4 to 3 inch gravel.

Installation procedure for gravel and wire mesh filters:

a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with one-half inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.

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b. Place 3/4 to 3 inch gravel over the filter fabric/wire mesh. The depth of the gravel should be at least 12 inches over the entire inlet opening (see attached figure).

Installation procedure for sand bag barrier:

a. Use sand bag made of geotextile fabric (not burlap), and fill with 3/4 in. rock or 1/4 in. pea gravel.
b. Construct on gently sloping street.
c. Leave room upstream of barrier for water to pond and sediment to settle.
d. Place several layers of sand bags--overlapping the bags and packing them tightly together.
e. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10-year storm) should not overtop the curb.

Maintenance Requirements

- For filter fabric fences: Inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one-half the depth of the hole.
- For gravel filters: If the gravel becomes clogged with sediment, it must be carefully removed from the inlet, and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, use the sediment-laden stone instead as fill and put fresh stone around the inlet.
- The inlet protection should be removed 30 days after the upslope area has been fully stabilized. Any sediment around the inlet must be carefully removed and disposed.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company.

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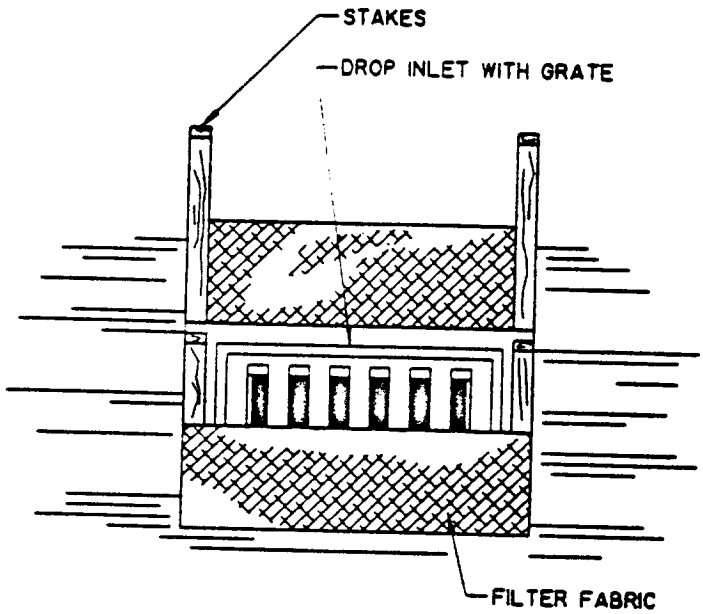
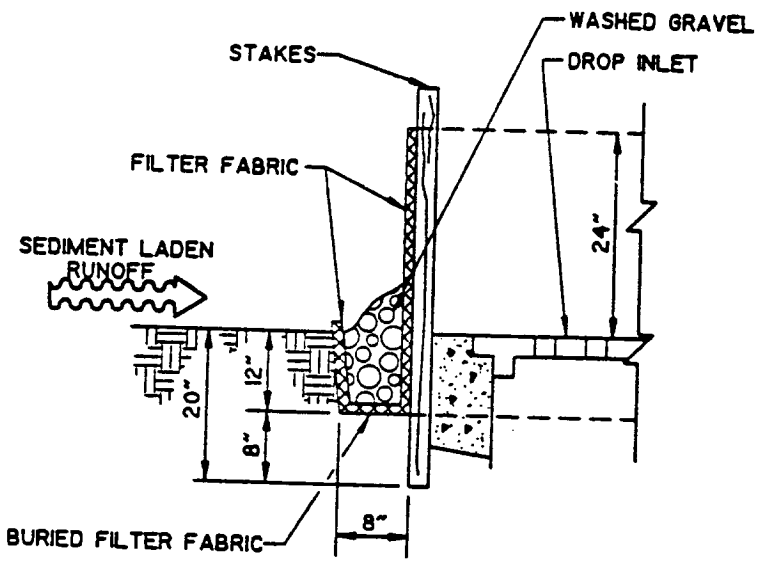
R0034505

Additional Information — Storm Drain Inlet Protection



ELEVATION



PROFILE

FILTER FABRIC FENCE DROP INLET FILTER

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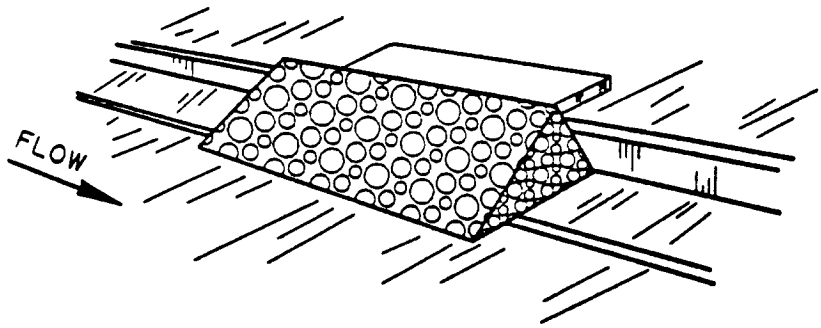

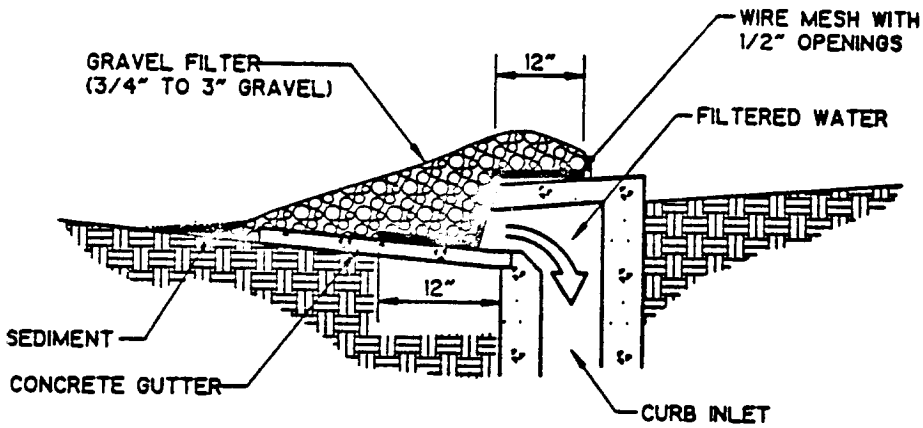

GRAVEL AND WIRE MESH FILTER FOR CURB INLET

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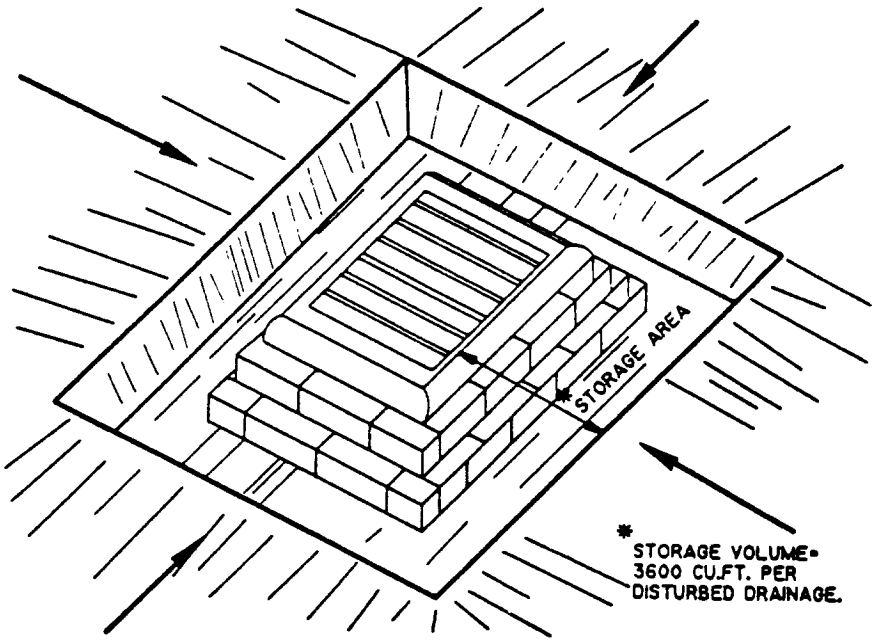
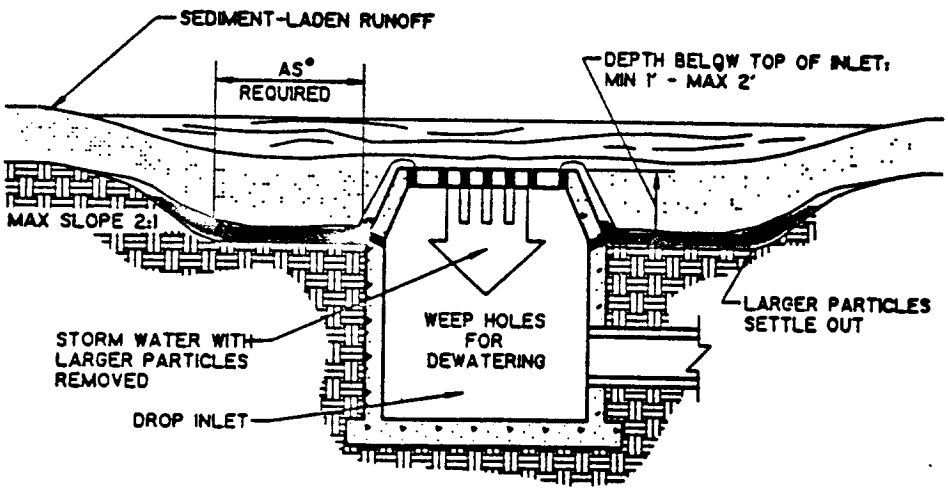
Additional Information — Storm Drain Inlet Protection





SPECIFIC APPLICATION

THIS METHOD OF INLET PROTECTION IS APPLICABLE WHERE HEAVY FLOWS ARE EXPECTED AND WHERE AN OVERFLOW CAPABILITY AND EASE OF MAINTENANCE ARE DESIRABLE.

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EXCAVATED DROP INLET SEDIMENT TRAP

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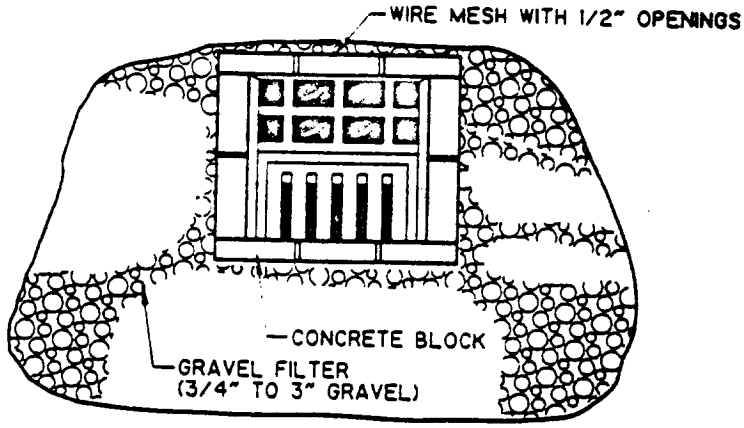
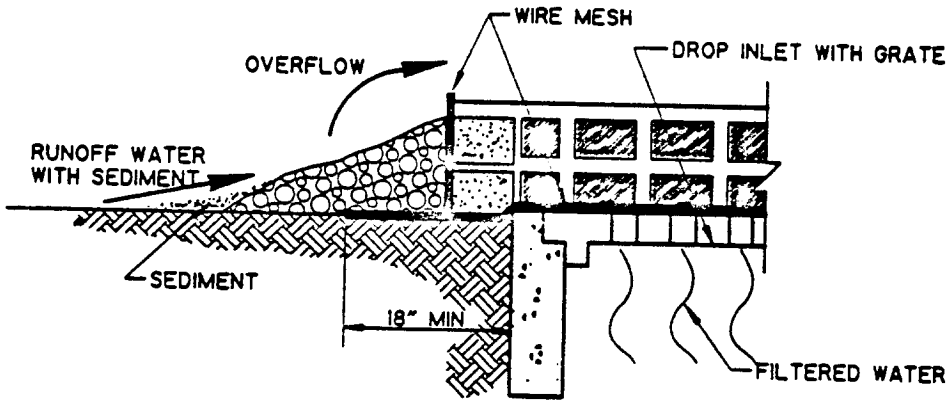
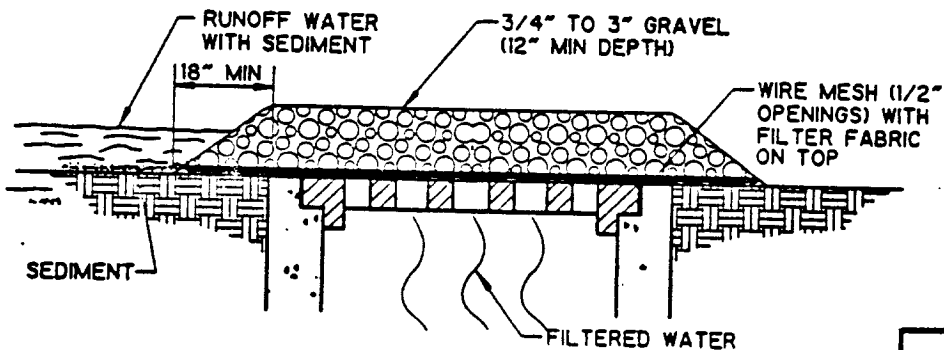
Additional Information — Storm Drain Inlet Protection





BLOCK AND GRAVEL FILTER AT DROP INLET



GRAVEL AND WIRE MESH FILTER
FOR DROP INLET

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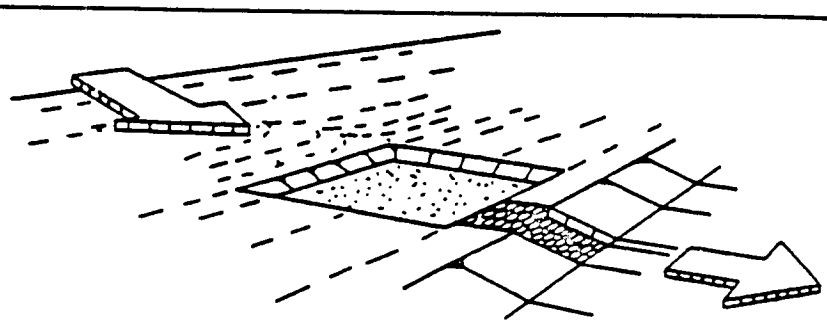
BMP: SEDIMENT TRAP



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabalize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

A sediment trap is a small, excavated or bermed area where runoff from small drainage areas is detained and sediment can settle.

SUITABLE APPLICATIONS

- Any disturbed area less than 5 acres. (Sediment Basins, ESC56, must be used for drainage areas greater than 5 acres).
- Along the perimeter of the site at locations where sediment-laden runoff is discharged off-site.
- Around and/or upslope from storm drain inlet protection measures.
- At any point within the site where sediment-laden runoff can enter stabilized or natural areas or waterways.

INSTALLATION/APPLICATION CRITERIA

- Build outside the area to be graded before clearing, grubbing, and grading begin.
- Locate where the trap can be easily cleared of sediment.
- Trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency.
- The larger the trap, the less frequently sediment must be removed.
- The outlet of the trap must be stabilized with rock, vegetation, or another suitable material.
- A stable emergency spillway must be installed to safely convey major floods (see your local flood control agency).

REQUIREMENTS

- Maintenance
  - Remove sediment when the sediment storage zone is no more than 1 ft. from being full.
  - Inspect weekly and after each rain.
- Cost (source: EPA, 1992)
  - Average annual cost per installation and maintenance (18 month useful life) is \$0.70 per $ft.^3$ (\$1,300 per drainage acre).

LIMITATIONS

- Only use for drainage areas up to 5 acres (see Sedimentation Basin BMP ST8 for larger areas).
- Only removes coarse sediment (medium silt size and larger) unless sized like a sedimentation basin.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

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R0034510

Additional Information — Sediment Trap

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation and/or by constructing an earthen embankment. Its purpose is to collect and store sediment from sites cleared and/or graded during construction. It is intended for use on small drainage areas, with no unusual drainage features, and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately 6 months, and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Application Criteria

Planning:

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to Sediment Basins (ST8), or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed of, such as for in fill areas on-site, or removal to an approved off-site dump. Sediment traps used as a perimeter control should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. Also, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks.

1. Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
2. Restrict basin side slopes to 3:1 or flatter.

Design:

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see Sedimentation Basin ESC56). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a two-year, 24-hour storm is a common design criteria for sedimentation trap. The sizing criteria below assume that this runoff volume is 0.042 ac-ft/ac (0.5 inches of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California.

- Trap settling volume at least 67 cu. yd. per acre.
- Trap sediment storage volume at least 33 cu. yd. per acre (note: the larger this volume, the less frequently the trap must be cleaned out).
- Trap length greater than twice the basin width.
- Flood volume large enough to contain a major flood without upstream damage and overtopping the embankment.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a barrier or low-head dam. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainageways. The following steps must be followed during installation.

1. The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
2. The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.

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R0034511

Additional Information — Sediment Trap

3. The trap is removed and the area stabilized when the upslope drainage area has been properly stabilized.
4. All cut-and-fill slopes should be 3:1 or flatter.
5. When a riser is used, all pipe joints must be watertight.
6. When a riser is used, at least the top two-thirds of the riser shall be perforated with 1/2-inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally. (See Sediment Basin, ESC56)
7. When an earth or stone outlet is used, the outlet crest elevation should be at least 1 foot below the top of the embankment.
8. When a crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Rough Draft - July 1992.

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"Environmental Criteria Manual", City of Austin, Texas.

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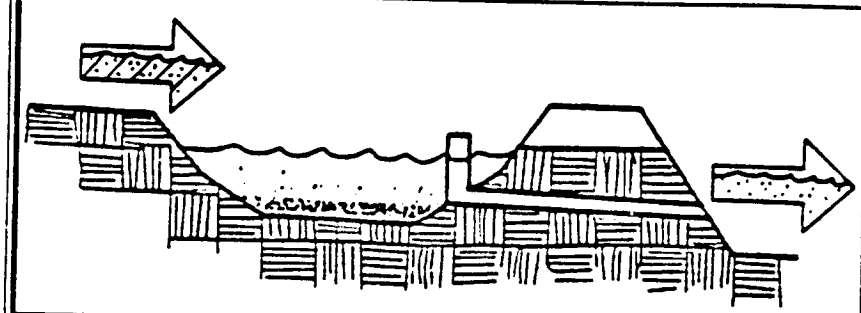
R0034512

BMP: SEDIMENT BASIN



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

A pond created by excavation or constructing an embankment, and designed to retain or detain runoff sufficiently to allow excessive sediment to settle.

SUITABLE APPLICATIONS

- At the outlet of all disturbed watershed 10 acres or larger.
- At the outlet of smaller disturbed watersheds, as necessary.
- Where post construction detention basins will be located.
- Should be used in association with dikes, temporary channels, and pipes used to divert disturbed areas into the basin and undisturbed areas around the basin.

INSTALLATION/APPLICATION

- Construct before clearing and grading work begins.
- Do not locate in a stream.
- All basin sites should be located where failure of the embankment would not cause loss of life/property damage.
- Large basins are subject to state/local dam safety requirements.
- Securely anchor and install an anti-seep collar on the outlet pipe/riser, and provide an emergency spillway for passing major floods (see local flood control agency).
- The basin volume should be sized to capture runoff from a 2-year, 24-hour storm, or other appropriate design storms specified by the local agency. A detention time of 24 to 40 hours should allow 70 to 80 percent of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 foot deep.
  - A settling zone at least 2 feet deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- The length to width ratio should be greater than 6:1, or baffles are required to prevent short circuiting.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Remove sediment where the sediment storage zone is half full.
- Cost: Average annual cost for installation and maintenance (2 year useful life, source: EPA, 1992)
  - Basin less than 50,000 $ft.^3$: \$0.40 per $ft.^3$ (\$700 per drainage acre)
  - Basin size greater than 50,000 $ft.^3$: \$0.20 per $ft.^3$ (\$350 per drainage acre)

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC56

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R0034513

BMP: SEDIMENT BASIN (Continue)

LIMITATIONS

- The basin should have shallow side slopes (minimum 4:1) or be fenced to prevent drowning.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins in excess of 25 feet height and/or an impounding capacity of 50 ac. ft. must obtain approval from Division of Safety of Dams.
- Standing water may cause mosquitos or other pests to breed.
- Basins in excess of certain depth and storage volume criteria must meet State Division of Safety of Dams (DSOD) and local safety requirements.

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Additional Information — Sediment Basin

A sediment basin is a controlled storm water release structure formed by excavation or by constructing an embankment of compacted soil across a drainageway, or other suitable location. Its purpose is to collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of permanent drainage structures. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure (with a design life of 12 to 18 months) and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sedimentation basins are suitable for nearly all types of construction projects. Whenever possible, construct the sedimentation basins before clearing and grading work begins.
Basins should be located at the stormwater outlet from the site, but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a storm water detention basin for post-construction flood control, desiltation, or storm water pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 percent of the sediment which flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Installation/Application Criteria

Planning:

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a stream but should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Design:

- The sedimentation basin volume consists of two zones:
  - The sediment storage zone (at least 1 foot in depth).
  - A settling zone at least 2 feet in depth.
- The sedimentation basin may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points.
- A securely anchored riser pipe with an anti-seep collar is the principal outlet, along with an emergency overflow spillway. A solid riser pipe with two 1-inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe usually provides sufficient detention time for basins draining about 10 acres. Rock, rip-rap, or other suitable outlet protection is provided to reduce erosion at the riser pipe outlet.
- Settling Zone Volume

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R0034515

Additional Information — Sediment Basin

The settling zone volume is determined by the following equation:

$$(V) = 1.2(SD)Q / V_{SED}$$

Q = design inflow based on the peak discharge from a specified design storm (e.g., a 2-year, 24-hour duration design storm event) from the tributary drainage area as computed using the methods required by the local flood control agency. Provide a minimum of 67 cubic yards of settling volume per acre of drainage if a design storm is not specified.

V_{SED} = the settling velocity of the design soil particle. The design particle chosen is medium silt (0.02 mm). This has a settling velocity (V_{SED}) of 0.00096 ft/sec. As a general rule it will not be necessary to design for a particle of size less than 0.02 mm, especially since the surface area requirement increases dramatically for smaller particle sizes. For example, a design particle of 0.01 mm requires about three times the surface area of 0.02 mm. Note also that choosing V_{SED} of 0.00096 ft/sec equates to a surface area (SA) of 1250 sq. ft. per cfs of inflow.

SD = settling depth, which should be at least 2 ft., and no shallower than the average distance from the inlet to the outlet of the pond (L) divided by 200 (i.e., SD > L/200).

Total sediment basin volume and dimension are determined as outlined below:

a. The details shown in the attached figure may be useful in designing the sediment basin.
b. Determine basin geometry for the sediment storage volume calculated above using a minimum of 1 ft depth and 3:1 side slopes from the bottom of the basin. Note, the basin bottom is level.
c. Extend the basin side slopes (at 3:1 max.) as necessary to obtain the settling zone volume as determined above.
d. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.
e. Provide an emergency spillway with a crest elevation one foot above the top of the riser pipe.
f. The ratio between the basin length and width of the pond should either be greater than 6:1, or baffles should be installed to prevent short-circuiting.

Limitations

Sediment traps and ponds must be installed only within the property limits. Failure of the structure must not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location shall be shown in the SWPPP and in the construction specifications.

- Generally, temporary sedimentation ponds are limited to drainage of 5 acres or more.
- Sediment ponds may be capable of trapping smaller sediment particles if additional detention time is provided. However, they are most effective when used in conjunction with other BMPs such as seeding or mulching.
- Ponds may become an "attractive nuisance" and care must be taken to adhere to all safety practices.
- Sediment ponds designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to stabilize the soil quickly.

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Additional Information — Sediment Basin

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, Jun 1981.

Proposed Guidance Specifying Mnangement Measures for Sources of Nonpoint Pollution in Coastal Water, Work Group Working Paper, USEPA, April, 1992.

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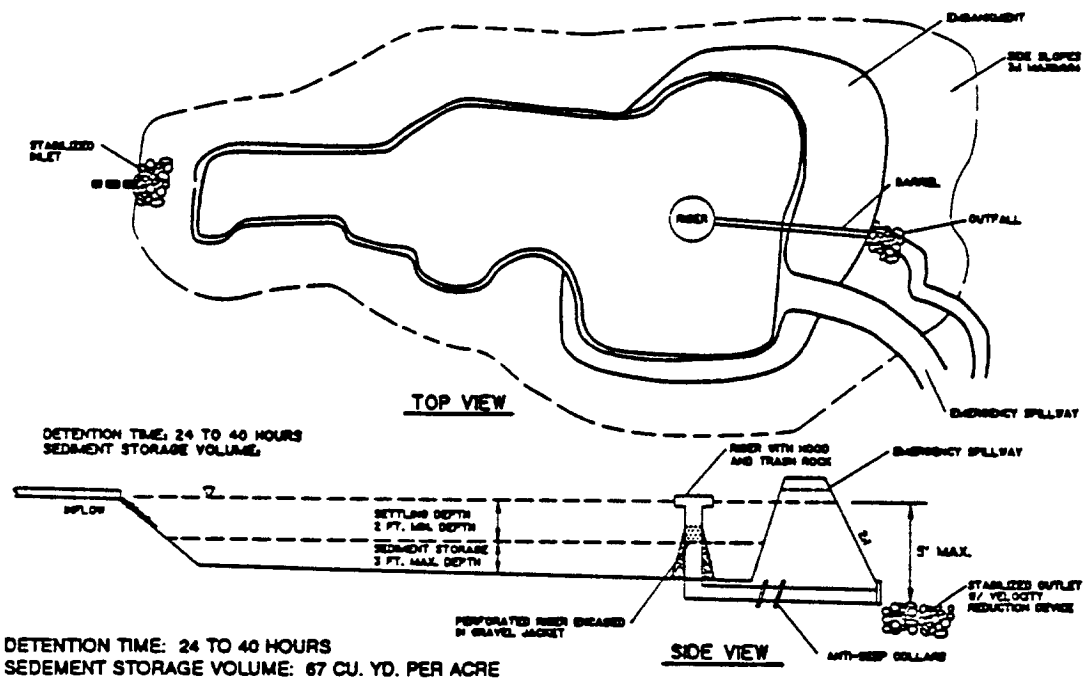
Additional Information — Sediment Basin



DETENTION TIME: 24 TO 40 HOURS
SEDEMENT STORAGE VOLUME: 67 CU. YD. PER ACRE

TEMPORARY SEDIMENT BASIN

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Best Management Practices

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Chapter 6

R0034519

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6. MEASURING BMP PERFORMANCE

INTRODUCTION

One of the final steps in the preparation of the Storm Water Pollution Prevention Plan (SWPPP) is to develop a program to monitor how well the BMPs work, and to evaluate whether additional BMPs are required. The construction general permit requires that a monitoring, inspection, and maintenance plan with the following objectives be a component of the SWPPP:

- To inspect BMPs annually, as well as prior to and after a storm event.
- To aid in implementation of the SWPPP.
- To measure the effectiveness of the BMPs.

To meet these objectives the monitoring effort has these elements:

- Site inspection
- Certification of compliance
- BMPs monitoring
- Record keeping
- SWPPP review and modifications

SITE INSPECTIONS

Inspections before and after a storm event are required by the construction general permit. At the onset of a construction project (e.g., clearing, grubbing, earth movement) it may be more appropriate to perform inspection of the BMPs on a regular basis instead of just before and after a storm. This will allow sufficient time for any corrections or improvements to be made in time before the storm. An inspector should be identified in the SWPPP. Inspection can usually be performed as part of a regular construction inspection program.

According to the general permit, a tracking or follow-up procedure must follow an inspection which discovers deficiencies in the BMPs.

The results of the inspection and assessment must be written. Include the date of the inspection, the person(s) who performed the inspection, and the observations. Inspection records must be retained for three years. A sample inspection form is provided at the end of this chapter.

It is possible that activities may have changed since the last inspection, by type or location. These should be noted. New BMPs and adjustments to the SWPPP may be necessary.

CERTIFICATION OF COMPLIANCE

You must certify, based on the annual inspection, that your facility is in compliance with the requirements of the general permit and the SWPPP. If the inspection indicates you are not in compliance, you are to notify your Regional Water Quality Control Board. The notification is to identify the type(s) of noncompliance, the actions identified to come into compliance, and a time schedule to achieve compliance.

BMPs MONITORING

The type of BMP monitoring depends on which BMP is implemented. In the case of contractor activity BMPs the monitoring consists of visual inspection to ensure that the BMP was implemented and maintained according to the SWPPP. Such inspection would include:

- looking for evidence of spills and resulting clean -up procedures (e.g., supplies of spill cleanup material);

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- examining integrity of containment structures;
- verifying use of employees education programs for the various activities;
- noting the location of activity (e.g., outdoor vs. indoor, concrete vs. grass);
- verifying adequacy of trash receptacles;
- verifying waste disposal practices (e.g., recycle vs. hazardous waste bins);

Other inspection areas are described in the fact sheets found in Chapter 4.

In the case of sediment and erosion control BMPs, the monitoring program should consist of regular inspection to determine the following:

Are the BMPs installed effective?

The effectiveness of the BMP would be based on the presence of silt behind or within control devices, the presence of silt downstream of the site and signs of erosion in stabilized areas after a storm event. The system may be deemed ineffective if:

1. Silt is present outside of the control area;

2. Structural controls are breached or fail under storm events of minor (less than 2 year, 24 hour) intensity;

3. Rills and gullies are present in stabilized slopes;

4. Evidence of silt buildup in downstream storm drains and drainage ways is apparent; and

5. Controls are not maintained in accordance with design guidelines.

Have drainage patterns changed?

If the site has undergone significant grading operations, changing the drainage patterns, adjustments to the BMP controls will likely be required to address this change. The inspector shall determine the extent of the drainage pattern changes, if the changes are addressed in the SWPPP and if modifications to the erosion and sediment controls are required to address this change.

Are sediment and erosion BMPs installed properly?

The SWPPP BMPs should include details or references to allow for the proper construction of structural or vegetative erosion and sediment control devices. The inspector should insure that these systems are installed according to the SWPPP in the proper locations.

Are areas stabilized as quickly as possible after completion of construction activities in an area?

Active construction areas (inactive construction areas may be defined as areas in which no construction activity will occur for a period of 30 days or longer) which have been disturbed should be stabilized through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. If construction, climatological, or other site conditions do not allow stabilization within seven (7) days, the SWPPP should define alternative approaches (e.g., watering or chemicals for dust control).

Are the BMPs properly maintained?

Maintenance of the erosion and sediment control devices is the most critical as well as the potentially most expensive erosion control plan. The inspector should inspect the site on a regular basis and after any storm of 0.5 inches or greater to determine maintenance requirements and general condition of the installed system. The local jurisdiction may also inspect the site on a typical bi-weekly basis to assess the maintenance performed on the systems. The following maintenance tasks should be performed on a regular basis. All maintenance related to a storm event should be completed within 48 hours of the storm event.

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1. Removal of silt from barriers and sedimentation devices.

2. Replacement or repair of worn or damaged geotextile fabric.

3. Repair or replacement of damaged structural controls.

4. Seeding or mulching of damaged stabilized areas.

5. BMPs for any chemicals or fuels not addressed in the SWPPP must be developed.

6. Other control maintenance as defined in the BMP fact sheet of this handbook or part of the approved SWPPP.

RECORD KEEPING

Records of all inspections, compliance certifications, and noncompliance reporting are to be retained for at least three years by the owner/developer.

It is suggested that records of incidents such as spills, or other episodic releases be kept. Analyzing a history of this information can provide insight into modifying the BMPs. The history may suggest a predominance of spills in particular locations, from particular activities, and/or of particular materials. Efforts can be focused accordingly. Photographs may be useful. Also keep a record of maintenance activities or any other BMPs that are of an "action" nature. It is easy to demonstrate that a BMP that involves a physical change, such as berming or covering, has been accomplished. But actions that relate to good housekeeping can only be demonstrated by record keeping. Keeping a record of sediment trap cleaning, for example, also provides insight into how soon it takes for the trap to refill.

SWPPP REVIEW AND MODIFICATIONS

During the course of construction, unanticipated changes may occur which affects the SWPPP, such as schedule changes, phasing changes, staging area modifications, off-site drainage impacts and repeated failures of designed controls. These changes must be made known and SWPPP revised accordingly. During the preparation and review of the modified SWPPP, construction may continue with temporary modifications to the erosion and sediment control BMPs.

Revisions to the SWPPP are also required when the properly installed systems are ineffective in the prevention of silt transport off of the site. This may be due to unforseen site conditions or construction techniques which adversely affect the system as designed. Revisions to the SWPPP are also required if there is a new, deleted, or moved activity that could result in a significant amount of pollutants discharged in the storm water.

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SAMPLE
Construction General Permit
Inspection Checklist

[ ] Regular Inspection

[ ] Rainfall Event Inspection (Before)
[ ] Rainfall Event Inspection (After) Rainfall _____ Inches

Inspected By:_____ Date:_____

Project:_____

YES	NO	DOES NOT APPLY	
			Are the BMPs called for on the SWPPP installed in the proper location and according to the specifications for the SWPPP?
			Are all operational storm drain inlets protected from sediment inflow?
			Do any structural practices require repair or clean-out to maintain adequate function? If yes, indicate which ones:
			Are construction on-site traffic routes, parking, and storage of equipment and supplies restricted to areas specifically designated for those uses?
			Are locations of temporary soil stock piles or construction materials in approved areas?
			Do any seeded or landscaped areas require maintenance, irrigation, fertilization, seeding, or mulching?
			Is there any evidence that sediment is leaving the site?
			Is there any evidence of erosion or cut or fill slopes?
			Is there any evidence of sediment, debris, or mud on public roads at intersections with site access roads?
			Does the SWPPP require revisions? If yes, explain:

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Appendices

STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD
PAUL R. BONDERSON BUILDING
901 P STREET
P. O. BOX 100
SACRAMENTO, CALIFORNIA 95812-0100
916/657-0941

FAX: 916/657-0932

PETE WILSON, Governor

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SEP 8 1992

SEP 14 1992

TO: Interested Parties

GENERAL CONSTRUCTION ACTIVITY STORM WATER PERMIT

Enclosed is a copy of the General Construction Activity Storm Water Permit (Permit), including the Fact Sheet, Notice of Intent (NOI) form, and NOI instructions, which was adopted by the State Water Resources Control Board (State Water Board) on August 20, 1992.

To be covered by this Permit, the owners of land where a construction activity occurs must submit the completed NOI form, with the appropriate fee, to the State Water Board. Permits are required for all storm water discharges associated with a construction activity where clearing, grading, and excavation results in a land disturbance of five or more acres. Storm water discharges from a construction activity that results in a land disturbance of less than five acres, but which is part of a larger common plan of development or sale, also require a permit. Permits are required until the construction is complete.

A permit must be obtained by October 1, 1992 for an ongoing construction activity that satisfies these criteria. For a new construction activity that begins after October 1, 1992, a permit must be obtained before construction starts.

The NOI must be sent to the following address:

State Water Resources Control Board
Division of Water Quality
Attention: Storm Water Permit Unit
P. O. Box 1977
Sacramento, CA 95812-1977

The NOI must be accompanied by the appropriate annual fee. The fee will either be $250.00 or $500.00 depending on the area of the construction activity. The NOI will not be processed if not accompanied by the fee. Enclosure 1 describes those areas in which the $250.00 annual fee applies. Dischargers in all other areas of the State must pay the $500.00 fee.

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Attachment No. 1 to the Permit lists the nine California Regional Water Quality Control Boards' (Regional Water Boards) addresses and telephone numbers. If you have any questions or concerns related to the Permit, you should discuss them with Regional Water Board staff.

We would appreciate it if you would inform other members of the construction industry of the need to obtain a storm water permit. If you know of others that need to obtain a permit but may be unaware of the State's program, please have them call the State Water Board's Construction Activity Storm Water Hotline at 916/657-1146.

Sincerely,

Walt Pettit
Executive Director

Enclosures (2)

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September 3, 1992

Enclosure 1

AREAS OF THE STATE IN WHICH THE $250.00 ANNUAL FEE APPLIES

Municipality	Permitted Area
1. Alameda County	The permitted area of the county is the westerly side of the county which drains to San Francisco Bay.
2. Los Angeles County	The permitted area consists of the five hydrologic subbasins which drain into the Pacific Ocean as follows: Santa Monica Bay, Upper Los Angeles River, including Sycamore Channel, Upper San Gabriel River, Lower Los Angeles River, and Lower San Gabriel River, including Santa Clarita Valley. The permit does not cover the cities of Avalon, Lancaster, and Palmdale.
3. Orange County	The permitted area is delineated by the Los Angeles County line on the northwest, the San Bernardino County line on the north and northeast, the Riverside County line on the east, the San Diego County line on the south, and the Pacific Ocean on the southwest.
4. Riverside County	The permitted area is delineated by the San Bernardino County line on the north and northwest, the Orange County line on the west, the San Diego County line on the south, and the Santa Ana/Colorado River Basin Regional Boards' boundary line on the east (mountain crest).
5. Sacramento County	The entire county except for the incorporated City of Isleton.
6. San Bernardino County	The permitted area is delineated by the Santa Ana-Lahontan Regional Board boundary line on the north and northeast, the Santa Ana-Colorado River Basin Regional Board boundary line on the east, the San Bernardino-Riverside

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Municipality	Permitted Area
	County boundary line on the south and southeast, the San-Bernardino-Orange County boundary line on the southwest, and the San Bernardino-Los Angeles County boundary line on the west.
7. San Diego County	The permitted area is delineated by the San Diego County lines on the north and south, the Pacific Ocean on the west, and the San Diego/Colorado River Basin Regional Board boundary on the east (mountain crest).
8. Santa Clara County	The Santa Clara Valley Basin portion of the county containing eleven hydrologic subbasins which discharge into watercourses which in turn flow into South San Francisco Bay.

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STATE WATER RESOURCES CONTROL BOARD

901 P STREET, SACRAMENTO, CA 95814

FACT SHEET

FOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

GENERAL PERMIT FOR

STORM WATER DISCHARGES ASSOCIATED WITH

CONSTRUCTION ACTIVITY

BACKGROUND

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, the U.S. Environmental Protection Agency (USEPA) published final regulations that establish storm water permit application requirements for specified categories of industries. The regulations require that discharges of storm water associated with construction activity (storm water discharges) from soil disturbances of five (5) acres or more must be regulated as an industrial activity and covered by a NPDES permit.

In a recent ruling, the Ninth Circuit Court of Appeals invalidated the exemption granted by USEPA for storm water discharges from soil disturbances of less than five acres but remanded the regulation to USEPA for further action. The State Water Board, at this time, is not requiring storm water discharges from soil disturbances of less than five acres to be covered by this general permit. Instead, the State Water Board will await future USEPA or court action clarifying the types of storm water discharges that must be permitted. If necessary, the State Water Board will reopen the general permit to accommodate such a clarification.

While Federal regulations allow two permitting options for storm water discharges (individual permits and general permits), the State Water Board has elected to adopt only one statewide general permit at this time that will apply to all storm water discharges, except from those on Indian lands and the Lake Tahoe Hydrologic Unit. The State Water Board has previously adopted a seperate statewide general permit for all other industrial storm water discharge categories, except for those discharges in Santa Clara County that drain to San Francisco Bay and on Indian Lands.

This general permit requires all owners of land where construction activity occurs (dischargers) to:

1. Eliminate or reduce non-storm water discharges to storm sewer systems and other waters of the nation,
2. Develop and implement a storm water pollution prevention plan, and
3. Perform inspections of storm water pollution prevention measures (control practices).

This general permit will be implemented and enforced by the nine California Regional Water Quality Control Boards (Regional Water Boards).

The general permit accompanying this fact sheet is intended to initiate regulation of storm water discharges. Regulating many storm water discharges under one permit will greatly reduce the otherwise overwhelming administrative burden associated with permitting individual storm water discharges. Dischargers must submit a notice of intent (NOI) to obtain coverage under this general permit. It is expected that as the storm water program develops, the Regional Water Boards may issue general permits containing more specific permit provisions. When this occurs, those dischargers will no longer be regulated by this general permit.

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TYPES OF CONSTRUCTION ACTIVITY COVERED BY THIS GENERAL PERMIT

Construction activity includes clearing, grading, or excavation that results in soil disturbance of at least five acres of total land area. Construction activity that results in soil disturbances of less than five acres requires a permit if the construction activity is part of a larger common plan of development or sale. Construction activity does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility, nor does it include emergency construction activities required to protect public health and safety. Dischargers may confirm with the local Regional Water Board that a particular routine maintenance is not subject to this general permit.

Storm water discharges from those portions of a construction project which include dredging and/or filling which are subject to regulation by the U.S. Army Corps of Engineers (Corps), pursuant to Section 10 of the Rivers and Harbors Act and/or Section 404 of the CWA, are excluded from regulation under this general permit. Said portions of the project are, however, subject to the certification requirements of Section 401 of the CWA and must be addressed via the certification process. Storm water discharges from dredge spoil placement which occurs outside of Corps jurisdiction (upland sites) and is part of a construction activity which disturbs five or more acres of land are covered by this general permit.

NOTIFICATION REQUIREMENTS

The owner of the land where the construction activity is occurring is responsible for obtaining coverage under this general permit by filing a NOI and appropriate fee in accordance with the NOI instructions. For construction activity conducted on easements, or on nearby property by agreement or permission, the entity responsible for the construction activity must file a NOI.

A separate NOI must be submitted to the State Water Board for each covered construction activity. Owners of land with ongoing construction activity will be required to submit a NOI by September 30, 1992. Owners of land with construction activity commencing after September 30, 1992 must submit a NOI prior to commencement of construction activity. The NOI requirements of the general permit are intended to establish a mechanism which can be used to clearly identify the responsible parties, locations, and scope of operations of dischargers covered by the general permit.

The NOI must be sent to the following address:

California State Water Resources Control Board
Division of Water Quality
Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

The current annual fee for this general permit is either $500 or $250 depending on location. Dischargers who fail to obtain coverage under this general permit and are not otherwise covered by a NPDES permit for storm water discharges will be in violation of the CWA and the California Water Code. When construction is complete or ownership has been transferred, dischargers are required to notify the State Water Board indicating that all State and local requirements have been met in accordance with Special Provision 7 of the general permit.

TYPES OF CONSTRUCTION ACTIVITY NOT COVERED BY THIS GENERAL PERMIT

This general permit does not apply to storm water discharges from those areas on Indian lands and the Lake Tahoe Hydrologic Unit. Storm water discharges in the Lake Tahoe Hydrologic Unit will be regulated by a separate permit(s) adopted by the California Regional Water Quality Control Board, Lahontan Region (Lahontan Regional Water Board). USEPA will regulate storm water discharges on Indian lands. Permit applications for storm water discharges that will be conducted in the Lake Tahoe Hydrologic Unit should be submitted directly to the Lahontan Regional Water Board.

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DESCRIPTION OF GENERAL PERMIT CONDITIONS

The following is a brief description of the major provisions of the general permit and the basis for the general permit. Dischargers should read the general permit carefully.

Prohibitions

This general permit authorizes the discharge of storm water associated with construction activity from construction sites. It prohibits the discharge of materials other than storm water and all discharges which contain a hazardous substance in excess of reportable quantities established at 40 Code of Federal Regulations (CFR) 117.3 or 40 CFR 302.4 unless a separate NPDES permit has been issued to regulate those discharges.

Effluent Limitations

Permits for storm water discharges associated with construction activity must meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require controls of pollutant discharges that utilize best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to reduce pollutants, and any more stringent controls necessary to meet water quality standards.

It is not feasible at this time for the State Water Board to establish numeric effluent limitations. The reasons why establishment of numeric effluent limitations is not feasible is discussed in detail in State Water Board Orders Nos. WQ 91-03 and WQ 91-04. Therefore, the effluent limitations contained in this general permit are narrative and include the requirement to implement appropriate pollution prevention control practices and/or Best Management Practices (BMPs). The BMPs may include treatment of storm water discharges, along with source reduction, which will constitute BAT and BCT and will achieve compliance with water quality standards. The effluent limitations constitute compliance with the requirements of the CWA. However, if storm water discharges cause water quality standards to be exceeded, this general permit may be amended, or the appropriate Regional Water Board may adopt a general permit which replaces this general permit to include additional effluent limitations necessary to achieve water quality standards. Elimination or reduction of non-storm water discharges is a major goal of this general permit. Non-storm water discharges include a wide variety of sources, including improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges may contribute a significant pollutant load to receiving waters. Measures to control spills, leakage, and dumping and to prevent illicit connections during construction can often be addressed through BMPs. This general permit prohibits the discharge of materials other than storm water. The general permit, however, recognizes that certain non-storm water discharges may be necessary for the practical performance and completion of construction projects. Such discharges include, but are not limited to: landscape irrigation of erosion control measures, pipe flushing and testing, street washing, and dewatering. Such discharges are allowed by this general permit if the discharges are (1) infeasible to eliminate, (2) comply with BMPs as described in the Storm Water Pollution Prevention Plan, (3) do not cause or contribute to a violation of water quality standards, and (4) are not required to be permitted by the local Regional Water Board (e.g., some Regional Water Boards have adopted general permits for dewatering discharges).

Storm Water Pollution Prevention Plan (SWPPP)

This general permit requires development and implementation of SWPPPs emphasizing storm water BMPs. This approach provides the flexibility necessary to establish control practices which can appropriately address sources of pollutants at different construction activities.

All dischargers must prepare, retain at the construction site, and implement a SWPPP. The SWPPP has two major objectives: (1) to help identify the sources of sediment and other pollutants that affect the quality of storm water discharges and (2) to describe and ensure the implementation of practices to reduce sediment and other pollutants in storm water discharges. The SWPPP must include BMPs which address source reduction, and, if necessary, should include BMPs which require treatment.

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The SWPPPs are considered reports available to the public under Section 308(b) of the CWA and will be made available by the Regional Water Board upon request. Required elements of the SWPPPs include: (1) site description, (2) erosion and sediment controls, (3) waste disposal, (4) implementation of approved local plans, (5) proposed post-construction controls, including description of local post-construction erosion and sediment control requirements, and (6) non-storm water management.

Monitoring Program

Another major feature of the general permit is the development and implementation of a monitoring program. All dischargers are required to conduct inspections of the construction site prior to anticipated storm events and after actual storm events to identify areas contributing to a storm water discharge and to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the general permit or whether additional control practices are needed.

Each discharger must certify annually that its construction activity is in compliance with the requirements of this general permit and its SWPPP. Dischargers who cannot annually certify compliance or who have had other instances of noncompliance must notify the appropriate Regional Water Board. A well-developed monitoring program will provide a good method for checking on the effectiveness of the SWPPP.

Retention of Records

The discharger is required to retain records of all monitoring information, copies of all reports required by this general permit, and records of all data used to complete the NOI for the construction activity to be covered by the general permit for a period of at least three years. This period may be extended by request of the State and/or Regional Water Boards. With the exception of noncompliance reporting, dischargers are not required to submit the records, except upon specific request by the Regional Water Board.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
ORDER NO. 92-08-DWQ
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT NO. CAS000002

WASTE DISCHARGE REQUIREMENTS (WDRS)
FOR
DISCHARGES OF STORM WATER RUNOFF ASSOCIATED WITH CONSTRUCTION ACTIVITY

The State Water Board finds that:

1. Federal regulations for controlling pollutants in storm water runoff discharges were issued by the U.S. Environmental Protection Agency (USEPA) on November 16, 1990 (40 Code of Federal Regulations (CFR) Parts 122, 123, and 124). The regulations require discharges of storm water associated with construction activity including clearing, grading, and excavation activities (except operations that result in disturbance of less than five acres of total land area and which are not part of a larger common plan of development or sale)[1/] to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate storm water pollution.

2. This general permit shall regulate pollutants in discharges of storm water associated with construction activity (storm water discharges) except from those areas on Indian lands, the Lake Tahoe Hydrologic Unit, and where the storm water discharge is determined ineligible for coverage under this general permit by the California Regional Water Quality Control Boards (Regional Water Boards). Attachment 1 contains addresses and telephone numbers of each Regional Water Board office.

3. This general permit does not preempt or supersede the authority of local storm water management agencies to prohibit, restrict, or control storm water discharges to separate storm sewer systems or other watercourses within their jurisdiction, as allowed by State and Federal law.

4. To obtain authorization for current and future storm water discharges pursuant to this general permit, the owner of a site where construction activity occurs (discharger) must submit a Notice of Intent (NOI) and appropriate fee to the State Water Board. Dischargers who submit a NOI and appropriate fee are authorized to discharge storm water under the terms and conditions of this general permit.

5. If an individual NPDES permit is issued to a discharger otherwise subject to this general permit, or an alternative general permit is subsequently adopted which covers storm water discharges regulated by this general permit, the applicability of this general permit to such discharges is automatically terminated on the effective date of the individual permit or the date of approval for coverage under the subsequent general permit.

6. This action to adopt a NPDES permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

1/ In a recent ruling, the Ninth Circuit Court of Appeals invalidated the exemption granted by USEPA for storm water discharges from soil disturbances less than five acres but remanded to USEPA for further action. This general permit may be reopened, as necessary, to accommodate a redefinition of the types of storm water discharges that must be permitted.

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7. The State Water Board adopted the California Ocean Plan on March 22, 1990 and the California Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan on April 11, 1991. In addition, the Regional Water Boards have adopted and the State Water Board has approved Water Quality Control Plans (Basin Plans). Dischargers regulated by this general permit must comply with the water quality standards in these Plans and subsequent amendments thereto.

8. It is not feasible at this time to establish numeric effluent limitations for pollutants in storm water discharges from construction activities. Instead, the provisions of this general permit that require implementation of Best Management Practices (BMPs) to control and abate the discharge of pollutants in storm water discharges constitute compliance with BAT/BCT requirements and with requirements to achieve water quality standards.

9. Discharges of non-storm water may be necessary for the practical performance and completion of certain construction projects. Such discharges include, but are not limited to: landscape irrigation of erosion control measures, pipe flushing and testing, street washing, and dewatering. Such discharges are allowed under this general permit so long as they comply with BMPs as described in the Storm Water Pollution Prevention Plan and they do not cause or contribute to violation of any water quality standard.

10. Following adoption of this general permit, the Regional Water Boards shall enforce the provisions of this general permit including the monitoring and reporting requirements.

11. Following public notice in accordance with State and Federal laws and regulations, the State Water Board in a public meeting held May 14, 1992 heard and considered all comments. The State Water Board has prepared written responses to all significant comments.

12. This Order is a NPDES permit in compliance with Section 402 of the Clean Water Act (CWA) and shall take effect upon adoption by the State Water Board.

13. This general permit does not authorize discharges of fill or dredged material regulated by the U.S. Army Corps of Engineers under CWA Section 404 and does not constitute a waiver of water quality certification under CWA Section 401.

IT IS HEREBY ORDERED that all dischargers who file a Notice of Intent (NOI) indicating their intention to be regulated under the provisions of this general permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of material other than storm water, which are not otherwise regulated by a NPDES permit, to a separate storm sewer system or waters of the nation are prohibited, except as allowed in Provision C.3.

2. Storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

3. Storm water discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

B. RECEIVING WATER LIMITATIONS:

1. Storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. Storm water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters Plan, Enclosed Bays and Estuaries Plan, or the applicable Regional Water Board's Basin Plan.

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C. SPECIAL PROVISIONS FOR CONSTRUCTION ACTIVITY:

1. All dischargers must file a NOI and appropriate fee for construction activities conducted at each site as required by Attachment 2: Notice of Intent--General Instructions.

2. All dischargers must develop and implement a Storm Water Pollution Prevention Plan in accordance with Section A: Storm Water Pollution Prevention Plan (SWPPP).

3. Discharges of non-storm water are allowed only when necessary for performance and completion of construction projects and where they do not cause or contribute to a violation of any water quality standard. Such discharges must be described in the SWPPP. Wherever feasible, alternatives which do not result in discharge of non-storm water shall be implemented, in accordance with Section A.7 of the SWPPP requirements.

4. All dischargers must develop and implement a monitoring program and reporting plan in accordance with Section B: Monitoring Program and Reporting Requirements.

5. All dischargers must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to separate storm sewer systems or other watercourses under their jurisdiction, including applicable requirements in municipal storm water management programs developed to comply with NPDES permits issued by the Regional Water Boards to local agencies.

6. All dischargers must comply with the standard provisions and reporting requirements contained in Section C: Standard Provisions.

7. The discharger may revoke (cancel) coverage under this general permit by submitting to the State Water Board certification, in accordance with the signatory requirements of Section C: Standard Provisions, Items 9 and 10, that construction activity has been completed, that all elements of the SWPPP have been completed, that construction and equipment maintenance waste have been disposed of properly, that the site is in compliance with all local storm water management requirements including erosion/sediment control requirements, policies, and guidelines. In addition, a discharger may revoke (cancel) coverage under this general permit when ownership of all or a portion of the project has been transferred. The new owner must comply with the provisions of Section A(2)(c) and B(3)(b) of this general permit. The revocation should accompany the NOI from the new owner when possible.

8. This general permit will expire on August 20, 1997. Upon reissuance of a NPDES general permit by the State Water Board, dischargers subject to the reissued general permit may be required to file a revised NOI.

D. REGIONAL WATER BOARD AUTHORITIES:

1. Following adoption of this general permit, Regional Water Boards shall:

   a. Implement the provisions of this general permit. Implementation of this general permit may include, but is not limited to, reviewing SWPPPs, reviewing monitoring reports, conducting compliance inspections, and taking enforcement actions.

   b. Issue permits as they deem appropriate to individual dischargers, categories of dischargers, or dischargers in a geographic area. Upon issuance of such permits by a Regional Water Board, the affected dischargers shall no longer be regulated by this general permit.

2. Regional Water Boards may provide guidance to dischargers on SWPPP and Monitoring Program implementation.

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3. Regional Water Boards may require dischargers to retain records for more than three years.

4. Regional Water Boards may require additional monitoring and reporting program requirements.

CERTIFICATION

The undersigned, Administrative Assistant to the State Water Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on August 20, 1992.

AYE: W. Don Maughan
Eliseo M. Samaniego
Marc Del Piero
James M. Stubchaer

NO: None

ABSENT: John Caffrey

ABSTAIN: None

Maureen Marché
Administrative Assistant to the Board

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Section A: STORM WATER POLLUTION PREVENTION PLAN

1. Objectives

A Storm Water Pollution Prevention Plan (SWPPP) shall be developed and implemented for each construction site covered by this general permit. The SWPPP shall be certified in accordance with the signatory requirements of Standard Provision C.9. The SWPPP shall be developed and amended, when necessary, to meet the following objectives:

a. To identify pollutant sources that may affect the quality of discharges of storm water associated with construction activity (storm water discharges) from the construction site, and

b. To identify, construct, and implement storm water pollution prevention measures (control practices) to reduce pollutants in storm water discharges from the construction site both during construction and after construction is completed.

2. Implementation Schedule

a. For construction activity commencing on and after October 1, 1992, the SWPPP must be developed and implemented concurrent with commencement of construction activities.

b. For construction activity commencing prior to and continuing beyond October 1, 1992, the SWPPP must be developed and implemented by October 1, 1992.

c. For ongoing construction activity involving a change of ownership of property covered by this general permit, the new owner must accept and maintain the existing SWPPP.

3. Availability

The SWPPP shall be kept on site during construction activity and made available upon request of a representative of the Regional Water Board and/or local agency.

4. Required Changes

a. The discharger shall amend the SWPPP whenever there is a change in construction or operations which may affect the discharge of significant quantities of pollutants to surface waters, ground waters, or a municipal separate storm sewer system. The SWPPP should also be amended if it is in violation of any condition of this general permit or has not achieved the general objective of reducing pollutants in storm water discharges.

b. The Regional Water Board, or local agency with the concurrence of the Regional Water Board, may require the discharger to amend the SWPPP.

5. Source Identification

The SWPPP shall provide a description of potential sources which are likely to add significant quantities of pollutants to storm water discharges or which may result in non-storm water discharges from the construction site. The SWPPP shall include, at a minimum, the following items:

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a. A map extending approximately one-quarter mile beyond the property boundaries of the construction site showing: the construction site, surface water bodies (including known springs and wetlands[1/]), known wells, an outline of off-site drainage areas that discharge into the construction site, general topography, and the anticipated discharge location(s) where the construction site's storm water discharges to a municipal storm sewer system or other water body. The requirements of this paragraph may be included in the site map required under the following paragraph if appropriate.

b. A site map(s) showing:

i. Location of control practices used during construction;

ii. Areas used to store soils and wastes;

iii. Areas of cut and fill;

iv. Drainage patterns and slopes anticipated after major grading activities are completed;

v. Areas of soil disturbance;

vi. Surface water locations;

vii. Areas of potential soil erosion where control practices will be used during construction;

viii. Existing and planned paved areas and buildings;

ix. Locations of post-construction control practices;

x. An outline of the drainage area for each on-site storm water discharge point;

xi. Vehicle storage and service areas; and

xii. Areas of existing vegetation.

c. A narrative description of the following:

i. Toxic materials that are known to have been treated, stored, disposed, spilled, or leaked in significant quantities onto the construction site;

ii. Practices to minimize contact of construction materials, equipment, and vehicles with storm water;

iii. Construction material loading, unloading, and access areas;

iv. Preconstruction control practices (if any) to reduce sediment and other pollutants in storm water discharges;

v. Equipment storage, cleaning, and maintenance areas;

1/ The determination of whether wetlands exist shall be made by the person who prepares the SWPPP and shall not be binding upon any other person.

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vi. Methods of on-site storage and disposal of construction materials; and

vii. The nature of fill material and existing data describing the soil on the construction site.

d. A list of pollutants (other than sediment) that are likely to be present in storm water discharges in significant quantities. Describe the control practices (if different from Item 6 below) appropriate to reduce these pollutants in the storm water discharges.

e. An estimate of the size of the construction site (in acres or square feet), an estimate of the runoff coefficient of the construction site before and after construction, and an estimate of the percentage of the area of the construction site that is impervious (e.g., pavement, buildings, etc.) before and after construction.

f. A copy of the NOI.

6. Erosion and Sediment Control

The SWPPP shall include:

a. A description of soil stabilization practices. These practices shall be designed to preserve existing vegetation where feasible and to revegetate open areas as soon as feasible after grading or construction. In developing these practices, the discharger shall consider: temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffer strips, protection of trees, or other soil stabilization practices. At a minimum, the operator must implement these practices on all disturbed areas during the rainy season.

b. A description or illustration of control practices which, to the extent feasible, will prevent a net increase of sediment load in storm water discharge. In developing control practices, the discharger shall consider a full range of erosion and sediment controls such as detention basins, straw bale dikes, silt fences, earth dikes, brush barriers, velocity dissipation devices, drainage swales, check dams, subsurface drain, pipe slope drain, level spreaders, storm drain inlet protection, rock outlet protection, sediment traps, temporary sediment basins, or other controls. At a minimum, sandbag dikes, silt fences, straw bale dikes, or equivalent controls practices are required for all significant sideslope and downslope boundaries of the construction area. The discharger must consider site-specific and seasonal conditions when designing the control practices.

c. Control practices to reduce the tracking of sediment onto public or private roads. These public and private roads shall be inspected and cleaned as necessary.

d. Control practices to reduce wind erosion.

7. Non-Storm Water Management

The SWPPP shall include provisions which eliminate or reduce to the extent feasible the discharge of materials other than storm water to the storm sewer system and/or receiving waters. Such provisions shall ensure, to the extent feasible, that no materials are discharged in quantities which will have an adverse effect on receiving waters. Materials other than storm water that are discharged shall be listed along with the estimated quantity of the discharged material.

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8. Post-Construction Storm Water Management

The SWPPP shall describe the control practices to reduce pollutants in storm water discharges after all construction phases have been completed at the site. These must be consistent with all local post-construction storm water management requirements, policies, and guidelines. The discharger must consider site-specific and seasonal conditions when designing the control practices. Operation and maintenance of control practices after construction is completed shall be addressed, including short- and long-term funding sources and the responsible party.

9. Waste Management and Disposal

All wastes (including equipment maintenance waste) disposed at the site or removed from the site for disposal shall be disposed of in compliance with Federal, State, and local laws, regulations, and ordinances.

10. Maintenance, Inspection, and Repair

The SWPPP shall include maintenance, inspections, and repair procedures to ensure that all grade surfaces, walls, dams and structures, vegetation, erosion and sediment control measures, and other protective devices identified in the site plan are maintained in good and effective condition and are promptly repaired or restored.

11. Training

The SWPPP shall include procedures to ensure that all inspections required in Section B.4 of the Monitoring Program and Reporting Requirements of this general permit and maintenance and repair required in Paragraph 10 of this Section are done by trained personnel.

12. List of Contractors/Subcontractors

The SWPPP shall include a list of all contractors (or subcontractors) responsible for implementing the SWPPP.

13. Other Plans

This SWPPP may incorporate, by reference, the appropriate elements of other plans required by local, State, or Federal agencies. A copy of any requirements incorporated by reference shall be kept at the construction site.

14. Public Access

The SWPPP is considered a report that shall be available to the public under Section 308(b) of the CWA. Upon request by members of the public, the discharger shall make available for review a copy of the SWPPP either to the Regional Water Board or directly to the requester.

15. Preparer

The SWPPP shall include the signature and title of the person responsible for preparation of the SWPPP and include the date of initial preparation and each amendment, thereto.

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Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

1. General

Dischargers are required to conduct inspections before and after storm events and to annually certify that they are in compliance with the general permit and their SWPPP. Other than reporting incidents of noncompliance, dischargers are not required to submit reports or certifications.

2. Required Changes

The Regional Water Board may require the discharger to conduct additional site inspections, submit reports and certifications, or to perform sampling and analysis.

3. Implementation

a. The requirements of this Section shall be implemented by October 1, 1992 or commencement of the construction activity. The discharger is responsible for implementing these requirements until construction activity is complete.

b. For ongoing construction activity involving a change in ownership of property covered by this general permit, the new owner must implement the requirements of this Section concurrent with the change of ownership.

4. Site Inspections

Dischargers shall conduct inspections of the construction site prior to anticipated storm events and after actual storm events to identify areas contributing to a discharge of storm water associated with construction activity and to evaluate whether control practices to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the general permit or whether additional control practices are needed. A record of the inspections must include the date of the inspection, the individual(s) who performed the inspection, and the observations.

5. Compliance Certification

Each discharger must annually certify that its construction activity is in compliance with the requirements of this general permit and its SWPPP. This certification should be based upon the site inspections required in Paragraph 4 of this Section. The first certification must be completed by July 1, 1993, and each July 1 thereafter.

6. Noncompliance Reporting

Dischargers who cannot certify compliance, in accordance with Paragraph 5 of this Section and/or who have any other instances of noncompliance, must notify the appropriate Regional Water Board. The notifications shall identify the type(s) of noncompliance, describe the actions necessary to achieve compliance, and include a time schedule, subject to the modifications by the Regional Water Board, indicating when compliance will be achieved. Noncompliance notifications must be submitted within 30 days of identification of noncompliance.

7. Monitoring Records

Records of all inspections, compliance certifications, and noncompliance reporting must be retained for a period of at least three years. With the exception of noncompliance reporting, dischargers are not required to submit these records.

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Section C: STANDARD PROVISIONS FOR CONSTRUCTION ACTIVITY

1. Duty to Comply

The discharger must comply with all of the conditions of this general permit. Any permit noncompliance constitutes a violation of the CWA and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action and/or removal from general permit coverage.

The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this general permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

This general permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a general permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any general permit condition.

If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this general permit, this general permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition; and the dischargers so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this general permit.

4. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this general permit which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this general permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems, installed by a discharger when necessary to achieve compliance with the conditions of this general permit.

6. Property Rights

This general permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

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7. Duty to Provide Information

The discharger shall furnish the Regional Water Board, State Water Board, or USEPA, within a reasonable time, any requested information to determine compliance with this general permit. The discharger shall also furnish, upon request, copies of records required to be kept by this general permit.

8. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, USEPA, and/or, in the case of construction sites which discharge through a municipal separate storm sewer, an authorized representative of the municipal operator of the separate storm sewer system receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises at reasonable times where a regulated construction activity is being conducted or where records must be kept under the conditions of this general permit;

b. Have access to and copy at reasonable times, any records that must be kept under the conditions of this general permit;

c. Inspect at reasonable times the construction site and the related erosion/sediment controls; and

d. Sample or monitor at reasonable times for the purpose of ensuring general permit compliance.

9. Signatory Requirements

a. All Notices of Intent submitted to the State Water Board shall be signed as follows:

1. For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

2. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

3. For a municipality, State, Federal, or other public agency: by either a principal executive officer, ranking elected official, or duly authorized representative. The principal executive officer of a Federal agency includes the chief executive officer of the agency or the senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of USEPA).

b. All storm water pollution prevention plans, reports, certifications, or other information required by the general permit and/or requested by the Regional Water Board, State Water Board, USEPA, or the local storm water management agency shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative if:

1. The authorization is made in writing by a person described above and retained as part of the SWPPP;

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2. The authorization specifies either an individual or a position having responsibility for the overall operation of the construction activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and

3. If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the construction activity, a new authorization must be attached to the SWPPP prior to submittal of any reports, information, or certifications to be signed by the authorized representative.

10. Certification

Any person signing documents under Provision 8 shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

11. Anticipated Noncompliance

The discharger will give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the construction activity which may result in noncompliance with general permit requirements.

12. Penalties for Falsification of Reports.

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this general permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years or by both.

13. Oil and Hazardous Substance Liability

Nothing in this general permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject under Section 311 of the CWA.

14. Severability

The provisions of this general permit are severable, and, if any provision of this general permit or the application of any provision of this general permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this general permit shall not be affected thereby.

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15. Reopener Clause

This general permit may be modified, revoked and reissued, or terminated for cause due to promulgation of amended regulations, receipt of USEPA guidance concerning regulated activities, judicial decision, or in accordance with 40 CFR 122.62, 122.63, 122.64, and 124.5.

16. Penalties for Violations of Permit Conditions

a. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the CWA or any permit condition or limitation implementing any such section in a permit issued under Section 402. Any person who violates any permit condition of this general permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties which in some cases are greater than those under the CWA.

17. Availability

A copy of this general permit shall be maintained at the construction site during construction activity and be available to operating personnel.

18. Transfers

This general permit is not transferable. A new owner of an ongoing construction activity must submit a NOI in accordance with the requirements of this general permit to be authorized to discharge under this general permit. An owner who sells property covered by this general permit shall inform the new owner of the duty to file a NOI and shall provide the new owner with a copy of this general permit.

19. Continuation of Expired Permit

This general permit continues in force and effect until a new general permit is issued or the State Water Board rescinds this general permit. Only those dischargers authorized to discharge under the expiring general permit are covered by the continued general permit.

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Attachment 1

STATE WATER RESOURCES CONTROL BOARD

P. O. Box 100, Sacramento, CA 95812-0100

Legislative and Public Affairs: (916)657-2390
Water Quality Information: (916) 657-0687
Clean Water Programs Information: (916) 739-4400
Water Rights Information: (916) 657-2170

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)

5550 Skylane Blvd. Suite A
Santa Rosa, CA 95403
(707) 576-2220

SAN FRANCISCO BAY REGION (2)

2101 Webster Street, Ste. 500
Oakland, CA 94612
(510) 464-1255

CENTRAL COAST REGION (3)

81 Higuera St., Suite 200
San Luis Obispo, CA 93401-5414
(805) 549-3147

LOS ANGELES REGION (4)

101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213) 266-7500

CENTRAL VALLEY REGION (5)

3443 Routier Road, Suite A
Sacramento, CA 95827-3098
(916) 361-5600

Fresno Branch Office

3614 East Ashlan Ave.
Fresno, CA 93726
(209) 445-5116

Redding Branch Office

415 Knollcrest Drive
Redding, CA 96002
(916) 224-4845

LAHONTAN REGION (6)

2092 Lake Tahoe Boulevard, Suite 2
South Lake Tahoe, CA 96150
(916) 544-3481

Victorville Branch Office

Civic Plaza,
15428 Civic Drive, Suite 100
Victorville, CA 92392-2359
(619) 241-6583

COLORADO RIVER BASIN REGION (7)

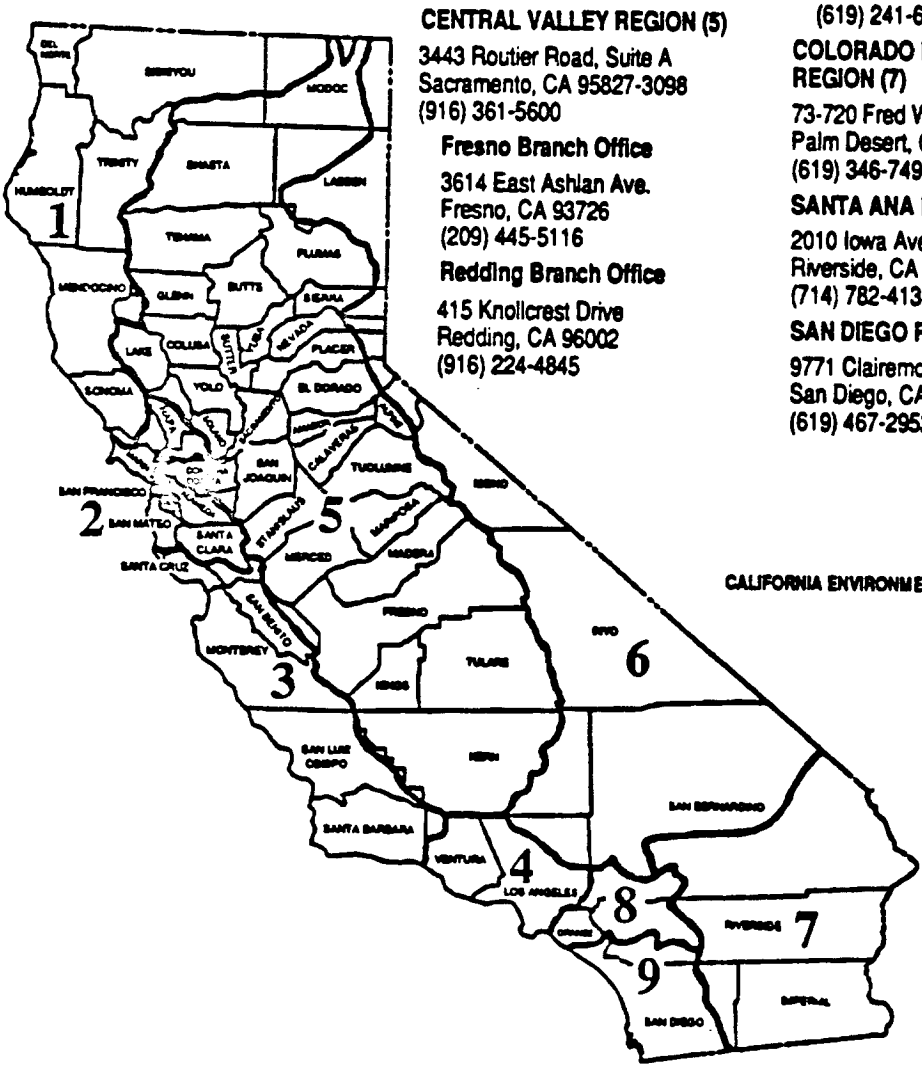
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
(619) 346-7491

SANTA ANA REGION (8)

2010 Iowa Avenue, Suite 100
Riverside, CA 92507-2409
(714) 782-4130

SAN DIEGO REGION (9)

9771 Clairemont Mesa Blvd. Ste. B
San Diego, CA 92124
(619) 467-2952



STATE OF CALIFORNIA
Pete Wilson, Governor

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
James M. Strock, Secretary

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Attachment 2

NOTICE OF INTENT (NOI) TO COMPLY WITH THE TERMS OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH CONSTRUCTION ACTIVITY

GENERAL INSTRUCTIONS

Who Must Submit

Discharges of storm water associated with construction activity (storm water discharges) that results in the disturbance of five acres or more of total land area or which is part of a larger common area of development or sale must be permitted. Construction activity includes clearing, grading, excavation, and reconstruction of existing facilities involving removal and replacement. Construction activity does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

The owner of the land where the construction activity is occurring is responsible for obtaining a permit. Owners may obtain coverage under the General Storm Water Permit to Discharge Storm Water Associated with Construction Activity (General Permit) by filing a NOI in accordance with the following instructions. Coverage for construction activity conducted on easements (e.g., pipeline construction), or on nearby properties by agreement or permission, shall be obtained by the entity responsible for the construction activity.

Construction Activities Not Covered by This General Permit

Storm water discharges in the Lake Tahoe Hydrologic Unit will be regulated by a separate permit(s) adopted by the California Regional Water Quality Control Board, Lahonton Region, and may not seek coverage under the State Water Board's general permit. Storm water discharges on Indian lands will be regulated by the U.S. Environmental Protection Agency.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
Attn: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

When to Apply

Owners of ongoing construction must file a NOI, along with the appropriate annual fee, by September 30, 1992. Owners of new construction (those beginning construction after September 30, 1992) must file a NOI prior to the commencement of construction. For ongoing construction activity involving a change of ownership, the new owner must submit a new NOI within 30 days of the date of change of ownership. Preferably, the NOI should be sent with the revocation prepared by the previous owner.

Fees

The current annual fee is $250.00 for each construction site which discharges into a municipal separate storm sewer system regulated by an areawide urban storm water permit and $500.00 for all other construction sites.

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Completing the NOI

Completion and submittal of the attached NOI (Form NOI-2) is required to gain coverage under the general permit. It must be completely and accurately filled out. A construction site will be considered to be covered by the general permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. Upon receipt of the NOI and fee, each discharger will be sent a letter containing the discharger's identification number.

Questions?

If you have any questions on completing the NOI after reading the following line-by-line instructions, please call us at (916) 657-1146.

NOI-- BY LINE INSTRUCTIONS

The NOI consists of two parts--a NOI Form (Form NOI-2) and a site map. Please type or print when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for ongoing construction, box 2 if the construction site is new (commencing on or after October 1, 1992), and box 3 if the NOI is being submitted to report changes for a construction site already covered by the general permit. An example of a change that warrants a resubmittal of the NOI would be a change of ownership of the construction site. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID No. must be included.

SECTION I--OWNER

Enter the owner of the construction site's official or legal name, address, contact person, and contact person's title and telephone number.

SECTION II--CONSTRUCTION SITE INFORMATION

In Part A, enter the name of the developer (or general contractor), official, or legal name, address, contact person, and contact person's title and telephone number. The contact person should be the construction site manager completely familiar with the construction site and charged with compliance and oversight of the general permit.

In Part B, enter the address, county, and telephone number (if any) of the construction site. Construction sites that do not have a street address must attach to the NOI a legal description of the construction site.

In Part C, indicate whether the construction site is part of a larger common plan of development or sale. For example, indicate yes if the construction activity is occuring on a two-acre site within an industrial park development of greater than five acres. If the construction site is part of a larger common plan of development or sale, name the common plan (e.g., XYZ Estates, ABC Industrial Park).

In Part D, indicate the construction commencement date (month, day, year). When there is a change in ownership of the property that requires a new NOI, the construction commencement date should be the date of the change in ownership.

In Part E, indicate when the construction is expected to be completed.

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SECTION III--BILLING ADDRESS

To continue coverage under the general permit, the annual fee must be paid. Use this section to indicate whether the annual fee invoices should be sent to the owner, developer, or other party (include address).

SECTION IV--RECEIVING WATER INFORMATION

In Part A of this section, the owner is required to indicate whether the construction site's storm water runoff discharges to a separate storm sewer system, directly to waters of the United States, or indirectly to waters of the United States.

Discharges to separate storm sewer systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the United States will typically have an outfall structure directly from the facility to a river, creek, ocean, etc. Indirect discharges are those that may flow over adjacent properties or rights-of-way prior to discharging to waters of the United States.

Regardless of point of discharge, the owner must determine the closest receiving water for the construction site's storm water discharge. If discharge is to a separate storm sewer system, the owner of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V--TYPE OF CONSTRUCTION

Indicate the type of construction taking place. Transportation should be checked for the construction of roads. Utility should be checked for installation of sewer, electric, and telephone systems.

SECTION VI--MATERIAL HANDLING/MANAGEMENT PRACTICES

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If materials other than those listed are maintained on site, please check "other" and describe the type of material.

Part B of this section requests information on proposed management practices to reduce pollutants in storm water discharges. Check the appropriate categories or list other control measures you will use at your construction site.

SECTION VII--SITE INFORMATION

List the size, in acres, of the facility and the percentage of the site that is impervious before construction and after construction is completed.

SECTION VIII--REGULATORY STATUS

Indicate whether the construction site's erosion/sediment control plan must be reviewed and approved by a local agency. If yes, identify the name of the local agency.

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SECTION IX--CERTIFICATION

This section must be completed by the owner of the construction site. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner to certify that the provisions in the general permit will be complied with.

The NOI must be signed by:

For a corporation: a responsible corporate officer (or authorized individual).
For a partnership or sole proprietorship: a general partner or the proprietor, respectively.
For a municipality, State, Federal, or other public agency: either a principal executive officer, ranking elected official, or duly authorized representative.

SITE MAP

Provide a "to scale" drawing of the construction site and its immediate surroundings. Include as much detail about the construction site as possible. At a minimum, show existing and proposed buildings, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH CONSTRUCTION ACTIVITY (WQ Order No. 92-08-DWQ)

MARK ONLY ONE ITEM
1. ☐ Ongoing Construction
2. ☐ New Construction
3. ☐ Change of Information
WDID # _____

I. OWNER

Name			Contact Person
Local Mailing Address			Title
City	State	Zip	Phone

II. CONSTRUCTION SITE INFORMATION

A. Developer			Contact Person
Local Mailing Address			Title
City	State	Zip	Phone
B. Site Address			County
City	State CA	Zip	Phone

C. Is the construction site part of a larger common plan of development or sale? ☐ Yes ☐ No — If yes, name of plan or development

D. Construction commencement date M M D D Y Y — E. Projected construction completion date M M D D Y Y

III. BILLING ADDRESS

Send to:
☐ OWNER ☐ DEVELOPER
☐ OTHER *(Enter information at right)*

Name		
Mailing Address		
City	State	Zip

IV. RECEIVING WATER INFORMATION

A. Does your construction site's storm water discharge to: (Check one)
1. ☐ Storm drain system - Enter system owners name
2. ☐ Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water

STATE USE ONLY

WDID:	Regional Board Office:		Date Permit Issued:
NPDES Permit Number: CA	Order Number:	Fee Amount Received: $	Date NOI Received:

NOI 2
6/20/92

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V. TYPE OF CONSTRUCTION (Check all that apply)

1. ☐ Residential 2. ☐ Commercial 3. ☐ Industrial 4. ☐ Reconstruction 5. ☐ Transportation
6 ☐ Utility 99. ☐ Other (Please List)

VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials that will be handled and/or stored at the site: (Check all that apply)

1. ☐ Solvents 2. ☐ Metal 3. ☐ Petroleum Products 4. ☐ Plated Products
5. ☐ Asphalt/Concrete 6. ☐ Hazardous Substances 7. ☐ Paints 8. ☐ Wood Treated Products
99. ☐ Other (Please list)

B. Identify proposed management practices to reduce pollutants in storm water discharges: (Check all that apply)

1. ☐ Oil/Water Separator 2. ☐ Erosion Controls 3. ☐ Sedimentation Controls 4. ☐ Overhead Coverage
5. ☐ Detention/Desiltation Pond 99. ☐ Other (Please list)

VII. SITE INFORMATION

A. Total size of construction site: _____ Acres

B. Percent of site impervious: (Including rooftops)
Before construction _____ % After construction _____ %

VIII. REGULATORY STATUS

Is the site subject to a locally approved erosion/sediment control plan ? ☐ Yes ☐ No

If yes, name of local agency

IX. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date: _____

Title: _____

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6 20 92

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DEFINITIONS

1. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, waste disposal, or drainage from raw material storage.

2. "Clean Water Act" ("CWA") means the Federal Water Pollution Control Act enacted by Public Law 92-500 as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; 33 USC. 1251 et seq.

3. "Construction Site" is the location of the construction activity.

4. "Non-Storm Water Discharge" means any discharge to storm sewer systems that is not composed entirely of storm water except discharges pursuant to a NPDES Permit and discharges resulting from fire fighting activities.

5. "Significant Materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERLCA); any chemical the facility is required to report pursuant to Section 313 of Title III of Superfund Amendments and Reauthorization Act (SARA); fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

6. "Significant Quantities" is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and cause or contribute to a violation of any applicable water quality standards for the receiving water.

7. "Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage. It excludes infiltration and runoff from agricultural land.

8. "Pollution" means "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water". [Clean Water Act Section 502(19)]. Pollution also means "an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either...the waters for beneficial uses...or facilities which serve these beneficial uses." [California Water Code Section 13050(l)]

9. "Contamination" means "an impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease ... including any equivalent affect resulting from the disposal of waste, whether or not waters of the state are affected." [California Water Code Section 13050(k)]

10. "Nuisance" means "anything which meets all of the following requirements: (1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life and property; (2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal; (3) occurs during or as a result of the treatment or disposal of wastes." [California Water Code Section 13050(m)]

11. "Local Agency" means any agency that is involved with providing review, approval, or oversight of the construction sites' (a) construction activity, (b) erosion and sediment controls, or (c) storm water discharge.

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APPENDIX B

EXAMPLE SWPPP FOR A CONSTRUCTION PROJECT

This Appendix gives an example of a storm water pollution prevention plan (SWPPP) for a relatively straight forward, short-term construction project. It uses the SWPPP worksheets found at the end of Chapter 2. The level of detail provided is appropriate for projects in California of similar size and complexity. The BMPs selected for this example are appropriate for the example problem only -- other projects/sites will typically require a unique set of BMPs tailored to the particular site conditions. It may be useful to include additional working site maps and/or other materials used for selecting appropriate BMPS, such as those discussed in Chapters 2 and 3, for background. These materials are not required in the SWPPP, however, and are not included here. Also, a project location map and complete set of BMP fact sheets are not included in this example, but should be part of a complete SWPPP.

It is impossible to cover the full range of construction projects within California with a single example. Long-term, complex construction projects will probably require additional information to supplement the SWPPP worksheet, or may require phased SWPPPs for each construction phase. The concepts and level of detail shown in this example should be used only as a guide for preparing an SWPPP.

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REVISIONS	DATE

NOI attached?
[ ] Yes
[✓] No

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Storm Water Pollution Prevention Plan (SWPPP) Worksheet
California Construction General Permit

Worksheet 1. Project Information

Project Name: NOI WAREHOUSE

Project Location: Street Address (or Equivalent): 461 MAJOR ROAD

City: ANYTOWN County: CONTRA PERMIT Zip Code: 99999

Project Owner: NOI PACKAGING, INC.

Contact Person: S.W. RUNOFF Phone No. (213) 555-1212

Owner's Mailing Address: Street Address (or Equivalent): 999 INDUSTRY BLVD.

City: ANYTOWN County: CONTRA PERMIT Zip Code: 99999

[✓] Identify responsible personnel:

[✓] Implementing and revising the SWPPP: S.W. RUNOFF

[✓] Inspecting equipment: M. POOL

[✓] Regular inspections of BMPs: I. C. PROBLEMS

[✓] Training employees about BMPs affecting their job: U. C. FIXES

List all Contractors and Subcontractors responsible for implementing SWPPP for the project:

NAME	CONTACT PERSON	DATE WORK BEGINS	DATE WORK ENDS
ABC General Contractor	Geo. Foreman	10/15/92	9/1/93
XYZ Electric	U. R. Sparks	3/10/93	6/10/93
DEF Mechanical	C. R. Gear	2/1/93	7/1/93
Dirt Excavation	E. Mover	10/15/92	12/1/92
Flowers Landscaping	Fred Flowers	7/1/93	9/1/93

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Worksheet 2. Project Site Map Requirements

Please Check the Boxes, and provide supporting information as requested:

[✓] Topographic Base Map Attached? Map shows:

- [✓] An area extending one-quarter mile beyond the property boundaries of the construction site: See Location Map on Project Construction Drawings.
- [✓] The boundary of the construction site. Construction Area = 12 Acres
- [✓] Nearby surface water bodies, including water courses, wetlands, springs and wells.
- [✓] The location(s) where storm water drains onto or off of the property.
- [✓] Boundary of off-site areas that drain into the construction site.

[✓] Site map(s) attached? Maps show:

- [✓] Temporary storm water structures used during construction.
- [✓] Areas used to store soils and construction waste.
- [✓] Areas of cut and fill.
- [✓] Drainage patterns and slopes anticipated after major grading activities, including the location of storm water structures to be constructed on the property (e.g., storm drains, detention ponds, channels).
- [✓] Areas of soil disturbance.
- [✓] Locations of potential soil erosion requiring BMPs during construction.
- [✓] Existing and proposed paved areas and buildings.

  Existing Area: 0 percent of site Proposed Area: 70 percent of site

- [✓] Estimated runoff coefficient before construction: 35 after construction 78 (See the local municipality for approved runoff coefficients for your community.)
- [✓] Locations where storm water structures and controls will be built to control storm water pollution after construction is complete.
- [✓] The boundary of the drainage area upstream of each location where storm water leaves the property. See Hydrology Report for Project, Page 25.
- [✓] Any vehicles storage and service areas. NONE
- [✓] Areas of existing vegetation.

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Worksheet 3. Inventory of Contractor's Activities and Special Site Conditions

Provide a description of contractor's activities that could result in the discharge of pollutants in the storm water runoff from the site. In addition, provide a description of special site conditions that may impact pollutants in storm water discharges.

Contractor's Activities

[✓] Describe toxic materials that are known to have been stored, disposed, spilled, or leaked in significant quantities onto the construction site:
No toxic materials were stored, disposed, spilled or leaked on-site prior to construction.

[✓] Describe construction materials, equipment and vehicles that comes in contact with storm water:
Construction Materials: Concrete, structural steel, aluminum wall panels, asphalt roofing, shrubbery, fertilizer, corrugated metal drainage pipe.
Equipment & Vehicles: Bulldozer, grader, concrete truck/forming, welder.

[✓] Describe construction material loading, unloading and access areas/activities:
All construction materials will be delivered to and stored on pallets in a bermed area staging at the northwest corner of the site (except concrete and asphalt roofing, which will be used immediately upon delivery to the site.

[✓] Describe equipment storage, cleaning, and maintenance areas/activities:
Equipment will be stored off-site if not needed within a 21 day period. Equipment will be stored on-site either in the bermed staging area or inside the partially completed warehouse. Fueling and routine maintenance will take place in the bermed staging area. Major equipment overhauls will take place off-site.

[✓] Describe storage and disposal of construction materials (on-site and off-site):
Materials will be stored on pallets in a bermed staging area until installation, and will be installed within 72 hours after removing from the bermed staging area. Building material waste will be placed nightly in dumpsters in the waste containment areas which will be emptied weekly. Excess concrete and asphalt roofing materials will be taken to approved off-site disposal areas.

Special Site Conditions

[✓] Describe storm water structures and controls on the site prior to construction and how these structures/controls will be integrated into the SWPPP to reduce sediment and other pollutants in storm water discharges:
No structures/controls existed on-site prior to construction.

[✓] List materials/waters other than storm water which will flow from the site during dry weather, the approximate amount of flow, and methods for preventing other dry weather flows:
No dry weather flows/discharges will be generated on-site by this construction project.

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Worksheet 4. BMPs for Contractor Activities

Provide a list of BMPs selected to reduce pollutants associated with contractor activities (see Worksheet 3). For each BMP selected, identify the pollution(s) of concern (see Table 1.1). Attach modified BMP fact sheets and/or appropriate information for the BMP selected. (See Chapter 4, BMPs for Contract or Activities.)

Contractor Activities (Worksheet 3)	Construction Practices			Materials Management			Waste Management					Vehicle & Equipment Management			Primary Pollutant(s) of Concern
	CA1	CA2	CA3	CA10	CA11	CA12	CA20	CA21	CA22	CA23	CA24	CA30	CA31	CA32	
1. Toxic material on-site															
2. Construction material equipment & vehicles in contact with storm water		✓	✓		✓								✓	✓	See Worksheet 3
3. Material loading, unloading and access areas/activities				✓		✓									Various Building Materials (Floatables)
4. Equipment storage cleaning, and maintenance areas/activities													✓	✓	Fuels, Oil, Grease, Hydraulic Fluids
5. Storage and disposal of construction materials (on-site and off-site)							✓			✓	✓				Various Building Materials (Floatables), Concrete, Asphalt

NOTE: Modified BMP Fact Sheet CA10 is included as an example. The Complete SWPPP would include other modified BMP Fact Sheets.

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Worksheet 5. BMPs for Erosion and Sedimentation Control

[ ] Describe the source and composition of the existing soil and fill material
(Soil Report Attached? Yes [ ] No [✓])
No significant fill materials are needed for this project. Only native soils available on-site will be used. The native soil is a loamy clay. Temporary stock piles will be created during construction.

[ ] Provide a site map showing locations where BMPs for erosion and sediment control are placed. This map should be updated when BMPs are revised to meet evolving construction conditions. Provide a brief description of BMP selected, and, if appropriate, attach modified fact sheets or additional information for erosion and sedimentation control BMPs.

✓	BMPs SELECTED	DESCRIPTION OF BMPs FOR EROSION & SEDIMENTATION CONTROL
SITE PLANNING CONSIDERATIONS		
	Scheduling	
✓	Preservation of Existing Vegetation	**Existing tree, vegetation along Minor Creek**
SOIL STABILIZATION		
✓	Seeding and Planting	**Final site stabilization of slopes, site periphery**
	Mulching	
PHYSICAL STABILIZATION		
	Geotextiles and Mats	
	Dust Control	
	Temporary Stream Crossing	
	Construction Road Stabilization	
✓	Stabilized Construction Entrance	**Perimeter Control: vehicular sediment tracking onto major road**
DIVERSION OF RUNOFF		
	Earth Dike	
✓	Temporary Drains and Swales	**Intercept, collect flows to prevent slope erosion**
✓	Slope Drain	**Slope Protection: convey runoff from top to toe of slope**

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✓	BMPs SELECTED	DESCRIPTION OF BMPs FOR EROSION & SEDIMENTATION CONTROL
VELOCITY REDUCTION		
✓	Outlet Protection	**Prevent stream erosion from high velocities at pipe outlets**
	Check Dams	
	Slope Roughing/Terracing	
SEDIMENT TRAPPING/FILTERING		
✓	Silt Fence	**Trap sediment along Minor Creek**
	Straw Bale Barrier	
	Sand Bag Barrier	
	Rock or Brush Filter	
✓	Storm Drain Inlet Protection	**Prevent sediment from entering new D.L's**
	Sediment Trap	
✓	Sediment Basin	**Sedimentation for most site runoff before discharge to Minor Creek**

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Worksheet 6. Post-Construction BMPs

Provide a site map locating treatment control BMPs which will be constructed as part of this project to reduce storm water pollution after construction is complete. Selection of these and other post-construction BMPs may be guided using the Municipal BMP Handbook, and must consider site-specific and seasonal conditions. Provide on the worksheet below the BMP selected, the responsible party for maintenance and operation, and source for funding the operation and maintenance.

✓	BMPs SELECTED	MAINTENANCE RESPONSIBILITY	FUNDING SOURCE FOR O&M
	TREATMENT CONTROL BMPs		
	Infiltration		
	Wet Ponds		
	Constructed Wetlands		
	Vegetated Swales and Strips		
✓	Extended Detention Basins (To be constructed where sediment basin is located during construction.)	NOI Packaging will contract for maintenance services annually	NOI Packaging will pay for all maintenance costs
	Media Filtration		
	Oil/Water Separators and Water Quality Inlets		
	Multiple Systems		
	SOURCE CONTROL BMPs		
✓	Inlet Stencilling/Employee Education	Anytown O&M crews will stencil and provide brochure to employees	Restencil every 3 years, regular Anytown O&M activity
✓	Prevent Illicit Connections	Anytown City inspectors will check drains before issuing occupancy permit	Fee for occupancy permit covers inspection cost.

Describe other measures which will be employed on the project site to control storm water pollution after construction is complete, and steps to be taken by the current owner to ensure that these measures are conducted.

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Worksheet 7. Monitoring, Inspection, and Maintenance Plan

[✓] Describe maintenance/repair efforts to ensure BMPs are in good and effective condition:

- Sediment will be removed from sedimentation basin, silt fence, and inlet protection when sediment depth reaches 1/3 of the total available depth.
- Any silt fence/inlet protection washed out or otherwise disrupted will be replaced or repaired within 48 hours of discovery.

[✓] Describe inspection procedures and record keeping efforts:
Attached inspection form to be filled out and inserted after this worksheet in the SWPPP.

[✓] Annual Inspection:
Inspection will occur about October 10, when site clearing is complete and all ESC measures are installed.

[✓] Pre-storm Inspection:
On days before predicted rainfall, a drive-by inspection will be conducted to check for any damage. Inspector will call a crew to immediately repair damage.

[✓] Post-storm Inspection:
Each BMP will be closely inspected within 48 hours after each rainfall of 0.5" or more. BMPs will be checked for 1) structural integrity; 2) sediment accumulation greater than 1/3 total depth of BMP; 3) evidence of excessive sediment downstream of the site; and 4) evidence of other construction materials washed off-site.

[✓] Describe training program/material for site personnel responsible for installing, inspecting, and maintaining BMPs:

1) BMP fact sheets from this SWPPP will be copied and distributed to site personnel engaged in the activity in question and/or installation/maintenance of ESC BMPs.

2) Site inspector observing improper construction measures or pollution caused by ineffective construction pollution management practices will inform site personnel performing these practices of proper BMPs, along with special follow-up inspections for further training.

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Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name S. W. Runoff Title Environmental Coordinator

Signature S. W. Runoff Date October 1, 1992

This SWPPP was prepared by:

Name S. W. Runoff Title Environmental Coordinator

Signature S. W. Runoff Date October, 1992

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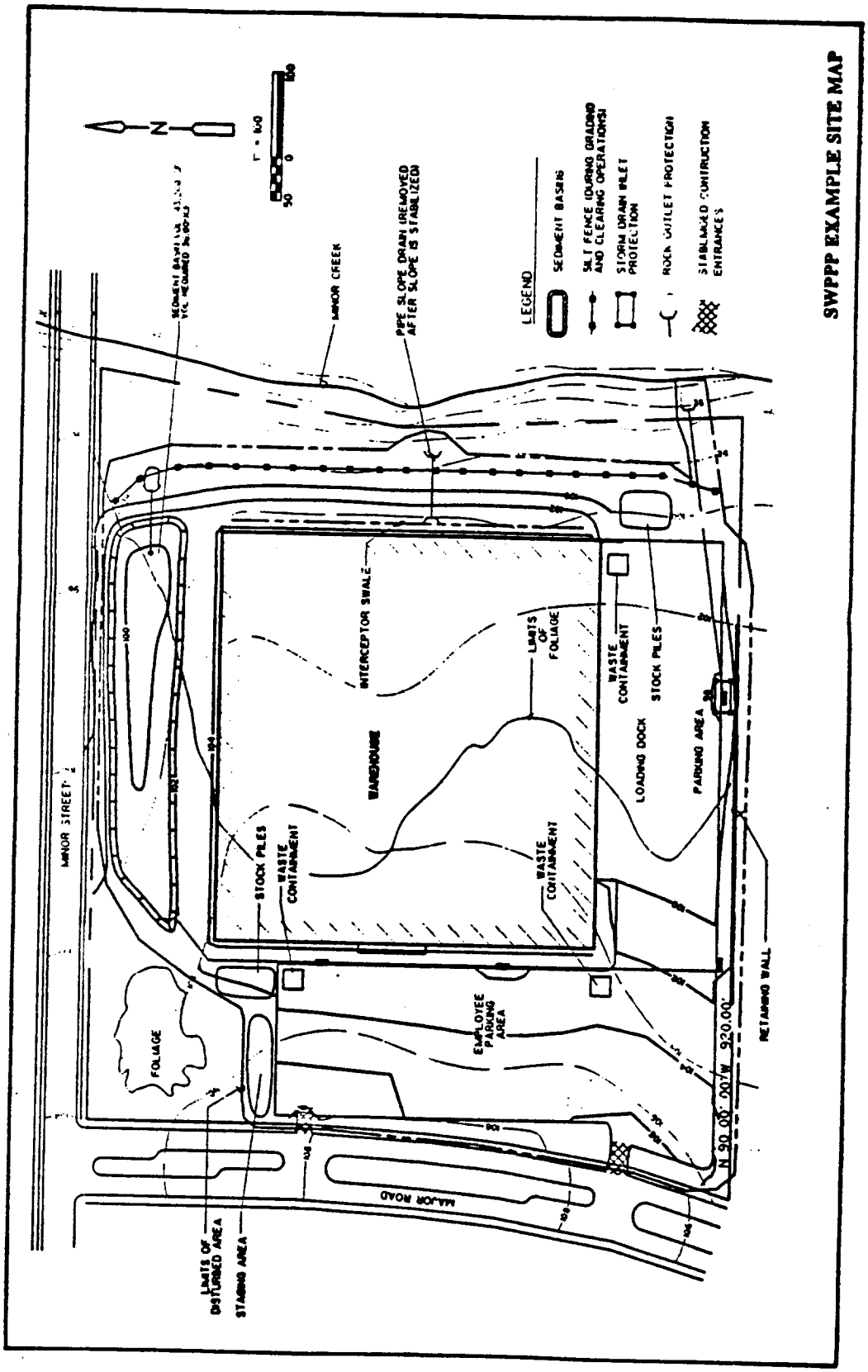

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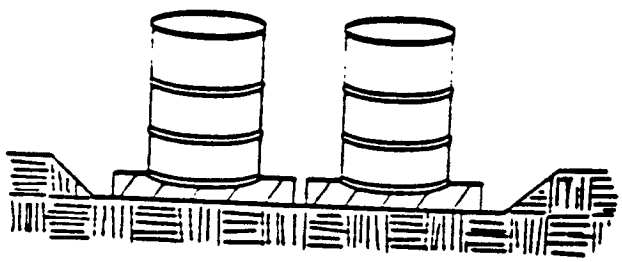
ACTIVITY: MATERIAL DELIVERY AND STORAGE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

Targeted Pollutants

- ◒ Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ◒ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

SYMBOL

CA10

Best Management Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see CA11 (Material Use), or CA12 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following materials are commonly stored on this construction sites:

- ~~Soil~~
- ~~Pesticides and herbicides~~
- Fertilizers,
- ~~Detergents~~,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Designate areas of the construction site for material delivery and storage.
  - -Place near the construction entrances, away from waterways (Southeast corner)
  - -Avoid transport near drainage paths or waterways
  - -Surround with earth berms (see ESC30, Earth Dike.)
  - -Place in an area which will be paved
- Storage of reactive, ignitible, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
- Keep your inventory down.
- Minimize hazardous materials on-site storage.
- Handle hazardous materials as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in ~~secondary containment, such as an earthen dike, hay bale, trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints.~~

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ACTIVITY: MATERIAL DELIVERY AND STORAGE (Continue)

- Small amounts of material ~~may~~ will be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- ~~If drums must be kept uncovered, store them at a slight angle to reduce ponding or rainwater on the lids and to reduce corrosion.~~ No Drum Storage
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil(See CA22). If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

REQUIREMENTS

Cost (Capital, O&M)

- All of the above are low cost measures.

Maintenance

- Keep the designated storage area clean and well organized.
- Conduct routine weekly inspections and check for external corrosion of material containers.
- Keep an ample supply of spill cleanup materials near the storage area.

LIMITATIONS

- ~~Storage sheds often must meet building and fire code requirements.~~ No storage sheds.

REFERENCES

Storm Water Pollution Prevention for Construction Activities (Draft); USEPA, April 1992

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992

Construction-Related Industries: Best Management Practices for Industrial Storm Water Pollution Control; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

Additional BMPs

- Use materials removed from bermed storage area w/in 72 hrs.
- Deliver concrete & asphalt roofing materials directly to points of application, and follow appropriate material use BMP (CA 11)

SYMBOL

CA10

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH CONSTRUCTION ACTIVITY (WQ Order No. 92-08-DWQ)

MARK ONLY ONE ITEM
1. ☐ Ongoing Construction
2. ☒ New Construction
1. ☐ Change of Information
WDID # _____

I. OWNER

Name: NOI Packaging, Inc
Contact Person: S. W. Runoff
Local Mailing Address: 999 Industry Blvd
Title: Facility Manager
City: Anytown
State: CA Zip: 99999-0000
Phone: 213-555-1212

II. CONSTRUCTION SITE INFORMATION

A. Developer: Same as Owner
Contact Person:
Local Mailing Address:
Title:
City:
State: Zip:
Phone:

B. Site Address: 461 Major Road
County: Contra Permit
City: Anytown
State: CA Zip: 99999-0000
Phone: NONE

C. Is the construction site part of a larger common plan of development or sale? ☐ Yes ☒ No
If yes, name of plan or development:

D. Construction commencement date (MMDDYY): 101592
E. Projected construction completion date (MMDDYY): 090193

III. BILLING ADDRESS

Send to:
☒ OWNER ☐ DEVELOPER
☐ OTHER (Enter information at right)

Name: Same as Owner
Mailing Address:
City:
State: Zip:

IV. RECEIVING WATER INFORMATION

A. Does your construction site's storm water discharge to: (Check one)
1. ☐ Storm drain system - Enter system owners name
2. ☒ Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water: Minor Creek

STATE USE ONLY

WDID:
Regional Board Office:
Date Permit Issued:
NPDES Permit Number: CA
Order Number:
Fee Amount Received: $
Date NOI Received:

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V. TYPE OF CONSTRUCTION (Check all that apply)

1. ☐ Residential 2. ☒ Commercial 3. ☐ Industrial 4. ☐ Reconstruction 5. ☐ Transportation
6. ☐ Utility 99. ☐ Other (Please List)

VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials that will be handled and/or stored at the site: (Check all that apply)

1. ☐ Solvents 2. ☒ Metal 3. ☐ Petroleum Products 4. ☐ Plated Products
5. ☒ Asphalt/Concrete 6. ☐ Hazardous Substances 7. ☐ Paints 8. ☐ Wood Treated Products
99. ☐ Other (Please list)

B. Identify proposed management practices to reduce pollutants in storm water discharges: (Check all that apply)

1. ☐ Oil/Water Separator 2. ☒ Erosion Controls 3. ☒ Sedimentation Controls 4. ☐ Overhead Coverage
5. ☒ Detention/Desiltation Pond 99. ☐ Other (Please list)

VII. SITE INFORMATION

A. Total size of construction site: 12 Acres

B. Percent of site impervious: (Including rooftops)
Before construction 0 % After construction 70 %

VIII. REGULATORY STATUS

Is the site subject to a locally approved erosion/sediment control plan ? ☒ Yes ☐ No

If yes, name of local agency Anytown Public Works Dept.

IX. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: S. W. Runoff

Signature: S. W. Runoff Date: 10/1/92

Title: Facility Manager

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APPENDIX C

GLOSSARY

Backfill: Earth refilling a trench or an excavation.

Berm: An earthen mound used to direct the flow of runoff around or through a structure.

Best Management Practices (BMPs): Includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Buffer Strip or Zone: Strip of erosion-resistant vegetation between a waterway and an area of more intensive land use.

Catch Basin: Box-like underground concrete structure with openings in curbs and gutters designed to collect runoff from streets and pavement.

Clean Water Act (CWA): (33 U.S.C. 1251 et seq.) requirement of the NPDES program are defined under Sections 307, 402, 318 and 405 of the CWA.

Conduit: Any pipe for collecting and directing the storm water.

Conveyance System: Any channel or pipe for collecting and directing the storm water.

Construction General Permit: A National Pollutant Discharge Elimination System (NPDES) permit issued by the State Water Resources Control Board for the discharge of storm water associated with construction activity from soil disturbance of five (5) acres or more.

Culvert: A covered channel or a large-diameter pipe that directs water flow below the ground level.

Denuded: Land stripped of vegetation or land that has had its vegetation worn down due to the impacts from the elements or humans.

Discharge: The release of storm water or other substance from a conveyance system or storage container.

Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber-cutting.

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Excavation: The process of removing earth, stone, or other materials, usually by digging.

Filter Fabric: Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable).

Grading: The cutting and/or filling of the land surface to a desired slope or elevation.

Hazardous Substance:

1. Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive.

2. Any substance named by EPA to be reported is a designated quantity of the substance is spilled in the waters of the United States or if otherwise emitted into the environment.

Hazardous Waste: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (flammable, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Illegal Discharge: Any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges authorized by an NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire-fighting and other miscellaneous activities.

Inlet: An entrance into a ditch, storm drain, or other waterway.

Material Storage Areas: On site locations where raw materials, products, final products, by-products, or waste materials are stored.

Non-Storm Water Discharge: Any discharge to municipal separate storm sewer that is not composed entirely of storm water. Discharges containing process wastewater, non-contact cooling water, or sanitary wastewater are non-storm water discharges.

Notice of Intent (NOI): A formal notice to SWRCB submitted by the owner/developer that a construction project is about to begin. The NOI provides information on the owner, location, type of project, and certifies that the permittee will comply with the conditions of the construction general permit.

Notice of Termination (NOT): Form to notify authorities when a construction project is complete.

NPDES Permit: An authorization, license, or equivalent control document issued by EPA or an approved State agency to implement the requirements of the NPDES program.

Oil Sheen: A thin, glistening layer of oil on water.

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Organic Pollutants: Substances containing carbon which may cause pollution problems in receiving waters.

Organic Solvents: Liquid organic compounds capable of dissolving solids, gases, or liquids.

Outfall: The point where storm water discharges from a pipe, channel, ditch, or other conveyance to a waterway.

Permeability: The quality of a soil that enables water or air to move through it. Usually expressed in inches/hour or inches/day.

Point Source: Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

Precipitation: Any form of rain or snow.

Retention: The storage of storm water to prevent it from leaving the development site; may be temporary or permanent.

Runon: Off-site flows which flows onto your site.

Runoff: Water originating from rainfall and other sources (e.g., sprinkler irrigation) that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, wetlands, and shallow groundwater.

Scour: The erosive and digging action in watercourse by flowing water.

Secondary Containment: Structures, usually dikes or berms, surrounding tanks or other storage containers and designed to catch spilled material from the storage containers.

Sedimentation: The process of depositing soil particles, clays, sands, or other sediments that were picked up by runoff.

Sediments: Soil, sand, and minerals washed from land into water usually after rain, that pile up in reservoirs, rivers, and harbors, destroying fish-nesting areas and holes of water animals and clouding the water so that needed sunlight might not reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to be washed off the land after rainfalls.

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Significant Materials: Include, but not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designed under Section 101(14) of CERLCA; any chemical the facility is required to report pursuant to Section 313 of Title III or SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Significant Quantities: Is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance, that adversely impact human health or the environment, and cause or contribute to a violation of any applicable water quality standards for the receiving water.

Source Control BMPs: Everyday operational practices that prevent pollution by reducing potential pollutants at the source.

Spill Guard: A device used to prevent spills of liquid materials from storage containers.

Spill Prevention Control and Countermeasures Plan (SPCC): Plan consisting of structures, such as curbing, and action plans to prevent and respond to spills of hazardous substances as defined in the Clean Water Act.

Storm Drains: Above and below ground structures for transporting storm water to streams or outfalls for flood control purposes.

Storm Water: Rainfall runoff, snow melt runoff, surface runoff, and drainage. It excludes infiltration.

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APPENDIX D

LIST OF ACRONYMS

APWA	American Public Works Association
BMPs	Best Management Practices
CA	Contractor Activities
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CEQA	California Environmental Quality Act
CFR	Code of Federal Register
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act (Federal Water Pollution Control Act of 1972 as amended in 1987)
DTSC	California Department of Toxic Substance Control
EIR	Environmental Impact Report
ESC	Erosion and Sedimentation Control
FHWA	Federal Highway Authority
Hazmat	Hazardous Material
O&M	Operations and Maintenance
MSDS	Material Safety Data Sheet
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAHs	Polyaromatic Hydrocarbons
POTW	Publicly Owned Treatment Works
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SPCC	Spill Prevention Control and Countermeasure
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TSS	Total Suspended Solids
UFC	Uniform Fire Code
USEPA	United States Environmental Protection Agency

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APPENDIX A

STATE OF CALIFORNIA GENERAL CONSTRUCTION ACTIVITY STORM WATER PERMIT

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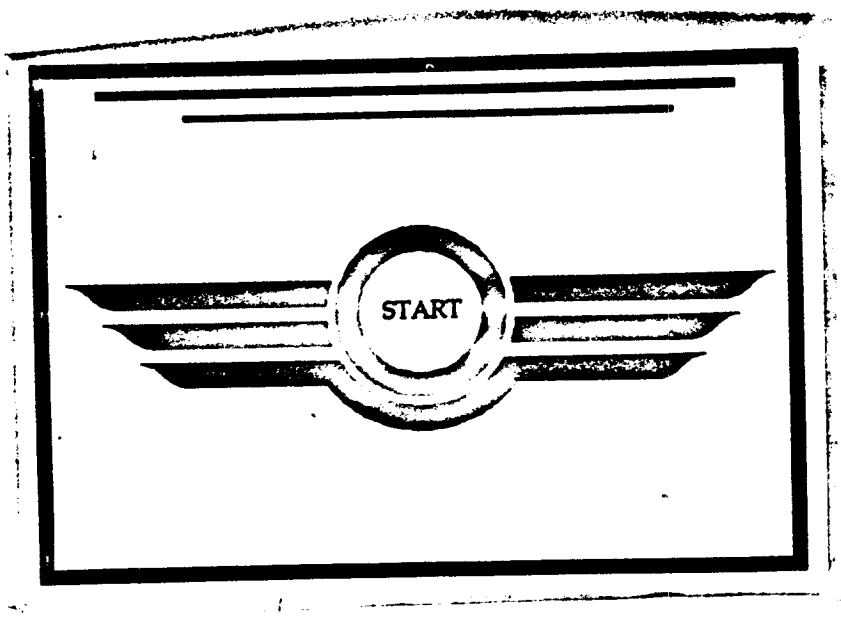

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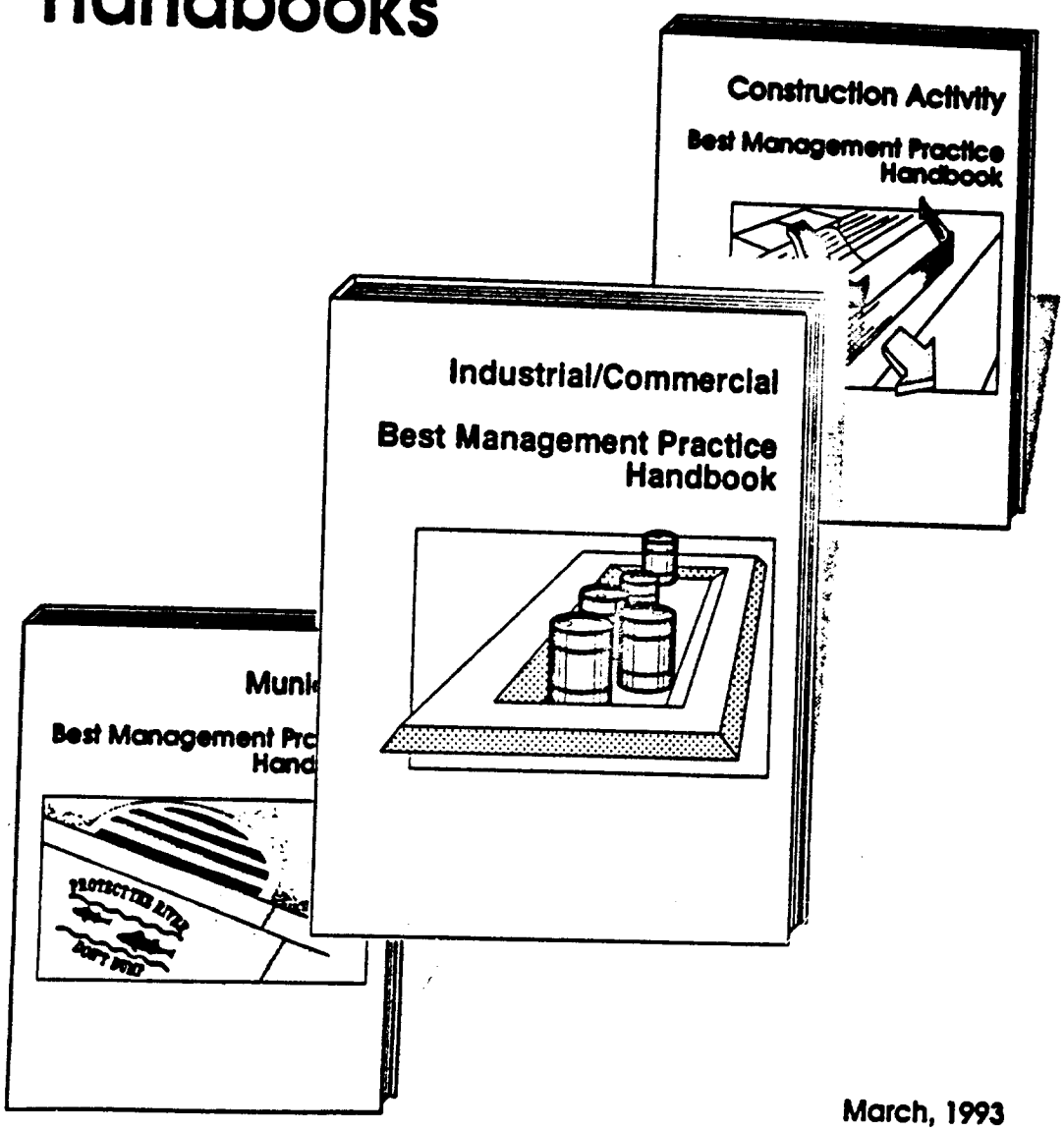

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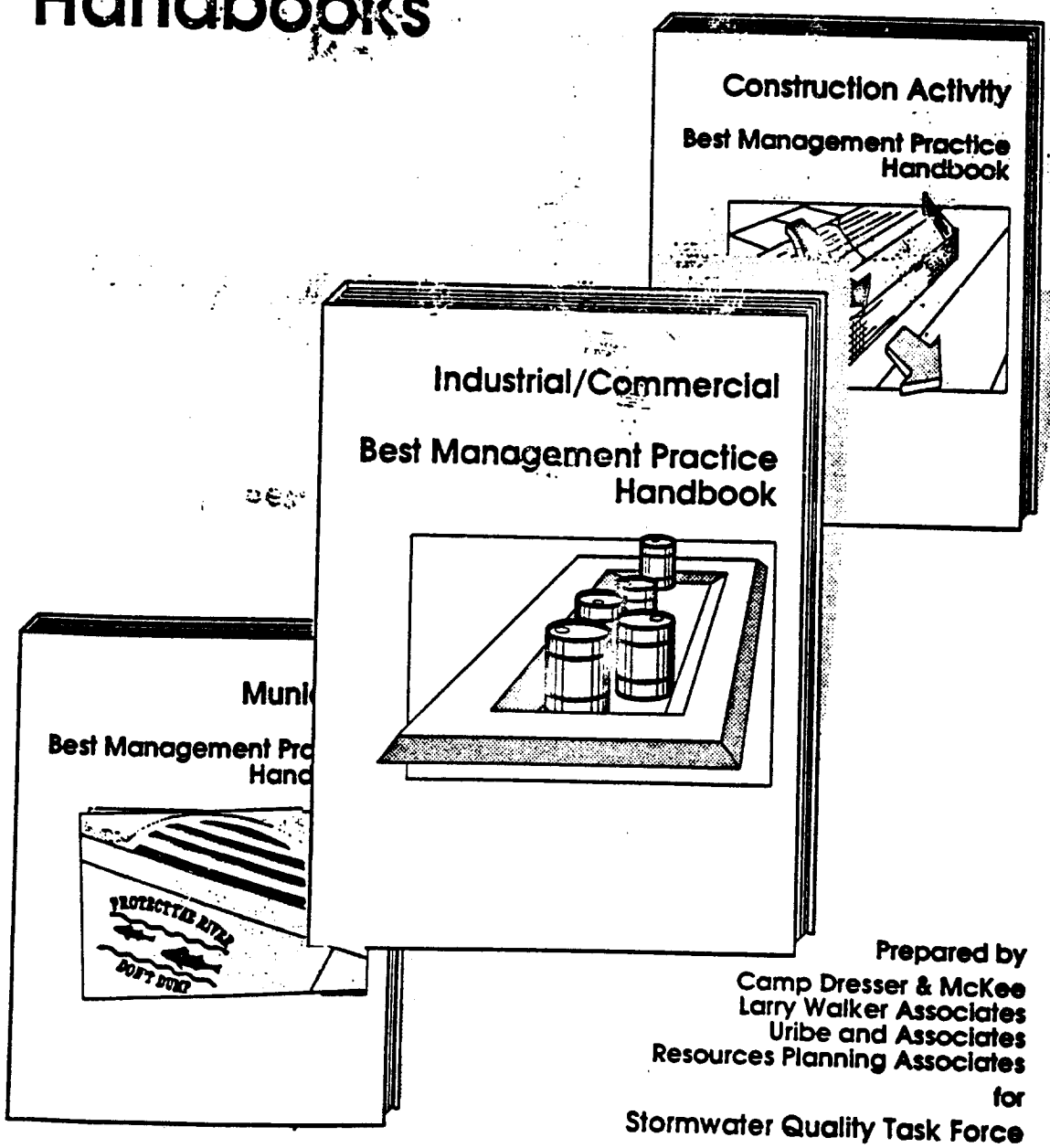

Prepared by
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Stormwater Quality Task Force

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ABSTRACT

The Industrial/Commercial Best Management Practices (BMPs) Handbook presents specific guidance on selecting best management practices for reducing pollutants in storm water discharges from industrial and commercial activities. The primary audience of the handbook is the operators/owners of the industries that are required to obtain a State of California NPDES general permit for storm water discharges. The handbook outlines a procedure and provides worksheets for preparing a Storm Water Pollution Prevention Plan (SWPPP) as required under the general permit and for selecting BMPs that become a part of the SWPPP.

Detailed fact sheets are provided for the BMPs which include information regarding where they should be applied, what are the targeted pollutants of the BMP, design criteria (when applicable), and examples of their application. The handbook also gives guidelines for measuring the BMP performance.

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FOREWORD

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from storm water is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination (NPDES) permit. The 1987 amendments to the CWA added Section 402(p) which established a framework for regulating municipal, industrial, and construction storm water discharges under the NPDES program. In California, these permits are issued through the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCB). In general, municipalities with a population of over 100,000, industries which have been identified by the Environmental Protection Agency to be a probable source of storm water pollutants, and construction projects that disturb more than five acres must obtain an NPDES permit.

The SWRCB and California members of the American Public Works Association (APWA), recognizing the complex issues involved with developing and implementing an NPDES permit system from storm water discharges, formed the Storm Water Quality Task Force to work as a team to develop a state regulatory program that complies with federal requirements, addresses California's unique demography, topography and climatology, and is affordable for the permittee. The Task Force, in turn, identified the need to have a State handbook to guide permittees in selecting Best Management Practices (BMPs) to reduce pollutants in storm water discharges. This series of Storm Water Best Management Practices Handbooks was funded by members of the Task Force and is directed specifically at developing and implementing storm water quality management programs in California.

The Handbook consists of three volumes:

- Volume 1: Municipal BMP Handbook - Addresses storm water quality management for most municipal activities, particularly those required under the NPDES municipal permit program.

- Volume 2: Commercial/Industrial BMP Handbook - Addresses storm water quality management for facilities that are (or will eventually be) covered by a NPDES general permit for industrial activities.

- Volume 3: Construction BMP Handbook - Addresses erosion control and other storm water quality management concerns required under a NPDES general permit for construction activities.

Each handbook is comprised of six chapters. Chapter 1 describes the pertinent regulations regarding the NPDES permit and defines who must obtain a permit. Chapter 2 describes how to develop a Storm Water Management Program or Storm Water Pollution Prevention Plan, while Chapter 3 provides guidance on the selection of BMPs for the plan. Chapters 4 and 5 describe the details of individual BMPs. Chapter 6 gives guidelines for measuring BMP performance. While the handbooks are meant to provide guidance to regulators and permittees, it should be understood that any final interpretation of the regulations will be done by the appropriate Regional Water Quality Control Board.

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ACKNOWLEDGEMENTS

This Handbook was prepared under the direction of Dr. Larry Roesner, Officer-in-Charge, Camp Dresser & McKee Inc. (CDM) and Malcolm Walker, Project Manager, Larry Walker Associates (LWA). Principal authors were Dr. Gary Minton, Resource Planning Associates; Geoff Brosseau, Uribe & Associates; and John Aldrich, CDM. In addition Dr. Robert Brashear, Ed Glass, and Mike McKay of CDM; and Dr. Kenneth Kerri of California State University, Sacramento contributed portions of the handbook. The assistance of Carol Pace, Eric Zeigler and Charlene Huffaker (LWA) is especially appreciated and acknowledged.

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Alameda County Public Works Agency

Fresno Metropolitan Flood Control District

City of Los Angeles

Los Angeles County Department of Public Works

Riverside County Flood Control and Water Conservation District

County of San Bernardino Environmental Public Work Agency

City of San Diego

Contra Costa County Flood Control

Orange County Storm Water Program

Santa Clara Valley Water District

City of Modesto

City of Sacramento

Sacramento County Water Resources Division

City of Monterey

Placer County Flood Control and Water Conservation District

Project Officer was Jack Lindley of Alameda County Public Works Agency and the State Contract Officer was Sid Taylor assisted by Marla Lafer of the SWRCB.

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Municipal Handbook

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Construction Handbook

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Mission Viejo Company

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San Diego Construction Industry Federation

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Industrial Handbook

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Tom Cooper
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Regulatory

Tom Mumley
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INDUSTRIAL HANDBOOK

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Chapter 1

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1. INTRODUCTION

Storm water runoff is part of a natural hydrologic process. However, human activities, particularly urbanization and associated industrial activities, can alter natural drainage patterns and add pollutants to rivers, lakes, and streams. Recent studies have shown storm water runoff is a significant source of water pollution, causing declines in fisheries and restrictions on swimming, and limiting our ability to enjoy many of the other benefits that water provides (USEPA, 1992).

For many years the effort to control the discharge of storm water focused on quantity (e.g., flood control), and to a limited extent, on quality of the storm water (e.g. sediment and erosion control). In recent years awareness of the need to improve water quality has increased. With this awareness Federal, State, and local programs have been established to pursue the ultimate goal of reducing pollutants contained in storm water discharges to our waterways. The emphasis of these programs is to promote the concept and the practice of preventing pollution at the source, before it can cause environmental problems (USEPA, 1992). However, where further controls are needed, treatment of contaminated runoff could be required.

PURPOSE AND SCOPE OF THE HANDBOOK

This handbook provides general guidance in developing and implementing best management practices (BMPs) for storm water quality at industrial sites. These include both source control BMPs and treatment control BMPs. As will be discussed in the following sections, Federal and State programs require selected industries to obtain a National Pollutant Discharge Elimination System (NPDES) permit and to prepare a Storm Water Pollution Prevention Plan (SWPPP) which includes the identification and implementation of various BMPs. It is not the intent of this handbook to dictate the actual BMPs (this will be done by the owner and/or operators of the industrial facilities), but rather to provide the framework for selecting the appropriate BMPs for a given situation.

In addition, the use of the handbook does not ensure that the user will be in compliance with the requirements of its NPDES permit. Such compliance can only be provided through a review and concurrence of the appropriate Regional Water Quality Control Board.

This handbook primarily addresses the requirements of the storm water program as developed from section 402 (p) of the Clean Water Act. There are, however, other Federal and State programs that either directly or indirectly regulate the discharge of storm water from industrial sites. The handbook provides a reference rather than a comprehensive review of these programs.

USERS OF THE HANDBOOK

The primary users of this handbook are the operators/owners of the industries that are required pursuant to regulations to obtain a NPDES permit for storm water discharges. In addition, operators/owners of other industries, not identified in the regulations, will find this handbook useful in selecting BMPs for their sites or activities.

ORGANIZATION OF THE HANDBOOK

The organization of this handbook is intended to be a logical sequence of steps that the owner/operator of an industrial facility would

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follow to comply with the State of California General Permit.

- In Chapter 1, the handbook user learns why storm water management is important as it provides a basic primer of what pollutants are found in storm water and their impact on the environment. The user is also introduced to the various Federal, State, and local storm water programs that impact the industry.

- In Chapter 2, the user learns what a SWPPP is and how to prepare one. A six step program is identified and worksheets are provided to assist the user.

- Chapter 3 serves as a compliment to Chapter 2 by identifying a process that the user may follow to select BMPs that become a part of the SWPPP.

- In Chapters 4 and 5, the BMPs are described in detailed fact sheets. The user, by carefully reviewing these BMP fact sheets, will be able to select BMPs appropriate for the industrial situation.

- Finally, in Chapter 6, the user learns how to evaluate the effectiveness of the BMPs that are implemented at the industrial facility.

DEFINITIONS

Many of the common definitions for storm water control methods are found in the Glossary (see Appendix E). Throughout the handbook the user will find references to the following terms:

- *NPDES General Permit for Storm Water Discharges*. NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the national program for administering and regulating Sections 307, 318, 402 and 405 of the Federal Clean Water Act (CWA). In California, the State Water Resources Control Board (SWRCB) has issued a general permit for storm water discharges associated with industrial activities (see Appendix A).

- *Notice of Intent (NOI)* is a formal notice to the SWRCB submitted by the owner/operators of existing industrial facilities. The NOI provides information on the permittee, location of discharge, type of discharge and certifies that the permittee will comply with conditions of the Industrial General Permit. The NOI is not a permit application and does not require approval.

- *The Storm Water Pollution Prevention Plan* consists of a series of phases and activities to, first, characterize your site, and then, to select and carry out actions which prevent the pollution of storm water discharges.

- *A Best Management Practice* is defined as any program, technology, process, siting criteria, operating method, measure, or device which controls, prevents, removes, or reduces pollution.

- *Source Control BMPs* are operational practices, that prevent pollution by reducing potential pollutants at the source. They typically do not require maintenance or construction.

- *Treatment Control BMPs* are methods of treatment to remove pollutants from storm water.

WATER QUALITY POLLUTANTS AND THEIR IMPACTS

Pollutants most frequently associated with storm water include sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, heavy metals, other toxic chemicals, and floatables. These pollutants and their impacts on water quality and aquatic habitat are described as follows:

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- *Sediment* is a common component of storm waters, and is a pollutant in its own right. Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, and reproduction. In addition, sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons (APWA, 1981). Sediment is the primary component of total suspended solids (TSS), a common water quality parameter.

- *Nutrients* including nitrogen and phosphorous are found in storm water. These nutrients can result in excessive or accelerated growth of vegetation or algae resulting in impaired use of water in lakes and other sources of water supply. For example, nutrients have led to a loss of water clarity in Lake Tahoe. In addition, unionized ammonia (one of the nitrogen forms) can be toxic to fish.

- *Bacteria and viruses* are common contaminants of storm water. For separate storm drain systems, main sources of these contaminants are animal excrement and sanitary sewer overflow. High levels of coliform bacteria in storm water have led to the closure of waterways including beaches as experienced in Santa Monica Bay.

- *Oxygen Demanding Substances* including plant debris (such as leaves and lawn-clippings), animal excrement, street litter, and organic matter are commonly found in storm water (USEPA, 1992; Woodward-Clyde, 1990). Such substances depress the dissolved oxygen levels in streams, lakes, and estuaries.

- *Oil and grease* contain a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations (Woodward-Clyde, 1990). Main sources of oil and grease are leakage from engines, spills at fueling stations, overfilled tanks, restaurants and waste oil disposal (Berman, L., et al, 1991).

- *Lead, zinc, cadmium, and copper* are the heavy metals found most commonly in storm water. Chromium and nickel are also frequently present (USEPA, 1983). Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies (see Table 1.1). Storm water runoff is considered a major contribution of metals that have accumulated in the sediment of South San Francisco Bay. This accumulation has resulted in restricted water uses and impaired aquatic habitat.

TABLE 1.1 RUNOFF CONCENTRATIONS AND WATER QUALITY OBJECTIVES (ug/l) OF VARIOUS METALS FROM INDUSTRIAL SITES

METALS	WATER QUALITY OBJECTIVE (a)	INDUSTRIAL SITES (b)
CADMIUM	0.66 (c)	5.5
CHROMIUM (d)	11	33
COPPER	6.5 (c)	49
LEAD	1.3 (c)	121
NICKEL	88 (c)	48
ZINC	59 (c)	1324

(a) Freshwater aquatic life 4-day average objective from California Inland Surface Waters Plan. Objectives are written in terms of total recoverable concentrations. Runoff concentrations are total concentrations.
(b) Concentrations reported as median values (Woodward-Clyde, 1989).
(c) Objective is calculated based on an assumed hardness in the receiving water of 50 mg/L as $CaCo_3$.
(d) Objective is for hexavalent chromium.

- *Other toxic materials* (priority pollutants) may be found in storm water in low concentrations. Pesticides, phenols, and polynuclear or polycyclic aromatic hydrocarbons (PAHs) are the most frequently found in storm water (City of Seattle, 1989).

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- *Floatables* in storm water are pollutants that may contain significant amounts of heavy metals, pesticides, and bacteria. Typically resulting from street refuse or industrial yard waste, floatables also create an aesthetic "eye sore" in waterways or detention basins.

STORM WATER PROGRAMS

The need to protect our environment has resulted in a number of laws and subsequent regulations/programs. At times, this has resulted in overlap and ambiguity between the programs. This situation is true for storm water programs. The Federal Clean Water Act, as amended in 1987, is the principal vehicle for the control of storm water pollutants. There are, however, other programs that directly or indirectly deal with the control of storm water pollutants. Examples include: Federal Coastal Zone Act Reauthorization Amendments of 1990, and the State Hazardous Waste Source Reduction and Management Review Act. In addition, the implementation of storm water programs must take place at a number of levels: federal, state, local, and industrial. The industrial owner and operator must understand the relationship between the agencies, their jurisdictions, and the requirements of each.

In the following section, various programs are discussed in relationship to the control of pollutants in storm water. The discussion, however, is not conclusive and the user is advised to contact local regulatory officials for further information.

FEDERAL NPDES PROGRAM

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, United States Environmental Protection Agency (USEPA) published final regulations that establish application requirements for storm water permits. The regulations require specific categories of industrial facilities (see Appendix B), which discharge storm water associated with industrial activity (industrial storm water), to obtain a NPDES permit. These facilities which discharge industrial storm water either directly to surface waters or indirectly, through municipal separate storm drains, must be covered by a permit. This includes the discharge of "sheet flow" through a drainage system or other conveyance.

FACILITIES REQUIRED TO HAVE INDUSTRIAL GENERAL PERMIT

- "heavy" manufacturing facilities;
- manufacturing facilities if materials are exposed to storm water;
- active and inactive mining and oil and gas facilities;
- recycling facilities;
- transportation facilities;
- facilities subject to the requirements of 40 CFR Subchapter N;
- hazardous waste treatment, storage, or disposal facilities;
- landfills, land application sites, and open dumps;
- steam electric generating facilities;
- wastewater treatment plants with design flows greater than 1 million gallons a day.

STATE NPDES PROGRAM

In California, the NPDES storm water permitting program is administered by the SWRCB through the nine Regional Water Quality Control Boards (RWQCB). For industrial facilities and construction activities, the SWRCB elected to issue a statewide general permit that applies to all storm water discharges requiring a NPDES permit. The San Francisco RWQCB also has a general permit which applies to industries within Santa Clara Valley.

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The two permits are very similar and compliance with one will normally result in compliance with the other. (A copy of the State General Permit is provided in Appendix A). In addition to the storm water industrial general permit, the RWQCB may, at their discretion, issue an industry specific general permit (e.g., San Francisco RWQCB has issued a boatyard general permit). For this reason, the readers are advised to contact their local RWQCB.

Industries may also request an individual NPDES permit instead of the general permit. The process, however, is expensive and time consuming and the RWQCB may choose not to issue an individual permit. RWQCB are only expected to consider individual permits where an individual facility has unique characteristics or poses a significant threat to water quality.

Federal law requires that industrial storm water discharges meet all provisions of Section 301 and 402 of the CWA in order to control pollutant discharges. These provisions require the use of best available technology (BAT) economically available and best conventional pollution control technology (BCT) to reduce pollutants and any more stringent controls necessary to meet water quality standards.

The State of California has interpreted Federal regulations to include the use of BMPs to control and eliminate sources of pollutants and limitations which prohibit the discharge of non-storm water. According to the State of California, BMPs are "schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment devices, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste removal, or drainage from raw material storage" (SWRCB, 1991).

The industrial general permitting process can be summarized as follows:

1. Submit a Notice of Intent (NOI) (to be covered by the general permit) to the SWRCB. Notice is given by filling out a three-page NOI form which requires basic ownership information, receiving water information, material handling practices, regulatory status, and a site map.

   New facilities must submit NOI thirty (30) days prior to beginning operation. Existing facilities were required to submit NOI by March 30, 1992. However, the SWRCB will consider accepting NOI from an existing facility after the March 30,1992 date.

   The applicant must also submit a permit fee with the NOI. The amount of the fee, which is subject to change, depends on whether the industrial facility is located within a jurisdiction that has already received an individual NPDES permit. Presently, the fee is $250 for a facility located in a municipality that has a NPDES storm water permit, and $500 otherwise (see box below).

California Counties with NPDES Storm Water Permits(1)

Alameda	Sacramento
Los Angeles	San Bernardino
Orange	San Diego
Riverside	Santa Clara

California Municipalities/Counties Pursuing NPDES Storm Water Permit

Cities		
Bakersfield	Modesto	Stockton
Fairfield	Oxnard	Vallejo
Fresno	Suisun City	
Counties		
Contra Costa	San Mateo	
Kern	Ventura	

(1) Consult with local RWQCB to determine if a municipality within these counties is covered by a NPDES permit.

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2. Industries are then required to develop a SWPPP and a monitoring program for storm water discharges. Existing industries were given until October 1, 1992 to implement the SWPPP. However, industries are encouraged to update and revise their SWPPP as necessary to reflect new information and inadequacies in the original SWPPP.

MUNICIPAL NPDES PROGRAM

Municipalities with a population over 100,000 or those that have been determined to be a significant contributor of pollutants are also required to obtain a NPDES storm water permit. The November 16, 1990 regulations detailed the information required by the municipality to prepare a NPDES permit application. The application is divided into two parts. Part 1, basically, requires the discharger to collect existing information regarding storm water discharges, receiving waters, management programs, fiscal resources, and associated elements. In Part 2, the municipality is then expected to take this information and formulate a storm water management program designed to reduce the discharge of pollutants to the maximum extent practicable.

As part of its storm water management program, the municipality is required to develop a program to monitor and control pollutants in storm water discharges from its municipal system. Such control may include regulating storm water discharges from industrial facilities that the municipality determines are contributing pollutants to the municipal storm drain system. Thus it is important for the industries located within such municipalities to realize that there may be municipal requirements on storm water discharges from their industrial facilities. It is imperative that the industry check with its local authority responsible for storm water management.

OTHER FEDERAL AND STATE PROGRAMS

California Coastal Nonpoint Pollution Control Program

The Coastal Zone Act Reauthorization Amendments of 1990 require states with approved coastal zone management programs to develop and submit a Coastal Nonpoint Pollution Control Program to USEPA and National Oceanographic and Atmospheric Administration (NOAA) for approval. The purpose of the program is to work closely with other state and local authorities to develop and implement management measures for nonpoint source pollution including urban runoff to restore and protect coastal waters. Coastal storm water control programs are not intended to supplant existing coastal zone management programs or nonpoint source management programs. Rather, they are to serve as an update and expansion of existing nonpoint source management programs and are to be coordinated closely with the existing nonpoint source management programs (USEPA, 1991). In California, the Coastal Commission and Water Quality Control Board are responsible for the development and implementation of this program.

National Estuary Program

USEPA administers the National Estuary Program under Section 320 of the Clean Water Act. This program focuses on all pollutant sources in geographically targeted, high priority estuarine waters. In this program, USEPA assists state, regional, and local governments to develop comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters (USEPA, 1991). The USEPA (Region 9), SWRCB, and RWQCBs are responsible for administering the California program.

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Pesticide Program

The USEPA also administers the pesticide program under the Federal Pesticide, Fungicide, and Rodenticide Act. Among other things, this program authorizes the USEPA to control pesticides (often found in storm water) that may threaten ground and surface water (USEPA, 1991). Potential actions carried out under this program include national requirements on labels, additional training, development of State Management Plans, and national prohibition of certain domestic uses of chemicals.

Hazardous Material/Waste Control Programs

There are numerous laws and regulations regarding the control of hazardous material and waste. Some of these programs, in turn, have a direct or indirect impact on an industrial facility's effort to control pollutants in storm water discharges. The following programs provide examples of how the hazardous control programs can be used to reduce storm water pollutants. The list, however, is not comprehensive and the user is advised to review carefully their hazardous material and waste control programs to determine the applicability of these programs to the storm water program.

- Hazardous Materials, Storage, and Emergency Response. The program regulates hazardous materials storage and emergency response planning. A company's annual Business Plan must include hazardous material (hazmat) inventory, estimates of hazardous waste amounts, and emergency response planning. Much of the information provided in the Business Plan is applicable to the SWPPP.

- Workers Right-to Know. Under this program, the employee is advised through the use of material safety data sheets (MSDS), material labeling, and employee training of the potential for contact with hazardous substances. Such training can be expanded to include issues regarding source control of storm water pollutants.

- Hazardous Waste Source Reduction and Management Review. Under this program, hazardous waste generators must look at source reduction as the preferred way of managing waste. The industry must prepare a "source reduction evaluation review and plan" which identifies all hazardous waste streams and potentially viable source reduction approaches. Again, this plan can serve well for the storm water program because of its emphasis on source reduction.

Wetlands and Groundwater

The SWRCB is the primary state agency in matters of water quality. State policies set forth by the SWRCB are administered by the Regional Water Quality Control Boards. RWQCB may also set water quality policy specific to their regions. These policies pertain to a wide variety of water quality and quantity issues. The NPDES program applies to all discharges to surface waters including wetlands. Storm water discharges may also pose a threat to groundwater. In such cases, the RWQCB may impose waste discharge requirements on storm water discharges to protect groundwater or wetlands.

The SWRCB has not yet formed a policy covering the use of artificial wetlands for storm water treatment. Important considerations for those constructing artificial wetlands for the treatment of storm water include:

- Creation of beneficial uses may result in a requirement to preserve and protect those beneficial uses, even if the source of water is artificial.

- Wetlands can act as sinks for pollutants. Constructed wetlands must be designed to facilitate maintenance, and regular maintenance must occur before levels become toxic to wildlife.

For the reasons stated above, consultation with the RWQCB and SWRCB is important during the planning phase of a project.

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Air Quality Programs

Deposits from the atmosphere are a contributing cause of storm water pollution. Source control of automobile and industrial emissions is required to reduce this source of contamination (Woodward-Clyde, 1990). Consequently, efforts to reduce air emissions at an industrial facility may have an added benefit of reducing pollutants in the storm water discharge. In California, the local air quality management districts set the standards for fixed sources while the State Air Resources Board provides the standards for mobile sources and toxic contaminants.

Of additional concern are air emissions from storm water conveyance (e.g., pipes, channels, etc.), detention, and treatment facilities. Such emissions may come under regulation by the local air quality management districts. Construction of new facilities may require compliance with "Toxics New-Source Review Rules." These rules apply to new or modified municipal wastewater treatment facilities (as well as any other new "stationary source" of emissions) and require such facilities to obtain a permit from the local district. Stationary sources are also required to participate in the "Air Toxics Hotspots Information and Assessment" program. Consult the local air quality management district for information regarding applicability of these regulations to storm water facilities.

Spill Prevention and Clean-up Plans

Federal regulations require on-shore facilities engaged in operations that could reasonably be expected to discharge oil in harmful quantities to prepare Spill Prevention Control and Countermeasure (SPCC) Plans. In addition, NPDES regulations for some industrial activities require SPCC Plans as part of the facility's BMP program. Elements from these SPCC Plans can be incorporated into a facility's SWPPP.

OTHER LOCAL PROGRAMS

Fire Code Requirements

Local fire codes may regulate materials with a potential to cause pollution of storm water. Many local fire districts have adopted the Uniform Fire Code (UFC). All local districts are required to enforce Article 79 of the UFC which regulates flammable and combustible liquids. Depending on the portions of the UFC adopted by a particular fire district, it may also be responsible for enforcement of regulations regarding hazardous materials. Consult your local fire district for more information.

Drainage to Sanitary Sewers

Storm water typically cannot be discharged to the local separate sanitary sewer. However, local sanitary districts may permit the discharge of non-storm water discharges (or dry weather flows) to the sanitary sewers. The requirements and conditions under which such discharges may take place will depend on the local district. Your local sanitary district must be consulted prior to any discharge.

Drainage Requirements

Local jurisdictions will also have drainage requirements for building improvements. The requirements will vary from jurisdiction to jurisdiction. In general the jurisdiction will define post-development runoff, design storm event, and design specifications for sizing drains and detention basins. Consequently, the development of the storm water program under the NPDES program should be complemented with the drainage limitations of the local jurisdiction. Otherwise, the drainage patterns may be negatively impacted and result in flood damage. Consultation with your local jurisdiction is imperative if runoff patterns are changed.

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Spill Prevention and Clean-up Plans

As a result of numerous Federal and State regulations, municipalities require industry Business Plans to include procedures to mitigate a release or threatened release of hazardous materials. These spill prevention and clean-up plans are ideally suited for the prevention of storm water pollution.

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Chapter 2

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2. HOW TO PREPARE A STORM WATER POLLUTION PREVENTION PLAN

INTRODUCTION

Chapter 2 provides a six step process to develop a Storm Water Pollution Prevention Plan (SWPPP). Presented here is a brief overview.

Step 1: Do you have to complete a SWPPP? - The first step is to determine if you have to prepare a SWPPP. Those businesses that fit the categories described in the General permit must prepare a SWPPP (see Appendix B).

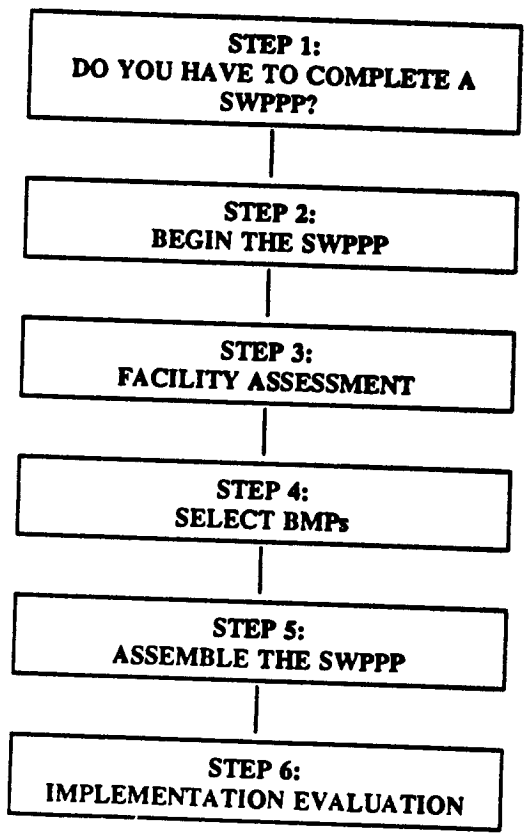
Step 2: Begin the SWPPP - The second step involves identifying the SWPPP Leader, forming a Pollution Prevention Team, and gathering existing relevant reports, information, data, and drawings.

Step 3: Facility Assessment - The SWPPP Leader with the assistance of the Pollution Prevention Team conducts an assessment of the facility, drainage patterns, identifying activities of concern, and the presence and effectiveness of Best Management Practices (BMPs) already in-place. Worksheets for conducting an assessment are provided at the end of this chapter.

Step 4: Select Best Management Practices - BMPs are selected to deal with the identified sources of storm water pollution. Emphasis is placed on source control BMPs with the adoption of treatment control BMPs if only clearly needed.

Step 5: Assemble the SWPPP - All of the information, data, and analysis are assembled into the SWPPP. Implementation and evaluation procedures are defined. Roles and responsibilities are defined. Legal requirements such as signatures of responsible parties are obtained.

Step 6: Implement and Evaluate - The SWPPP is implemented and its effectiveness evaluated. Adjustments are made in the SWPPP to redress observed inadequacies.



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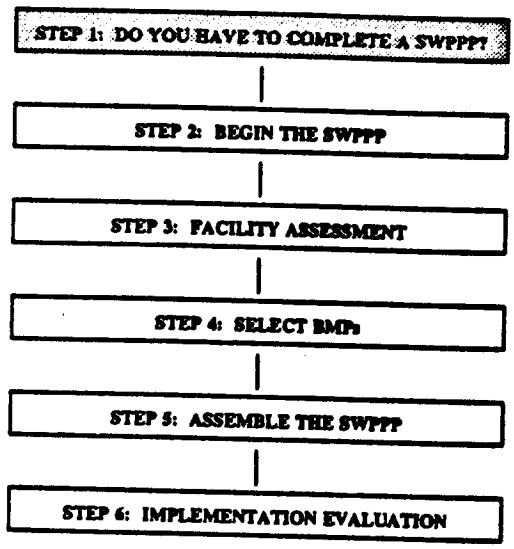
STEP 1:
DO YOU
HAVE TO
COMPLETE A
SWPPP?

Appendix B provides a list of industrial activities that are subject to the NPDES general permit which includes the preparation of a SWPPP. Table 2 of the appendix is a list of industrial activities that require the facility, where these activities take place, to have a NPDES permit while, Table 3 of the appendix provides a list of industrial activities that could possibly fall under the NPDES permit. In either event, the facilities where these industrial activities take place have the option of obtaining an individual NPDES permit or a general permit. It should be noted that some industrial activities although not listed in Appendix B should practice effective water pollution prevention and may be required to have a permit in the future. Also government owned or operated facilities that contain the activities listed in Appendix B are required to obtain a general permit and to prepare a SWPPP.

The critical decision to be made by the business that owns the facility is the classification of the facility by Standard Industrial Classification (SIC) code. In many instances, the SIC code is assigned based on the primary activity of the business and not the facility activity. Consequently, the SIC code has little resemblance to the activities actually occurring on site.

In California, the decision whether a facility is required to obtain a general permit is determine by what activity takes place on the site. It is the industrial activities at the facility site (and subsequent SIC code classification) that determine whether a general permit is required not the primary business of the facility owner. For example, a school district must obtain a general permit for its bus maintenance facility even though the primary business of the district is education.

Many businesses in California already have NPDES permits for storm water. These



permits were issued because the businesses either belong to a category for which Federal regulations were previously established, or because a problem was identified by the respective Regional Water Quality Control Board (RWQCB). RWQCBs have the authority to require a NPDES permit of any facility that is discharging storm water, not just those identified in Appendix B.

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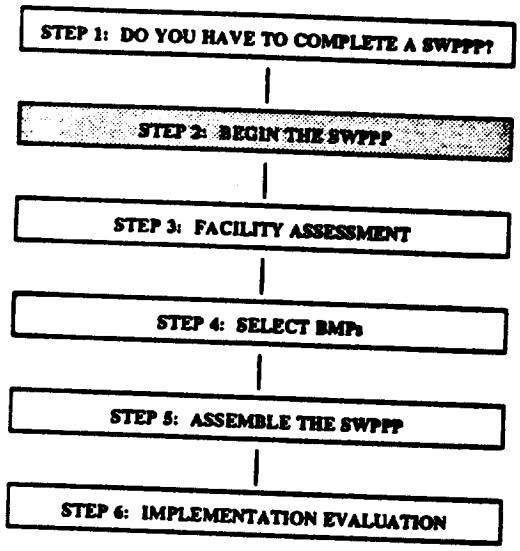
STEP 2: BEGIN THE SWPPP

The development of a SWPPP is not intended to be a complicated and expensive process, and the facility should look to doing as much of the SWPPP as possible. Technical consultants are available and can be a valuable asset. However, facility personnel should first become aware of the permit requirements, demonstrate site awareness as it relates to SWPPP, and be familiar with the BMPs that will be implemented. By taking this approach, facility personnel will be able to identify specific technical assistance more appropriate for a technical consultant. In any event, the following four things should be done first:

1. **Decide who will develop and implement the SWPPP.** If the facility is small, an individual may be sufficient. If the facility is large or complex, it would be better to designate a Pollution Prevention Team under the leadership of one individual. The size and composition of the team should be appropriate to the complexity of the facility. The team should consist of representatives from all departments, at all levels, that will have a role in implementing the SWPPP. The role of each member should be specified. The Pollution Prevention Team may have personnel that overlap with related pollution control responsibilities such as a spill prevention and response team.

   The SWPPP should contain a statement of management's policy and responsibilities for implementing the SWPPP, the responsibilities of each division, and the members of the Pollution Prevention Team.

2. **Review Appendix A for specifications on the content of the SWPPP.** Items of particular significance include: site map(s) showing the topography and drainage system, narrative description of the facility relevant to the potential for storm water pollution, list of pollutants that may reach the storm water, facility size, significant spills or leaks of toxic and hazardous pollutants to storm water that have occurred after November 19, 1988, existing sampling data, and existing and proposed BMPs.



3. **Gather background information.** The Team Leader should assemble the information and currently available data to be used in Step 3, Facility Assessment. This may include drawings of the facility's drainage system indicating locations of conveyance systems and drainage surveyor's boundaries; storm water quality data previously collected; requirements of the RWQCB regarding the surface water body into which the facility discharges, etc.

4. **Identify related environmental management plans and regulations.** These may include air pollution control, spill prevention and response, OSHA, fire code, and temporary storage of hazardous waste and materials. The Pollution Prevention Team should consider in Step 3 how these various plans affect, integrate with, or conflict with the SWPPP.

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STEP 3: FACILITY ASSESSMENT

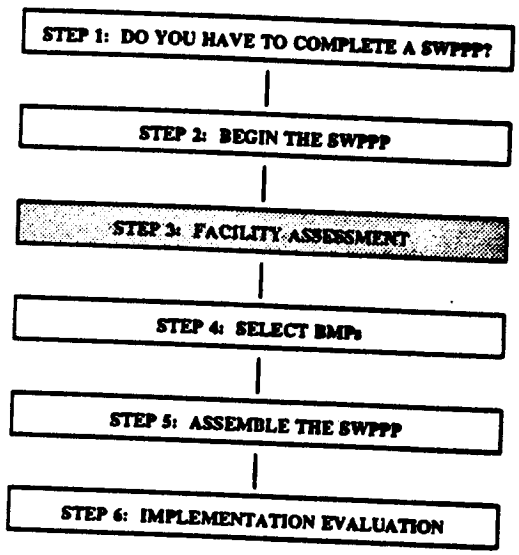
Use the Pollution Prevention Team to the maximum extent possible to assess the facility. The team is a likely wealth of information and will aid in the preparation of the worksheets. Including the team throughout the development of the SWPPP makes it more likely that they will understand, support, and therefore implement the SWPPP.

The recommended approach for determining which BMPs to use is to identify key activities or activity areas that are likely sources of pollutants. The BMPs are grouped in Chapter 4 according to the key activities which are introduced later in this section. The Team Leader proceeds as follows with involvement by the Pollution Prevention Team to the maximum extent possible.

1. **Prepare a preliminary site map.** A base map of the facility is most likely already available which shows the location of buildings and key surface facilities. Show the storm water conveyance systems with the location of the discharge outfall(s) and the drainage boundary to each outfall. Some field work will likely be necessary.

   Although facilities often have drawings of the drainage system, the drainage boundaries are usually not indicated. A level and rod can be used to quickly delineate the boundaries. Locations of all catch basins should be identified. Note areas where sheet flow directly enters the subject water body. Show treatment control BMPs (Chapter 5) already in place.

   Note buildings and/or activities that may be sources of non-storm water discharges to the storm water system: process wastewater, non-contact cooling water, wash water, sanitary wastewater. These possibilities may be inferred from such things as the age of each facility building with older buildings more likely to have inappropriate connections. Remodeling may have resulted in inadvertent connections of non-storm lines to the storm drains.



2. **Complete a Materials Inventory** (see Worksheets 1 and 2 on pages 2-9 and 2-10). How materials are stored and handled has a bearing on the potential for water pollution. A knowledge of the type and location of materials will provide insight into the pollutants likely to be present. Completing Worksheets 1 and 2 may be useful in this regard. Worksheet 1 lists all materials whereas Worksheet 2 lists only those significant materials that are regularly exposed to storm water. See the Glossary for a definition of "significant".

3. **Complete a Spills Inventory.** The SWPPP must include a history of significant spills since November 19, 1988. Worksheet 3 may be useful for this requirement. The word "significant" requires interpretation. List releases of oil or hazardous substances in excess of reportable quantities. Superfund Amendments and Reauthoization Act (SARA) Title III, Section 313 facilities must describe releases of "water priority" chemicals to land or water that have

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occurred during the three years prior to permit issuance.

Although you are required to include in the SWPPP only the significant spills, identifying areas where smaller spills occur frequently is also useful. Note on the site map the areas where repeated spills have occurred, or where the risk of spill is particularly significant.

4. **Begin an Activities Checklist.** Worksheet 4 lists activities following the format of Chapter 4, and provides space to indicate BMPs already in place. Check Chapter 4 for the BMPs relating to each activity area to see if you are already using them. Make some judgment as to whether they are 100% effective at this time, or how they might be improved if necessary. Mark the area of each activity on the preliminary site map. Completing the Activities Checklist facilitates BMP selection (Step 4). Completion of the checklist can be done with input from the Pollution Prevention Team and by touring the facility site.

5. **Conduct a facility site tour to confirm or locate activities.** Confirm the existence and nature of activities noted in Worksheet 4, and the nature of existing BMPs for each activity. Confirm the as-built drawings of the drainage system. During the tour, answer the following general questions:

   - Are catch basins full of sediment and not being cleaned regularly?
   - Does the facility show signs of poor housekeeping such as accumulated debris in open areas that is not being swept, uncovered materials, etc.?
   - Are there signs of spills, pools, stains, or other traces of fuels and chemicals that have been spilled?
   - Do you find leaking equipment, pipes, containers, or lines?
   - Do storage containers show signs of leakage?
   - Are containers and exposed piping labeled?
   - Are clean-up tools readily available (drip pans, absorbents, rags, etc.).

   Also complete Worksheet 5 which is a useful tool for identifying the BMPs that deal with the minimum requirements specified in the general permit. Note any flows present in the drainage system during dry weather as this is an indication of non-storm water discharges.

6. **Identify non-storm water discharges to the drainage system** (Worksheets 6 and 7). Chapter 4 provides a procedure for identifying non-storm water discharges. The regulations require that these be acted upon immediately and therefore the corrective process must begin immediately. You must certify this process. The certification should include: identification of potential non-storm water discharges; a description of the results of any tests for such discharges; the testing method used and the date; the site drainage points that were directly observed during the test. Worksheet 6 may be used for the certification. Allowable non-storm water discharges are presented in Chapter 4.

   If certification is not feasible because you do not have access to some point in the drainage system or because you are in the process of eliminating the discharge, you must notify the RWQCB of the situation. You must notify the RWQCB of any potential sources of non-storm water discharges for which you could not perform the necessary testing and why. Notification to the RWQCB should also include a responsive time schedule to complete elimination. Discharges that are essential to industrial operations, but that cannot be eliminated should be noted. For "essential" discharges you may request and the RWQCB will consider additional general permits. See Appendix A for the specific requirements. Worksheet 7 may help in this regard.

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7. **Summarize existing storm water quality data.** Prepare a list of contaminants that have a reasonable potential to be present in the storm water discharge in significant quantities, and an estimate of the annual quantities of these contaminants.

8. **Conduct more detailed field studies if necessary.** Complex facilities may require extensive field work to locate the drainage systems and outfalls. Some analysis of storm samples including flow measurements may be desirable to obtain a better understanding of the situation.

9. **Complete the site map.** Show on the site map the various activities and their boundaries, particularly if an activity extends across more than one drainage boundary. A series of map overlays may be necessary for complex facilities. Note areas of particular concern.

10. **Consider the potential and relative significance of each activity to cause storm water pollution.** This will be judgmental, based on the relative percentage of area covered by each activity, the nature of the activity, and the types of pollutants.

11. **Complete an Assessment Summary.** Compile all of the above information for review and comment by the Pollution Prevention Team. This summary will serve as the basis for Step 4. You should have sufficient information to determine which areas and/or activities may be contributors to storm water pollution, and which BMPs are most suitable. Prioritization of BMP implementation may also be apparent at this time.

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STEP 4: SELECT BEST MANAGEMENT PRACTICES

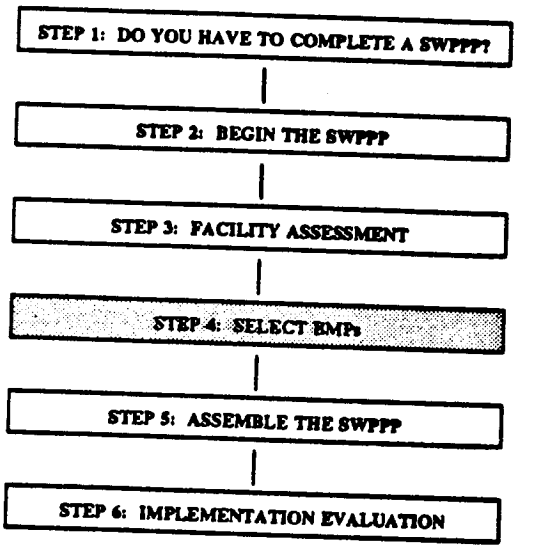
The next step is to select BMPs. BMPs are measures to prevent or mitigate pollution. They are very broad class of measures, many of which may already be use for reasons unrelated to storm water pollution. The selection process is introduced here but covered in detail in Chapter 3.

The permit states that compliance will be achieved if you have: (1) completed a SWPPP consistent with the content requirements identified in Appendix A; (2) terminated non-storm water discharges to the storm water system; and (3) implemented BMPs which are sufficient to meet numeric effluent standards for those industries for which such standards have been developed (see Appendix A).

BMPs can be placed into two groups: Source control and Treatment control. Source control BMPs (Chapter 4) are those that prevent contact between the storm water and the pollution source, or capture and handle the pollutant runoff before it reaches a drainage system. Examples include:

- Moving an outdoor operation indoors.
- Placing storage containers for recyclable oil in a shed or under a lean-to.
- Labelling containers and exposed piping
- Using drip pans.
- Preventing runoff of storm water from a clean area across a potential source of pollution.

Treatment control BMPs (Chapter 5) treat the storm water to remove the pollutant (referred to as "storm water management practices" in the general permit). Examples include catch basins with sumps, oil water separators, and grass swales.



BMPs must be selected that, at minimum, cover these general areas:

- good housekeeping,
- preventive maintenance,
- spill prevention and control,
- sediment and erosion prevention.

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STEP 5:
ASSEMBLE
THE SWPPP

Completing the SWPPP requires several actions.

Prepare the Implementation Plan

Chapter 6 provides detailed suggestions on how to implement and evaluate the relative success of the SWPPP. The general permit does specify that you:

- Designate the personnel responsible for carrying out the SWPPP.
- Develop an inspection process to determine if BMPs are being implemented.
- Keep records of the inspections, follow-up actions, and implementation of the BMPs.
- Train staff so they understand the SWPPP.

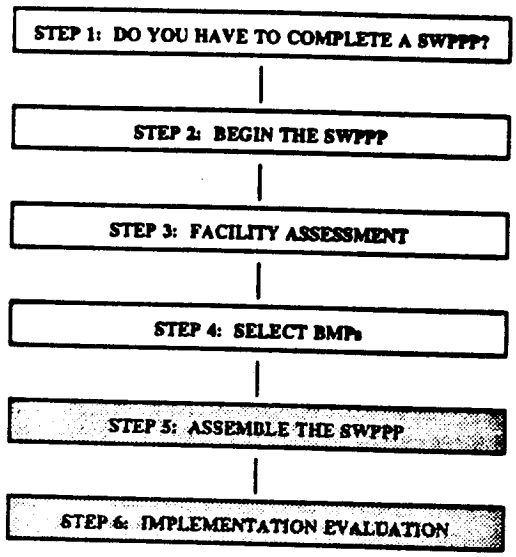
Action must be taken immediately with non-storm water discharges to the storm water system. You options: eliminate the discharge, reclaim or reuse the water, discharge to a sanitary sewer, or apply for a NPDES permit.

Obtain Required Signatures

The SWPPP is to include the signature and title of the person responsible for the SWPPP, the dates of its initial preparation and each amendment (see Appendix A, Section C).

Determine Plan Location

An official copy of the SWPPP is to be located at the facility, not off-site. However, if an office is not located at the facility (e.g., landfill), then the SWPPP should be kept at the appropriate administrative office. The SWPPP is primarily for use by the Pollution Prevention Team, not the RWQCB or the public. Therefore, locating the SWPPP off-site would negate its purpose. However, a copy of the SWPPP must be submitted to the RWQCB on request or be available for review should a representative of the RWQCB come on-site. The SWPPPs are considered to be available to



the public pursuant to Section 308(b) of the Clean Water Act, and therefore are available to the public at the RWQCB office when SWPPPs have been submitted to the RWQCB.

Provide for Plan Modifications

The RWQCB can require changes in the SWPPP. Upon reviewing the SWPPP, the Board may find that it does not meet one or more of the requirements set forth in Appendix A. The Board will notify you of the deficiencies. Modifications must be made to the SWPPP with 30 days of notification, unless the notification provides a different period.

STEP 6:
IMPLEMENTATION
EVALUATION

Finally, implement the SWPPP. It is important, as well as required by the general permit, that the frequent inspections occur to check if BMPs are being implemented, and to evaluate their relative effectiveness (see Chapter 6).

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MATERIAL INVENTORY

(Adopt from EPA, 1992)

Worksheet No. 1
Completed By:_____
Title:_____
Date:_____

Instructions: List all materials used, stored, or produced onsite. Assess and evaluate these materials for their potential to contribute pollutants to storm water runoff. Also complete Worksheet 3 if the material has been exposed during the last three years.

Material	Purpose/Location	Quantity (units)		Quantity Exposed in Last 3 Years*	Likelihood of contact with storm water.	Past Significant Spill or Leak**	
		Used	Produced			Yes	No

* Explain on separate sheet if quantity was more than the "minimum?"
** Explain items checked yes on a separate sheet.

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MATERIAL INVENTORY

(Adopt from EPA, 1992)

Worksheet No. 2
Completed By:_____
Title:_____
Date:_____

Instructions: Based on your material inventory, describe the significant materials that were exposed to storm water during the past three years and/or are currently exposed. For the definition of "significant materials" see Appendix E of the handbook.

Description of Exposed Significant Material	Period of Exposure	Quantity Exposed (units)	Location (as indicated on the site map)	Method of Storage or Disposal (e.g., pile, drum, tank)	Description of Material Management Practices (e.g., pile covered, drum sealed)

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SPILLS INVENTORY

(Adopt from EPA, 1992)

Worksheet No. 3
Completed By:_____
Title:_____
Date:_____

Instructions: Record below all significant spills and significant leaks of toxic or hazardous pollutants that have occurred at the facility in the three years prior to the effective date of the permit.

Definitions: Significant spills include, but are not limited to, releases of oil or hazardous substances in excess of reportable quantities.

1st Year Prior

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		

2nd Year Prior

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		

3rd Year Prior

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		

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WORKSHEET #4
ACTIVITIES ASSESSMENT CHECKLIST

Name of Reviewer:	Date:

ACTIVITIES - Check each activity present at site	EFFECTIVENESS		
	HIGH	MED.	LOW
☐ Non-storm water discharges to drains. Describe BMPs in place:			
☐ Vehicle and equipment fueling. Describe BMPs in place:			
☐ Vehicle and equipment washing and steam cleaning. Describe BMPs in place:			
☐ Vehicle and equipment maintenance and repair. Describe BMPs in place:			
☐ Outdoors loading/unloading of liquid materials. Describe BMPs in place:			
☐ Outdoor container storage of liquids. Describe BMPs in place:			
☐ Outdoor process equipment operations and maintenance. Describe BMPs in place:			
☐ Outdoor storage of raw materials, products and byproducts. Describe BMPs in place:			
☐ Waste handling and disposal. Describe BMPs in place:			
☐ Contaminated or erodible surface areas. Describe BMPs in place:			
☐ Building and grounds maintenance. Describe BMPs in place:			
☐ Building repair, remodeling, and construction. Describe BMPs in place:			
☐ Over-water activities. Describe BMPs in place:			

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WORKSHEET #5
CHECKLIST FOR CONSIDERATION OF MINIMUM BMPs

Check which of the following describe your facility.

Name of Reviewer:	Date:

Yes	No	N/A	
☐	☐	☐	Are outside areas kept neat and clean?
☐	☐	☐	Is the facility orderly and neat?
☐	☐	☐	Is process debris removed regularly?
☐	☐	☐	Is the area clear of excessive dust from industrial operations?
☐	☐	☐	Is there no evidence of leaks and drips from equipment and machinery?
☐	☐	☐	Are employees regularly informed of the importance of good housekeeping?
☐	☐	☐	Are catch basins, storm conveyance pipes, and storm water treatment facilities cleaned at the appropriate intervals (see Chapter 5)?
☐	☐	☐	Are good housekeeping procedures and reminders posted in appropriate locations?
☐	☐	☐	Are vehicle maintenance activities kept indoors and kept from "creeping" out the front door of the maintenance shop?
☐	☐	☐	Are containers for chemical substances and for temporary storage of wastes labeled?
☐	☐	☐	Is vehicle and equipment washing done in a designated area so that the wash water can be discharged to the sanitary or process wastewater sewer?
☐	☐	☐	Are regular housekeeping practices carried out?
☐	☐	☐	Is there a spill prevention and response team?
☐	☐	☐	Are appropriate spill containment and cleanup materials kept on-site and in convenient locations?
☐	☐	☐	Are cleanup procedures for spills followed regularly and correctly?
☐	☐	☐	Are used absorbent materials removed and disposed in a timely manner?
☐	☐	☐	Are personnel regularly trained in the use of spill control materials?
☐	☐	☐	Is exposed piping and process equipment regularly inspected and/or tested to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters?
☐	☐	☐	Are drainage ditches or the areas around the outfall(s) free of erosion?
☐	☐	☐	Are unpaved outdoor areas protected from water or wind erosion?

Any items checked "No" require consideration in the selection of BMPs.
N/A = Not Applicable.

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NON-STORM WATER DISCHARGE ASSESSMENT AND CERTIFICATION

(Source: EPA, 1992)

Worksheet #6
Completed by: _____
Title: _____
Date: _____

Date of Test or Evaluation	Outfall Directly Observed During the Test (identify as indicated on the site map)	Method Used to Test or Evaluate Discharge	Describe Results from Test for the Presence of Non-Storm Water Discharge	Identify Potential Significant Sources	Name of Person Who Conducted the Test or Evaluation

CERTIFICATION

I, _____ (responsible corporate official), certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name & Official Title (type or print)	B. Area Code and Telephone No.
C. Signature	D. Date Signed

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NON-STORM WATER DISCHARGE ASSESSMENT AND FAILURE TO CERTIFY NOTIFICATION

(Source: EPA, 1992)

Worksheet # 7
Completed by: _____
Title: _____
Date: _____

Directions: If you cannot feasibly test or evaluate an outfall due to one of the following reasons, fill in the table below with the appropriate information and sign this form to certify the accuracy of the included information.

List all outfalls not tested or evaluated, describe any potential sources of non-storm water pollution from listed outfalls, and state the reason(s) why certification is not possible. Use the key from your site map to identify each outfall.

Important Notice: A copy of this notification must be signed and submitted to the RWQCB within 180 days of the effective date of this permit.

Identify Outfall Not Tested/Evaluated	Description of Why Certification Is Infeasible	Description of Potential Sources of Non-Storm Water Pollution

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations, and that such notification has been made to the RWQCB within 180 days of _____ (date permit was issued), the effective date of this permit.

A. Name & Official Title (type or print)	B. Area Code and Telephone No.
C. Signature	D. Date Signed

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Chapter 3

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3. SELECTING BEST MANAGEMENT PRACTICES

INTRODUCTION

Chapter 3 provides guidance on the selection of Best Management Practices (BMPs), a term that embraces a variety of techniques. As noted in Chapter 2, BMPs are grouped into two broad categories: source control and treatment control. Source control BMPs prevent contact between the storm water and the pollution source. Treatment control BMPs are those that treat the storm water to remove the pollutant.

Source control BMPs are preferred for several reasons. They are generally 100% effective if implemented properly. Treatment control BMPs are not 100% effective, even if maintained and operated properly. There is also uncertainty as to the effectiveness and reliability of treatment control BMPs. Generally, source control BMPs are less expensive than treatment control BMPs.

A seven step process for the selection of BMPs is identified in this chapter. Presented here is a brief overview.

Step 1: Identify Activities by Type and Location - The approach to BMPs is structured around the concept of "activities." Refer to Worksheet 4 in Chapter 2.

Step 2: Identify BMPs Already In-Place and Evaluate - It is likely that you will already have BMPs in place, but some may need "tightening up" to achieve their full effectiveness. You will have by now developed a list of these BMPs using Worksheet 4 from Chapter 2.

Step 3: Identify Solutions to Non-Storm Water Discharges - The general permit prohibits certain types of non-storm water discharges. They either must be stopped or permitted under a NPDES permit at the outset of this regulatory process.

Step 4: Identify Low and Modest Cost Source Control BMPs - The axiom of "80% of the problem can be solved with 20% of the effort" probably is true for most industries. Low or modest cost BMPs, many of which are probably already in place, will usually satisfy permit requirements.

Step 5: Consider Other Source Control BMPs - If despite Step 4 you have areas where the amount of pollution will still be significant, or if you are required to meet numeric effluent limits, then consider source control BMPs that are more substantial, for example covering a large exposed activity area.

Step 6: Consider Treatment Control BMPs - At this point, treatment control BMPs may be less expensive than the results from Step 5.

Step 7: Prepare BMP List and Prioritize - Decide which BMPs to implement first. Make sure the BMP list meets the minimum requirements specified in the general permit.

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STEP 1: IDENTIFY ACTIVITIES

In this Handbook BMPs are structured around the concept of "activities," as experience has shown that with few exceptions one or more of these activities will satisfactorily describe all facilities. Source control BMPs are therefore organized in Chapter 4 by activity. Examples are fueling, vehicle maintenance, and temporary waste storage. You also should make at least a qualitative judgment as to which activities are of most concern.

You should have by this point completed Worksheet 4 in Chapter 2, and have a site map showing the location of each activity. Take these items and proceed to Step 2.

STEP 2: IDENTIFY AND EVALUATE BMPs IN-PLACE

For reasons unrelated to storm water, you likely already have in place several BMPs. Examples are berming, covered materials storage, and designated wash areas. You may have implemented these out of a desire for good housekeeping or financial savings, or because of other regulations such as the fire code. These BMPs can be counted as "BMPs for storm water control". But it may necessary to "tighten-up" one or more to meet storm water requirements. So "grade" each BMP, noting if modifications are appropriate.

You should have a list of these BMPs using Worksheets 4 and 5 from Chapter 2, with your "grading", so proceed to Step 3.

STEP 1: IDENTIFY ACTIVITIES

STEP 2: IDENTIFY & EVALUATE BMPs IN-PLACE

STEP 3: IDENTIFY SOLUTIONS TO NON-STORM WATER DISCHARGES

STEP 4: IDENTIFY LOW AND MODEST COST SOURCE CONTROL BMPs

STEP 5: CONSIDER OTHER SOURCE CONTROL BMPs

STEP 6: CONSIDER TREATMENT CONTROL BMPs

STEP 7: PREPARE BMP LIST AND PRIORITIZE

STEP 3: IDENTIFY SOLUTIONS TO NON-STORM WATER DISCHARGES

The general permit states explicitly that certain non-storm water discharges to the storm drainage system are not allowed. You must either terminate these discharges or obtain a NPDES permit for a process water discharge. The types of non-storm water discharges that are allowed are presented in Chapter 4 (Source Control 1), which describes the general recommended process for identifying and terminating non-storm water discharges. Determine if you have non-storm water discharges and identify specific corrective steps.

The regulations require that the corrective process begin immediately. You must certify this process. (Refer to Chapter 2 regarding the requirements.)

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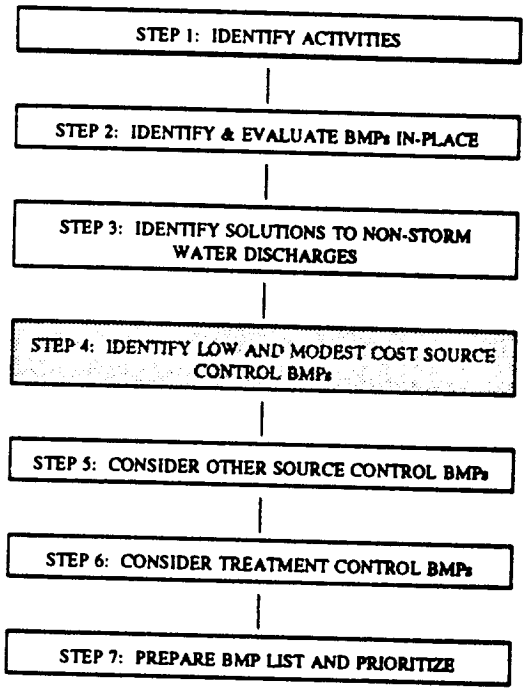
STEP 4: IDENTIFY LOW AND MODEST COST SOURCE CONTROL BMPs

Pollutant loads from various activities are highly variable, often episodic, and, in practical terms, defy quantification. The impact of a BMP on the loading will vary with each facility, even for the same type of industry. Although we may know that certain source control BMPs are 100% effective, for example covering, we cannot determine with a reasonable degree of certainly what will be the reduction in loading, given that we cannot, in most cases, determine the original loading from the activity. If the facility has only one activity, the analysis may be straight forward. For a site with many activities, any prediction of loading reduction carries great uncertainty. It is therefore arguably unrealistic in most cases to answer scientifically the question: "How do I know I have enough BMPs?"

To achieve compliance, it is reasonable to implement BMPs iteratively.

- First implement low and modest cost BMPs;
- Do not install elaborate source control BMPs unless it is clear now that the above BMPs will not satisfactorily reduce the loading ;
- Consider treatment control BMPs if:
  - Elaborate source control BMPs are needed and a treatment control BMP may be more cost-effective; or,
  - You are required to meet a numeric effluent limit that cannot be met with source control BMPs; or,
  - There is a pollutant of particular concern that can only be controlled with a treatment control BMP.



Each of these concepts should be considered as you complete Steps 4 through 6. Pay particular attention to your current practices that relate to:

- good housekeeping
- preventive maintenance
- spill prevention and control
- soil erosion control

The general permit specifies that BMPs must be incorporated into a facility to cover the above areas. (Refer to Worksheet 5 in Chapter 2.) If you have catch basins with sumps, consider increasing the cleaning frequency. Catch basins are small treatment control BMPs that are effective at removing particulate pollutants when properly cleaned and maintained. Soil erosion control is not relevant if your site is completely covered with pavement, buildings, or adequate vegetation. If, however, the site is not completely covered, then refer to the Construction Handbook for BMPs to control soil erosion.

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Other considerations:

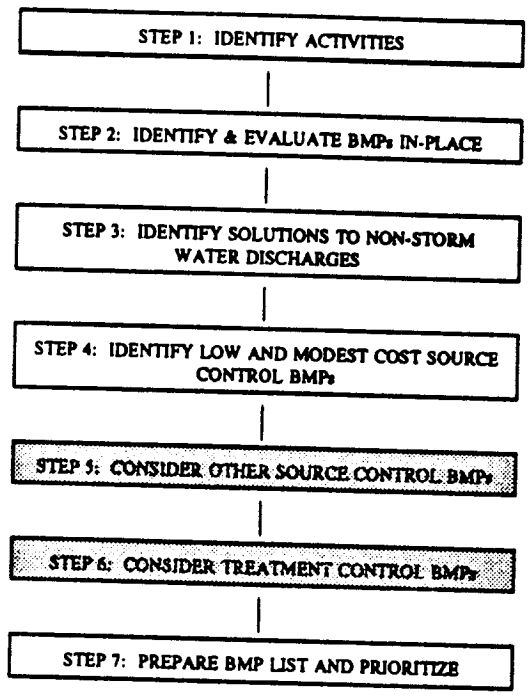
- Divert runoff water from around the activity area to reduce the amount of polluted storm water leaving the area.
- Segregate activities that are significant pollutant generators from those that are not so that it may be feasible to cover the former at a reasonable cost.

STEP 5: CONSIDER OTHER SOURCE CONTROL BMPs

At this point, you may find one or more activities in which it is clear that the BMPs selected in Step 4 will not be adequate. An example is a business with heavy equipment that must be washed frequently, requiring a designated wash facility for which the cost can be substantial. For outside activities that appear to require costly BMPs, focus on those that are potentially the most significant sources of pollution. Again, consider segregating the significant activities from the less significant. Avoid runoff of storm water through the areas of significant activity. Consider a simple structure with only a roof and a wall on the side of the prevailing wind during the wet season. (Do not forget to either seal the catch basins enclosed by the building or connect them to a sanitary sewer. However, prior to connecting to sanitary sewer, check with your local sewer agency.)

STEP 6: CONSIDER TREATMENT CONTROL BMPs

Treatment control BMPs need be used only if source control BMPs are insufficient to meet numeric effluent limits required either by current federal regulations for certain industries (Appendix A) or in special situations identified by the local Regional Water Quality Control Board. Many businesses in California already have individual NPDES permits for storm water in which numeric limits have been defined.



Evaluate the following possibilities:

- Don't forget the significant role that catch basin sumps can play. Consider the use of catch basin filtration units, special inserts that are discussed in Chapter 5 (Treatment Control 6). These "in-line" rather than "end-of-pipe" treatments may be more cost-effective.
- If you have several separate drainage systems, consider placing the offending activities into one system so that you have to install only one treatment device.
- Place a treatment device in the immediate vicinity of the activity, rather than at the far end of the drainage system. This will reduce the size of the unit.
- If you have a wastewater treatment system, consider diverting the sources of particular concern to the treatment plant.
- For activities that cover a small area, but are potentially significant polluters, such as equipment washing, consult your sewer

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district about installing a diversion pipe to the sanitary sewer. When the activity is in progress, a valve diverts the process water to the sanitary sewer. When the activity is not in progress, storm water is diverted to the storm drain system.

After completing the above analysis, consider again covering the activity of concern. Even if it is somewhat more expensive than treatment, covering has the advantage of being 100% effective. For certain industries, covering may avoid the need for a general permit.

STEP 7: PREPARE BMP LIST AND PRIORITIZE

The final step is to "wrap-up" the list of BMPs, clearly showing the BMPs identified for each activity and by location within the site. Here is a final checklist of considerations:

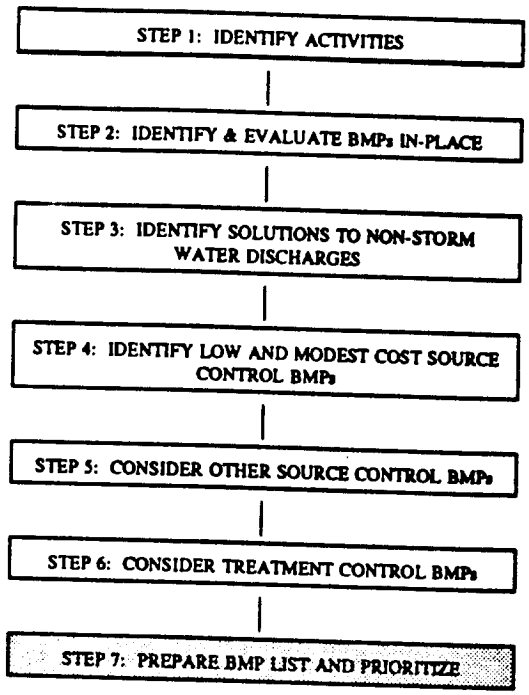
1. Have you identified BMPs that fulfill the minimum obligations defined in the general permit? These include (see Worksheet 5):

- termination of all non-storm water discharges to the storm water system
- good housekeeping,
- preventive maintenance,
- spill prevention and control.
- soil erosion control

2. Have you identified low and nominal-cost BMPs that cover all of the activities you checked in Worksheet 4?

3. Have you developed a strategy to deal with those activities that will still be significant sources of pollution for which more expensive BMPs are needed?

4. Are you required to comply with numeric effluent limits, and if so, have you identified the specific BMPs to fulfill this obligation?



5. Have you prepared a training program to provide the proper background to the employees who will implement the BMPs?

6. Do you have a commitment and schedule for implementation of BMPs, maintenance, inspection, and ongoing evaluation?

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Chapter 4

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4. SOURCE CONTROL BMPs

INTRODUCTION

This chapter describes specific source control Best Management Practices (BMPs) for common industrial activities that may pollute storm water. Chapter 2 led you through the steps of identifying activities at your facility that can pollute storm water while Chapter 3 provided guidance on selection of BMPs. This chapter provides you with the BMPs that best fill your facility's need. Best management practices for each of the activities shown below are provided in the following fact sheets.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Cost, including capital costs, and Operation and Maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The side bar presents information on where this BMP applies, targeted constituents, and an indication of the level of effort and cost to implement.

Further information is also provided in additional sheets. This information includes a more detailed description of the BMP, requirements to implement, examples of effective programs, and references.

BMPs are provided for each of the following industrial activities consistent with Worksheet 4 in Chapter 2.

Industrial Activities Requiring BMPs

SC1	Non-Storm Water Discharges to Drains
SC2	Vehicle and Equipment Fueling
SC3	Vehicle and Equipment Washing and Steam Cleaning
SC4	Vehicle and Equipment Maintenance and Repair
SC5	Outdoor Loading/Unloading of Materials
SC6	Outdoor Container Storage of Liquids
SC7	Outdoor Process Equipment Operations and Maintenance
SC8	Outdoor Storage of Raw Materials, Products, and By-Products
SC9	Waste Handling and Disposal
SC10	Contaminated or Erodible Surface Areas
SC11	Building and Grounds Maintenance
SC12	Building Repair, Remodeling, and Construction
SC13	Over-Water Activities
SC14	Employee Training

Fact sheet SC14, Employee Training, is a compilation of the training aspects of the individual source control fact sheets. Its purpose is to facilitate the integration and development of a comprehensive training program for all industrial activities at a facility.

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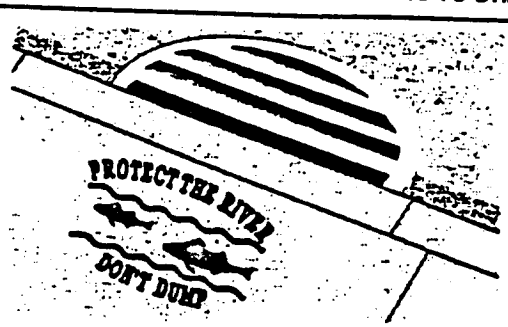
ACTIVITY: NON-STORM WATER DISCHARGES TO DRAINS



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Eliminate non-storm water discharges to the storm water collection system. Non-storm water discharges may include: process wastewaters, cooling waters, wash waters, and sanitary wastewater.

APPROACH

The following approaches may be used to identify non-storm water discharges:

- Visual Inspection
  - The easiest method is to inspect each discharge point during dry weather.
  - Keep in mind that drainage from a storm event can continue for three days or more and groundwater may infiltrate the underground storm water collection system.
- Piping Schematic Review
  - The piping schematic is a map of pipes and drainage systems used to carry wastewater, cooling water, sanitary wastes, etc.
  - A review of the "as-built" piping schematic is a way to determine if there are any connections to the storm water collection system.
  - Inspect the path of floor drains in older buildings.
- Smoke Testing
  - Smoke testing of wastewater and storm water collection systems is used to detect connections between the two systems.
  - During dry weather the storm water collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates that there may be a connection between the sanitary and the storm water system.
- Dye Testing
  - A dye test can be performed by simply releasing a dye into either your sanitary or process wastewater system and examining the discharge points from the storm water collection system for discoloration.

REQUIREMENTS

Costs (Capital, O&M)

- Can be difficult to locate illicit connections especially if there is groundwater infiltration.

LIMITATIONS

- Many facilities do not have accurate, up-to-date schematic drawings.
- TV and visual inspections can identify illicit connections to the storm sewer, but further testing is sometimes required (e.g. dye, smoke) to identify sources.

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ◒ Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training

● High ○ Low

SC1

Best Management Practices

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Additional Information — Non-Storm Water Discharges to Drains

Facilities subject to storm water permit requirements must include a certification that the storm water collection system has been tested or evaluated for the presence of non-storm water discharges. The State's General Industrial Storm Water Permit requires that non-storm water discharges be eliminated prior to implementation of the facility's SWPPP.

Non-storm water discharges to the storm water collection system may include any water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters. Table 4.1 presents disposal option information for specific types of wastewaters.

To ensure that the storm water system discharge contains only storm water, industry should:

- Locate discharges to the municipal storm sewer system or waters of the United States from the industrial storm sewer system from:
  - "as-built" pipeline schematics, and
  - visual observation (walk boundary of plant site).
- Locate and evaluate all discharges to the industrial storm sewer system (including wet weather flows) from:
  - "as-built" pipeline schematics,
  - visual observation,
  - dye tests,
  - TV camera,
  - chemical field test kits, and
  - smoke tests.
- Develop plan to eliminate illicit connections:
  - replumb sewer lines,
  - isolate problem areas, and
  - plug illicit discharge points.
- Develop disposal options.
- Document that non-storm water discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.

REFERENCES

General Industrial Storm Water Permit, SWRCB, 1992.

NPDES General Permit for Discharges of Storm Water Associated with Industrial Activity in Santa Clara County to South San Francisco Bay or its Tributaries, SFBRWQCB, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

SC1

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TABLE 4.1 QUICK REFERENCE - DISPOSAL ALTERNATIVES
(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use. **ALTERNATIVES ARE LISTED IN PRIORITY ORDER.**

Key:
- HHW — Household hazardous waste (Government-sponsored drop-off events)
- POTW — Publically Owned Treatment Plant
- Reg.Bd. — Regional Water Quality Control Board (Oakland)

"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance			
Excess paint (oil-based)	1. Recycle/reuse. 2. Dispose as hazardous waste.		1. Recycle/reuse. 2. Take to HHW drop-off.
Excess paint (water-based)	1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, dispose as hazardous waste.		1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, take to HHW drop-off
Paint cleanup (oil-based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste.		Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Take to HHW drop-off.
Paint cleanup (water-based)	Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.		Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.
Empty paint cans (dry)	1. Remove lids, dispose as trash.		1. Remove lids, dispose as trash.
Paint stripping (with solvent)	1. Dispose as hazardous waste.		1. Take to HHW drop-off.
Building exterior cleaning (high-pressure water)	1. Prevent entry into storm drain and remove offsite 2. Wash onto dirt area, spade in 3. Collect (e.g. mop up) and discharge to sanitary sewer	POTW	
Cleaning of building exteriors which have HAZARDOUS MATERIALS (e.g. mercury, lead) in paints	1. Use dry cleaning methods 2. Contain and dispose washwater as hazardous waste (Suggestion: dry material first to reduce volume)		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Non-hazardous paint scraping/ sand blasting	1. Dry sweep, dispose as trash		1. Dry sweep, dispose as trash
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste		1. Dry sweep, take to HHW drop-off
Soil from excavations during periods when storms are forecast	1. Should not be placed in street or on paved areas 2. Remove from site or backfill by end of day 3. Cover with tarpaulin or surround with hay bales, or use other runoff controls 4. Place filter mat over storm drain Note: Thoroughly sweep following removal of dirt in all four alternatives.		
Soil from excavations placed on paved surfaces during periods when storms are not forecast	1. Keep material out of storm conveyance systems and thoroughly remove via sweeping following removal of dirt		
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud 2. Use silt ponds and/or similar pollutant reduction techniques when flushing pavement		
Soil erosion, sediments	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant immediately.		
Fresh cement, grout, mortar	1. Use/reuse excess 2. Dispose to trash		1. Use/reuse excess 2. Dispose as trash
Washwater from concrete/mortar (etc.) cleanup	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer

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Table 4.1 (Continued)
Page 3

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Rinsewater from concrete mixing trucks	1. Return truck to yard for rinsing into pond or dirt area 2. At construction site, wash into pond or dirt area		
Non-hazardous construction and demolition debris	1. Recycle/reuse (concrete, wood, etc.) 2. Dispose as trash		1. Recycle/reuse (concrete, wood, etc. 2. Dispose as trash
Hazardous demolition and construction debris (e.g. asbestos)	1. Dispose as hazardous waste		1. Do not attempt to remove yourself. Contact asbestos removal service for safe removal and disposal 2. Very small amounts (less than 5 lbs) may be double-wrapped in plastic and taken to HHW drop-off
Saw-cut slurry	1. Use dry cutting technique and sweep up residue 2. Vacuum slurry and dispose off-site. 3. Block storm drain or berm with low weir as necessary to allow most solids to settle. Shovel out gutters; dispose residue to dirt area, construction yard or landfill.		
Construction dewatering (Nonturbid, uncontaminated groundwater)	1. Recycle/Reuse 2. Discharge to storm drain		
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1. Recycle/reuse 2. Discharge to sanitary sewer 3. As appropriate, treat prior to discharge to storm drain	POTW Reg. Bd.	
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW	POTW	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair 2. If dumpster is used for liquid waste, use plastic liner		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting; Street and Utility Maintenance (cont'd)			
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse)		
Dumpster cleaning water	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer 2. Clean on site and discharge through grease interceptor to sanitary sewer	POTW POTW	
Cleaning driveways, paved areas * (Special Focus = Restaurant alleys Grocery dumpster areas) * Note: Local drought ordinances may contain additional restrictions	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer). 3. Same as 2 above, but with rinsewater (2c)(no soap) discharged to storm drain.		1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, follow this 3-step process: a. Clean up leaks with rags or absorbents; dispose as hazardous waste. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer.
Steam cleaning of sidewalks, plazas * * Note: Local drought ordinances may contain additional restrictions	1. Collect all water and pump to sanitary sewer. 2. Follow this 3-step process: a. Clean oil leaks with rags or adsorbents b. Sweep (Use dry absorbent as needed) c. Use no soap, discharge to storm drain		
Potable water/line flushing Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching creeks		
Super-chlorinated (above 1 ppm) water from line flushing	1. Discharge to sanitary sewer 2. Complete dechlorination required before discharge to storm drain		

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Landscape/Garden Maintenance			
Pesticides	1. Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash 2. Dispose unused pesticide as hazardous waste		1. Use up. Rinse containers, use rinsewater as pesticide. Dispose rinsed container as trash. 2. Take unused pesticide to HHW drop-off
Garden clippings	1. Compost 2. Take to Landfill		1. Compost 2. Dispose as trash.
Tree trimming	1. Chip if necessary, before composting or recycling		1. Chip if necessary, before composting or recycling
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.	POTW	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.
Acid or other pool/spa/fountain cleaning	1. Neutralize and discharge to sanitary sewer	POTW	
Swimming pool, spa filter backwash	1. Reuse for irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer		1. Use for landscape irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer
Vehicle Wastes			
Used motor oil	1. Use secondary containment while storing, send to recycler.		1. Put out for curbside recycling pickup where available 2. Take to Recycling Facility or auto service facility with recycling program 3. Take to HHW events accepting motor oil
Antifreeze	1. Use secondary containment while storing, send to recycler.		1. Take to Recycling Facility
Other vehicle fluids and solvents	1. Dispose as hazardous waste		1. Take to HHW event
Automobile batteries	1. Send to auto battery recycler 2. Take to Recycling Center		1. Exchange at retail outlet 2. Take to Recycling Facility or HHW event where batteries are accepted
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer		1. Use holding tank, dispose to sanitary sewer.

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DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Vehicle Wastes (cont'd)			
Vehicle Washing	1. Recycle 2. Discharge to sanitary sewer, never to storm drain	POTW	1. Take to Commercial Car Wash. 2. Wash over lawn or dirt area 3. If soap is used, use a bucket for soapy water and discharge remaining soapy water to sanitary sewer.
Mobile Vehicle Washing	1. Collect washwater and discharge to sanitary sewer.	POTW	
Rinsewater from dust removal at new car fleets	1. Discharge to sanitary sewer 2. If rinsing dust from exterior surfaces from appearance purposes, use no soap (water only); discharge to storm drain.	POTW	
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags or absorbents 2. Sweep, using granular absorbent material (cat litter) 3. Mop and dispose of mopwater to sanitary sewer.		
Other Wastes			
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer	POTW	1. Dispose to sanitary sewer
Roof drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer 2. If no contamination is present, discharge to storm drain		
Cooling water Air conditioning condensate	1. Recycle/reuse 2. Discharge to sanitary sewer	POTW	
Pumped groundwater, infiltration/ foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer 3. Treat and discharge to storm drain	Reg. Bd. POTW Reg. Bd.	
Fire fighting flows	If contamination is present, Fire Dept. will attempt to prevent flow to stream or storm drain		

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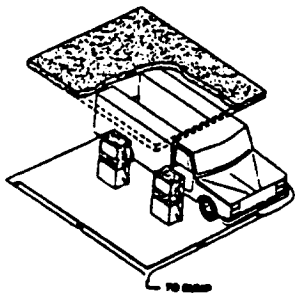
DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Other Wastes (cont'd)			
Kitchen Grease	1. Provide secondary containment, collect, send to recyler. 2. Provide secondary containment, collect, send to POTW via hauler.	POTW	1. Collect, solidify, dispose as trash
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer. 2. Clean outside in container or bermed area with discharge to sanitary sewer.		
Clean-up wastewater from sewer back-up	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer. (no rinse-water may flow to storm drain)		

R0034629

ACTIVITY: VEHICLE AND EQUIPMENT FUELING



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water.

APPROACH

- Design the fueling area to prevent the runon of storm water and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to sump.
  - Pave fueling area with concrete rather than asphalt.
- Where covering is infeasible and the fuel island is surrounded by pavement, apply a suitable sealant that protects the asphalt from spilled fuels.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Costs (Capital, O&M)
  - The retrofitting of existing fueling areas to minimize storm water exposure or spill runoff can be expensive. Good design must occur during the initial installation. Extruded curb along the "upstream" side of the fueling area to prevent storm water runon is of modest cost.
- Maintenance
  - Clean oil/water separators at the appropriate intervals.
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS

- Oil/water separators are only as effective as their maintenance program.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ◒ Training

● High ○ Low

SC2

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Additional Information — Vehicle and Equipment Fueling

Spills from fueling or from the transfer of fuels to the storage tank can be a significant source of pollution. Fuels carry contaminants of particular concern to humans and wildlife, such as heavy metals, toxic materials, and oil and grease, which are not easily removed by storm water treatment devices. Consequently, control at the source is particularly important. Adequate control can be achieved with careful design of the initial installation, retrofitting of existing installations, and proper spill control and cleanup procedures, as described below.

Design

With new installations, design the fueling area to prevent the runon of storm water and the runoff of spills. This can be achieved by contouring the site in the appropriate fashion. Covering the site is the best approach but may not be feasible if very large mobile equipment is being fueled. Storm water runon can be diverted around the fueling area by an extruded curb or with a "speed bump", if vehicle access is needed from this direction. Spills can be contained within the fueling area either by using a perimeter drain or by sloping the pavement inward with drainage to a sump. In both cases the drain can be connected to the storm drain with a valve that is only closed during fueling operations and left open at all other times. Pave the fueling area with Portland cement concrete rather than asphalt, since the latter will gradually disintegrate and be washed from the site.

Spill Control

The following spill control measures will reduce spilling or reduce the loss of spilled fuels from the site:

- Install vapor recovery nozzles.
- Do not "top off" tanks.
- Place secondary containment around the fuel truck when it is transferring fuel to the storage tank. The truck operator should remain with the truck while the transfer is in progress.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use dry methods to clean the fueling area whenever possible. If you periodically clean by pressure washing, place a temporary plug in the downstream drain and pump out the accumulated water. Properly dispose the water.
- Train employees on proper fueling and cleanup procedures.

Designated Area

If your facility has large numbers of mobile equipment working throughout the site and you currently fuel them with a mobile fuel truck, consider establishing a designated area for fueling. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time. Place temporary "caps" over nearby catch basins or manhole covers so that if a spill occurs it is prevented from entering the storm drain.

Examples of Effective Programs

- The Spill Prevention Control and Countermeasure (SPCC) Plan, which is required by law for some facilities, is an effective program to reduce the number of accidental spills.
- The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial facilities.

REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC2

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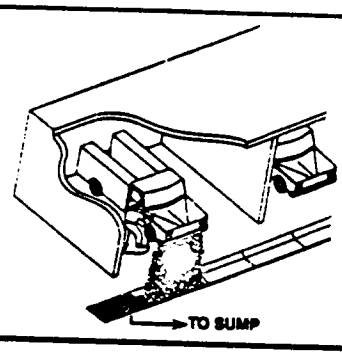
12995

R0034631

ACTIVITY: VEHICLE AND EQUIPMENT WASHING & STEAM CLEANING



Applications

- Manufacturing
- Material Handling
- **Vehicle Maintenance**
- **Construction**
- **Commercial Activities**
- Roadways
- Waste Containment
- **Housekeeping Practices**

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment washing and steam cleaning.

APPROACH

- Consider off-site commercial washing and steam cleaning businesses.
- Use designated wash areas, preferably covered to prevent contact with storm water and bermed to contain wash water.
- Discharge wash water to sanitary sewer, after contacting local sewer authority to find out if pretreatment is required.
- Educate employees on pollution prevention measures.
- Consider filtering and recycling wash water.
- Do not permit steam cleaning wash water to enter the storm drain.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Capital costs vary depending on measures implemented.
  - Low cost ($500-1,000) for berm construction.
  - Medium cost ($5,000-20,000) for plumbing modifications (including re-routing discharge to sanitary sewer and installing simple sump).
  - High cost ($30,000-150,000) for on-site treatment and recycling.
- O&M costs increase with increasing capital investment.
- Maintenance
  - Berm repair and patching.
  - Inspection and maintenance of sumps, oil/water separators, and on-site treatment/recycling units.

LIMITATIONS

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring permitting, monitoring, pretreatment, and inspections. The measures outlined in this fact sheet are insufficient to address all the environmental impacts and compliance issues related to steam cleaning.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training

● High ○ Low

SC3

Best Management Practices

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R0034632

Additional Information — Vehicle and Equipment Washing and Steam Cleaning

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. If your facility washes or steam cleans a large number of vehicles or pieces of equipment, consider contracting out this work to a commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Contracting out this work can also be economical by eliminating the need for a separate washing/cleaning operation at your facility.

If washing/cleaning must occur on-site, consider washing vehicles inside the building to control the targeted constituents by directing them to the sanitary sewer where they can be pretreated or sent directly to the sanitary treatment facility. Washing operations outside should be conducted in a designated wash area having the following characteristics:

- Paved with Portland cement concrete,
- Covered or bermed to prevent contact with storm water,
- Sloped for wash water collection,
- Discharges wash water to the sanitary or process waste sewer, or to a dead-end sump. Discharge pipe should have a positive control valve that allows switching between the storm drain and sanitary or process sewer,
- Clearly designated, and
- Equipped with an oil/water separator (see Chapter 5, TC7, Oil/Water Separators and Water Quality Inlets).

Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are applicable to industrial vehicle service facilities.

The U.S. Postal Service in West Sacramento has a new vehicle wash system that collects, filters, and recycles the wash water.

REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 8320R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC3

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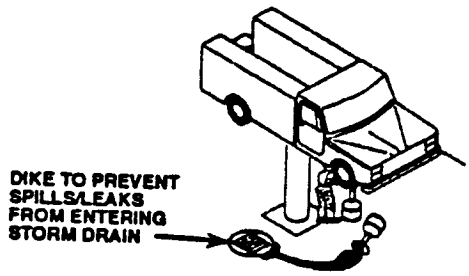
1291

R0034633

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE AND REPAIR



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance and repair by running a dry shop.

APPROACH

- Keep equipment clean, don't allow excessive build-up of oil and grease.
- Keep drip pans or containers under the areas that might drip.
- Do not change motor oil or perform equipment maintenance in non-appropriate areas. Use a vehicle maintenance area designed to prevent storm water pollution.
- Inspect equipment for leaks on a regular basis.
- Segregate wastes.
- Make sure oil filters are completely drained and crushed before recycling or disposal..
- Make sure incoming vehicles are checked for leaking oil and fluids.
- Clean yard storm drain inlets(s) regularly and especially after large storms.
- Do not pour materials down drains or hose down work areas; use dry sweeping.
- Store idle equipment under cover.
- Drain all fluids from wrecked vehicles.
- Recycle greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Switch to non-toxic chemicals for maintenance when possible.
- Clean small spills with rags, general clean-up with damp mops and larger spills with absorbent material.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Train employees.
- Minimize use of solvents.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Costs (Capital, O&M) - Should be low, but will vary depending on the size of the facility.
- Maintenance - Should be low if procedures for the approach are followed.

LIMITATIONS

- Space and time limitations may preclude all work being conducted indoors.
- It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours.
- Drain pans (usually 1 ft. x 1 ft.) are generally too small to contain antifreeze, which may gush from some vehicles, so drip pans (3 ft. x 3 ft.) may have to be purchased or fabricated.
- Dry floor cleaning methods may not be sufficient for some spills. Use three-step method instead.
- Identification of engine leaks may require some use of solvents.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training

● High ○ Low

SC4

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Additional Information — Vehicle and Equipment Maintenance and Repair

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service (parts cleaning, spilled fuel, oil, etc.), replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see SC2, Vehicle and Equipment Fueling, and SC3, Vehicle and Equipment Washing and Steam Cleaning.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners (e.g. wire brush) whenever possible reduces waste. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for re-use.

Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example:

- Use non-caustic detergents instead of caustic cleaning agents for parts cleaning (ask your supplier about alternative cleaning agents).
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sewer. Contact your local sewer authority for more information.
- Replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated.
- Choose cleaning agents that can be recycled.
- Contact your supplier or refer to trade journals for more waste minimization ideas.

Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents.

Recycling

Separating wastes allows for easier recycling and may reduce treatment costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits).

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

Spill Leak Clean Up

Clean leaks, drips, and other spills with as little water as possible. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Use the following three-step method for cleaning floors:

1. Clean spills with rags or other absorbent materials.
2. Sweep floor using dry absorbent material.
3. Mop floor. Mop water may be discharged to the sanitary sewer via a toilet or sink.

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Good Housekeeping

Also consider the following measures:

- Avoid hosing down your work areas. If work areas are washed, direct wash water to sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections. Used or leftover cleaning solutions, solvents, and automotive fluids and oil are toxic and should not be put in the sanitary sewer. Post signs at sinks to remind employees, and paint stencils at outdoor drains to tell customer and others not to pour wastes down drains.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Most municipalities prohibit or discourage disposal of these items in solid waste facilities. Place the oil filter in a funnel over the waste oil recycling or disposal collection tank to drain excess oil before disposal. Oil filters can be crushed and recycled. Ask your oil supplier or recycler about recycling oil filters.

Put pans under leaks to collect fluids for proper recycling or disposal. Keeping leaks off the ground reduces the potential for storm water contamination and reduces cleanup time and costs. If the vehicle or equipment is to be stored outdoors, oil and other fluids should be drained first.

Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer and drips and spills can be easily cleaned up.

Be especially careful with wrecked vehicles, whether you keep them indoors or out, as well as vehicles kept on-site for scrap or salvage. Wrecked or damaged vehicles often drip oil and other fluids for several days.

- As the vehicles arrive, place drip pans under them immediately, even if you believe that the fluids have leaked out before the car reaches your shop.
- Build a shed or temporary roof over areas where you park cars awaiting repair or salvage, especially if you handle wrecked vehicles. Build a roof over vehicles you keep for parts.
- Drain all fluids, including air conditioner coolant, from wrecked vehicles and "part" cars. Also drain engines, transmission, and other used parts.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial vehicle service facilities.

Pick N Pull Auto Dismantlers in Rancho Cordova drains all fluids from automobiles before they enter the yard.

Ecology Auto Wrecking in Rialto is surrounded by a steel plate/concrete fence and has a completely paved lot that is graded to a central low point. Collected storm water is channeled through as underground drainage system of clarifiers

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and then stored in a 60,000 gallon UST before being processed through a filter system. In addition, the work area is covered, ventilated and has an additional sump. Vehicle fluids are drained in this area and segregated for recycling.

All Auto Parts, Fontana, has a complete water recycling system in a 10,000 square foot concrete slab surrounded by a curb that contains all the runoff and sends it to the recycling system. All receiving, dismantling, and shipping occurs on the slab.

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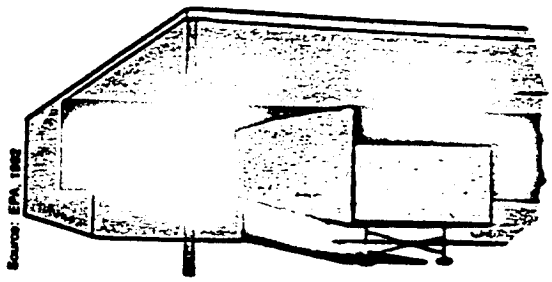
ACTIVITY: OUTDOOR LOADING/UNLOADING OF MATERIALS



Applications

- Manufacturing
- **Material Handling**
- Vehicle Maintenance
- **Construction**
- **Commercial Activities**
- Roadways
- Waste Containment
- **Housekeeping Practices**

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials.

APPROACH

- Park tank trucks or delivery vehicles so that spills or leaks can be contained.
- Cover the loading/unloading docks to reduce exposure of materials to rain.
- Seal or door skirt between trailer and building can also prevent exposure to rain.
- Design loading/unloading area to prevent storm water runon:
  - grading or berming, and
  - position roof downspouts to direct storm water away from loading/unloading areas.
- Contain leaks during transfer.
- Use drip pans under hoses.
- Make sure fork lift operators are properly trained.
- Employee training for spill containment and cleanup.

REQUIREMENTS

- Costs (Capital, O&M) - Should be low except when covering a large loading/unloading area.
- Maintenance
  - Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
  - Check loading and unloading equipment regularly for leaks:
    - valves,
    - pumps,
    - flanges, and
    - connections.

LIMITATIONS

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
- It may not be possible to conduct transfers only during dry weather.

Targeted Constituents

- ○ Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training

● High ○ Low

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Additional Information — Outdoor Loading/Unloading of Materials

The loading/unloading of materials usually takes place outside. Loading or unloading of materials occurs in two ways: materials in containers or direct liquid transfer. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned. Rainfall may wash pollutants from machinery used to unload or move materials. The loading or unloading may involve rail or truck transfer.

The most important factors in preventing these constituents from entering storm water is:

- Limit exposure of material to rainfall.
- Prevent storm water runon.
- Check equipment regularly for leaks.
- Contain spills during transfer operations.

Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements. Best management practices include:

- Use overhangs or door skirts that enclose the trailer.
- Park tank trucks during delivery so that spills or leaks can be contained.
- Design loading/unloading area to prevent storm water runon which would include grading or berming the area, and positioning roof downspouts so they direct storm water away from the loading/unloading areas.
- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.
- Use a written operations plan that describes procedures for loading and/or unloading.
- Have an emergency spill cleanup plan readily available.
- Employees trained in spill containment and cleanup should be present during the loading/unloading.
- Establish depots of cleanup materials next to or near each loading/unloading area, and train employees in their use.
- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used.
  - The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - Transfer area should be designed to prevent runon of storm water from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce runon.
  - Transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.
- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:
  - Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.
  - Drip pan systems should be installed between the rails to collect spillage from tank cars.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

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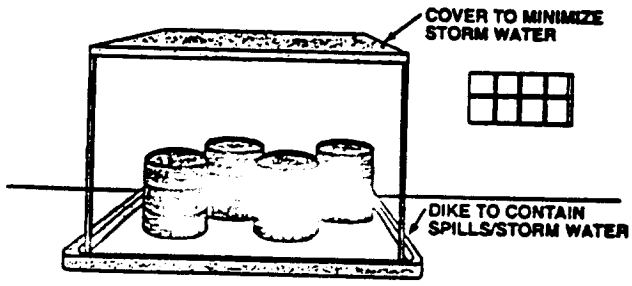
ACTIVITY: OUTDOOR CONTAINER STORAGE OF LIQUIDS



Applications

- Manufacturing
- **Material Handling**
- Vehicle Maintenance
- **Construction**
- **Commercial Activities**
- Roadways
- Waste Containment
- **Housekeeping Practices**

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas by installing safeguards against accidental releases, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.

APPROACH

- Protect materials from rainfall, runon, runoff, and wind dispersal:
  - Store materials indoors.
  - Cover the storage area with a roof.
  - Minize storm water runon by enclosing the area or buiding a berm around it.
  - Use "doghouse" for storage of liquid containers.
  - Use covered dumpsters for waste product containers.
- Storage of oil and hazardous materials must meet specific Federal and State standards including:
  - Spill Prevention Control and Countermeasure Plan (SPCC) Plan,
  - secondary containment,
  - integrity and leak detection monitoring, and
  - emergency preparedness plans.
- Train operator on proper storage.
- Safeguards against accidental releases:
  - overflow protection devices to warn operator or automatic shut down transfer pumps,
  - protection guards (bollards) around tanks and piping to prevent vehicle or forklift damage, and
  - clear tagging or labeling, and restricting access to valves to reduce human error.
- Berm or surround tank or container with secondary containment system:
  - dikes, liners, vaults, or double walled tanks.
- Some municipalities require that secondary containment areas be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- Facilities with "spill ponds" designed to intercept, treat, and/or divert spills should contact the appropriate regulatory agency regarding envirinmental compliance.

REQUIREMENTS

- Cost (Capital, O&M)
  - Will vary depending on the size of the facility and the necessary controls.
- Maintenance: Conduct routine weekly inspections.

LIMITATIONS

- Storage sheds often must meet building and fire code requirements.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ● Oxygen Demanding Substances
- ○ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- Capital Costs
- O&M Costs
- Maintenance
- Training

● High ○ Low

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Additional Information — Outdoor Container Storage of Liquids

Accidental releases of materials from aboveground liquid storage tanks, drums, and dumpsters present the potential for contaminating storm waters with many different pollutants. Materials spilled, leaked or lost from storage containers and dumpsters may accumulate in soils or on the surfaces and be carried away by storm water runoff. These source controls apply to containers located outside of a building used to temporarily store liquid materials. It should be noted that the storage of reactive, ignitable, or flammable liquids must comply with fire codes.

Container Management

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. If the containers are placed outside, the following procedures should be employed:

- Dumpsters used to store items awaiting transfer to a landfill should be placed in a lean-to structure or otherwise covered. dumpsters shall be kept in good condition without corrosion or leaky seams.
- Garbage dumpsters shall be replaced if they are deteriorating to the point where leakage is occurring. It should be kept undercover to prevent the entry of storm water. Employees should be made aware of the importance of keeping the dumpsters covered and free from leaks.
- A fillet should be placed on both sides of the curb to facilitate moving the dumpster.
- Waste container drums should be kept in an area such as a service bay. If drums are kept outside, they must be stored in a lean-to type structure, shed or walk-in container to keep rainfall from reaching the drums.

Storage of reactive, ignitible, or flammable liquids must comply with the fire codes of your area. Practices listed below should be employed to enhance the fire code requirements.

- Containers should be placed in a designated area.
- Designated areas should be paved, free of cracks and gaps, and impervious in order to contain leaks and spills.
- Liquid waste should be surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater.
- The area inside the curb should slope to a drain.
  - For used oil or dangerous waste, a dead-end sump should be installed in the drain.
  - All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- The designated storage area should be covered.
- Containers used for liquid removal by an employees must be placed in a containment area.
  - A drip pan should be used at all times.
- Drums stored in an area where unauthorized persons may gain access must be secured to prevent accidental spillage, pilferage, or any unauthorized use.
- Employees trained in emergency spill cleanup procedures should be present when dangerous waste, liquid chemicals, or other wastes are loaded or unloaded.

The most common causes of unintentional releases:

- External corrosion and structural failure,
- Installation problems,
- Spills and overfills due to operator error,
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves), and
- Leaks during pumping of liquids or gases from truck or railcar to a storage facility or vice versa.

Operator Training/Safeguards

Well-trained employees can reduce human errors that lead to accidental releases or spills. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. The employee should have the tools and knowledge to

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immediately begin cleaning up a spill if one should occur. Operator errors can be prevented by using engineering safe guards and thus reducing accidental releases of pollutant. Safeguards include:

- Overflow protection devices on tank systems to warn the operator to automatically shutdown transfer pumps when the tank reaches full capacity,
- Protective guards (bollards) around tanks and piping to prevent vehicle or forklift damage, and
- Clearly tagging or labeling all valves to reduce human error.

Tank systems should be inspected and tank integrity tested regularly. Problem areas can often be detected by visually inspecting the tanks frequently. Problems or potential problems should be corrected as soon as possible. Registered and specifically trained professional engineers can identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets for newly installed tank systems. The tank foundations, connections, coatings, and tank walls and piping systems also should be inspected. Inspection for corrosion, leaks, cracks, scratches in protective coatings, or other physical damage that may weaken the tank system should be a part of regular integrity testing.

Secondary Containment

Tanks should be bermed or surrounded by a secondary containment system. Leaks can be detected more easily and spills can be contained when a secondary containment systems are installed. Berms, dikes, liners, vaults, and double-wall tanks are examples of secondary containment systems.

One of the best protective measures against contamination of storm water is diking. Containment dikes are berms or retaining walls that are designed to hold spills. Diking is an effective pollution prevention measure for above ground storage tanks and railcar or tank truck loading and unloading areas. The dike surrounds the area of concern and holds the spill, keeping spill materials separated from the storm water side of the dike area. Diking can be used in any industrial facility, but it is most commonly used for controlling large spills or releases from liquid storage areas and liquid transfer areas.

For single-wall tanks, containment dikes should be large enough to hold the contents of the storage tank for the facility plus rain water. For trucks, diked areas should be capable of holding an amount equal to the volume of the tank truck compartment. Diked construction material should be strong enough to safely hold spilled materials. Dike materials can consist of earth, concrete, synthetic materials, metal, or other impervious materials. Strong acids or bases may react with metal containers, concrete, and some plastics. Where strong acids or bases or stored, alternative dike materials should be considered. More active organic chemicals may need certain special liners for dikes. Dikes may also be designed with impermeable materials to increase containment capabilities. Dikes should be inspected during or after significant storms or spills to check for washouts or overflows. Regular checks of containment dikes to insure the dikes are capable of holding spills should be conducted. Inability of a structure to retain storm water, dike erosion, soggy areas, or changes in vegetation indicate problems with dike structures. Damaged areas should be patched and stabilized immediately. Earthen dikes may require special maintenance of vegetation such as mulching and irrigation.

Curbing is a barrier that surrounds an area of concern. Curbing is similar to containment diking in the way that it prevents spills and leaks from being released into the environment. The curbing is usually small scaled and does not contain large spills like diking. Curbing is common at many facilities in small areas where handling and transfer liquid materials occur. Curbing can redirect contaminated storm water away from the storage area. It is useful in areas where liquid materials are transferred from one container to another. Asphalt is a common material used for curbing; however, curbing materials include earth, concrete, synthetic materials, metal, or other impenetrable materials. Spilled materials should be removed immediately from curbed areas to allow space for future spills. Curbs should have manually-controlled pump systems rather than common drainage systems for collection of spilled materials. The curbed area should be inspected regularly to clear clogging debris. Maintenance should also be conducted frequently to prevent overflow of any spilled materials as curbed areas are designed only for smaller spills. Curbing has the following advantages:

- Excellent runon control,
- Inexpensive,
- Ease of installment,
- Provides option to recycle materials spilled in curb areas, and
- Common industry practice.

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Additional Information — Outdoor Container Storage of Liquids

Maintenance

- Weekly inspection should be considered and include:
  - Check for external corrosion and structural failure,
  - Check for spills and overfills due to operator error,
  - Check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves),
  - Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa,
  - Visually inspect new tank or container installation loose fittings, poor welding, and improper or poorly fitted gaskets, and
  - Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.

Examples of Effective Programs

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successfully at Lockheed Missile and Space Company in Sunnyvale.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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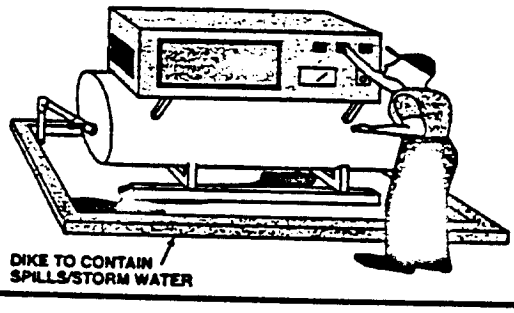
ACTIVITY: OUTDOOR PROCESS EQUIPMENT OPERATIONS AND MAINTENANCE



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor process equipment operations and maintenance by reducing the amount of waste created, enclosing or covering all or some of the equipment, installing secondary containment, and training employees.

APPROACH

- Alter the activity to prevent exposure of pollutants to storm water.
- Move activity indoors.
- Cover the area with a permanent roof.
- Minimize contact of storm water with outside manufacturing operations through berming and drainage routing (run on prevention).
- Connect process equipment area to pubic sewer or facility wastewater treatment system.
- Clean regularly the storm drainage system.
- Use catch basin filtration inserts (Chapter 5, TC6, Media Filtration) as a means to capture particulate pollutants.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

REQUIREMENTS

- Costs (Capital, O&M)
  - Variable depending on the complexity of the operation and the amount of control necessary for storm water pollution control..
- Maintenance
  - Routine preventive maintenance, including checking process equipment for leaks.

LIMITATIONS

- Providing cover may be expensive.
- Space limitations may preclude enclosing some equipment.
- Storage sheds often must meet building and fire code requirements.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training

● High ○ Low

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Additional Information — Outdoor Process Equipment Operations and Maintenance

Outside process equipment operations can contaminate storm water runoff. Activities, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, landfills, waste piles, wastewater and solid waste treatment and disposal, and land application are process operations that use hazardous materials and that can lead to contamination of storm water runoff. Pollutants from the wastewater and solid waste treatment and disposal areas result from waste pumping, additions of treatment chemicals, mixing, aeration, clarification, and solids dewatering.

Possible storm water contaminants include heavy metals, toxic materials, and oil and grease. Waste spilled, leaked, or lost from outdoor process equipment operations may build up in soils or on other surfaces and be carried away by storm water runoff. There is also a potential for liquid waste from lagoons or surface impoundments, associated with outdoor equipment operations, to overflow to surface waters or soak the soil, which can be picked up by storm water runoff.

The preferred (and possibly the most economical) action to reduce storm water pollution is to alter the nature of activity such that pollutants are not exposed to storm water. This may mean perfoming the activity during dry periods only or substituting benign materials for more toxic ones. Actions other than altering the activity include enclosing the activity in a building and connecting the floor drains to the sanitary sewer. The area used by the activity may be so great as to make enclosure prohibitively expensive. Building cost can be reduced by not covering the sides, and thus eliminating the need for ventilating and lighting systems. When certain parts of the activity are the worst source of pollutants, those parts can be segregated and enclosed or covered.

Curbs can be placed around the immediate boundaries of the process equipment. The storm drains from these interior areas can be connected to the facility's process wastewater system.

Reducing the amount of waste that is created and consequently the amount that must be stored or treated is another way to reduce the potential for storm water contamination from outside manufacturing activities. Waste reduction BMPs are available for a wide range of industries and are designed to provide ideas and ways to reduce waste (see References).

Hydraulic/Treatment Modifications

If storm water becomes polluted, it should be captured and treated. If you do not have your own process wastewater treatment system, consider discharging to the public sewer system. Use of the public sewer might be allowed under the following conditions:

- If the activity area is very small (less than a few hundred square feet), the local sewer authority may be willing to allow the area to remain uncovered with the drain connected to the public sewer.
- It may be possible under unusual circumstances to connect a much larger area to the public sewer, as long as the rate of storm water discharges do not exceed the capacity of the wastewater treatment plant. The storm water could be stored during the storm and then transferred to the public sewer when the normal flow is low, such as at night.

The majority of the pollutants in storm water are discharged over time by the small, high frequency storms. Less polluted runoff from the infrequent large storms can be bypassed to the storm drain. To implement this BMP, a hydraulic evaluation of the downstream sewer system should occur in consultation with the local sewer authority.

Industries that generate large volumes of process wastewater typically have their own treatment system that discharges directly to the nearest receiving water. These industries have the discretion to use their wastewater treatment system to treat storm water within the constraints of their permit requirements for process treatment. It may also be possible for the industry to discharge the storm water directly to its effluent outfall without treatment as long as the total loading of the discharged process water and storm water does not exceed the loading had a storm water treatment device been used. This could be achieved by reducing the loading from the process wastewater treatment system. Check with your Regional Water Quality Control Board, as this option would be subject to permit constraints and potentially regular monitoring.

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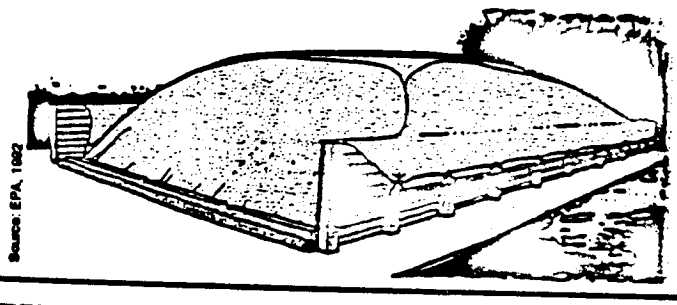
ACTIVITY: OUTDOOR STORAGE OF RAW MATERIALS, PRODUCTS, AND BY-PRODUCTS



Applications

- Manufacturing
- **Material Handling**
- Vehicle Maintenance
- **Construction**
- **Commercial Activities**
- Roadways
- Waste Containment
- **Housekeeping Practices**

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor material and product storage areas by enclosing or covering materials, installing secondary containment, and preventing storm water runon.

APPROACH

- Protect materials from rainfall, runon, runoff and wind dispersal:
  - Store material indoors.
  - Cover the storage area with a roof.
  - Cover the material with a temporary covering made of polyethylene, polypropylene, or hypalon.
  - Minimize storm water runon by enclosing the area or building a berm around the area.
  - Use "doghouse" for storage of liquid containers.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage area.
- Install pellet traps at storm water discharge points where plastic pellets are loaded and unloaded.
- Keep liquids in a designated area on a paved impervious surface within a secondary containment.
- Keep outdoor storage containers in good condition.
- Use berms and curbing.
- Use catch basin filtration inserts (Chapter 5, TC6, Media Filtration)

REQUIREMENTS

- Costs (Capital, O&M)
  - Costs should be low except where large areas may have to be covered.
- Maintenance
  - Berm and curbing repair and patching.

LIMITATIONS

- Space limitations may preclude storing some materials indoors.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- Storage sheds often must meet building and fire code requirements.

Targeted Constituents

- ● Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ◒ Training

● High ○ Low

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Additional Information — Outdoor Storage of Raw Materials, Products, and By-Products

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute storm water. Storm water can become contaminated by a wide range of contaminants when materials wash off or dissolve into water or are added to runoff by spills and leaks.

Paved areas should be sloped in a manner that minimize the pooling of water on the site, particularly with materials that may leach pollutants into storm water and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5 percent is recommended.

Curbing should be placed along the perimeter of the area to prevent the runon of uncontaminated storm water from adjacent areas as well as runoff of storm water from the stockpile areas. The storm drainage system should be designed to minimize the use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material. In these cases, consider the use of the catch basin insert filter described in Chapter 5, TC6 (Media Filtration). The area should be sloped to drain storm water to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled. If the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC6, Outdoor Container Storage of Liquids.

Examples

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successively at Lockheed Missile and Space Company in Sunnyvale.

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Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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ACTIVITY: WASTE HANDLING AND DISPOSAL

Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- (Construction)
- (Commercial Activities)
- Roadways
- (Waste Containment)
- (Housekeeping Practices)

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from waste handling and disposal by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, re-use, and recycling; and preventing runon and runoff from waste management areas.

APPROACH

- Maintain usage inventory to limit waste generation.
- Raw material substitution or elimination.
- Process or equipment modification.
- Production planning and sequencing.
- SARA Title III, Section 313 requires reporting for over 300 listed chemicals and chemical compounds. This requirement should be used to track these chemicals although this is not as accurate a means of tracking as other approaches.
- Track waste generated.
  - Characterize waste stream.
  - Evaluate the process generating the waste.
  - Prioritize waste streams using: manifests, biennial reports, permits, environmental audits, SARA Title III reports, emission reports, NPDES monitoring reports.
  - Inventory reports.
  - Data on chemical spills.
  - Emissions.
  - Shelf life expiration.
- Use design data and review: process flow diagram, materials and applications diagram, piping and instructions, equipment list, plot plan.
- Use raw material and production data and review: composition sheets, materials safety data sheets (MSDS), batch sheets, product or raw material inventory records, production schedule, operator data log.
- Use economic data and review:
  - Waste treatment and disposal cost.
  - Product utility and economic cost.
  - Operation and maintenance labor cost.
- Recycle materials whenever possible.
- Maintain list of and the amounts of materials disposed.
- Waste segregation and separation.
- Check industrial waste management areas for spills and leaks.
- Cover, enclose, or berm industrial wastewater management areas whenever possible to prevent contact with runon or runoff.
- Equip waste transport vehicles with anti-spill equipment.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Maintenance
- ◒ Training

● High ○ Low

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ACTIVITY: WASTE HANDLING AND DISPOSAL (Continue)

- Minimize spills and fugitive losses such as dust or mist from loading systems.
- Ensure that sediments or wastes are prevented from being tracked off-site.
- Training and supervision.
- Stencil storm drains on the facility's property with prohibitive message regarding waste disposal.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.
- Consider ordering industry-specific or waste stream-specific guidance from PPIC (see Appendix G).

REQUIREMENTS

- Costs (Capital, O&M)
  - Capital and O&M costs for these programs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.
- Maintenance
  - None except for maintaining equipment for material tracking program.

LIMITATIONS

- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

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Additional Information — Waste Handling and Disposal

Industrial waste management activities occur in areas that can contaminate storm water and include landfills, waste piles, wastewater and solid waste treatment and disposal, and land application. Typical operations which affect storm water pollution may include waste pumping, treatment chemicals storage, mixing, aeration, clarification, and solids dewatering.

Waste Reduction

Waste spilled, leaked, or lost from waste management areas or outside manufacturing activities may build up in soils or in other surfaces and be carried away by storm water runoff. There is also a potential for liquid waste from lagoons or surface impoundments to overflow to surface waters or soak the soil where pollutants may be picked up by storm water runoff.

Waste reduction for manufacturing activities is the best way to reduce the potential of storm water contamination from waste management areas. Reduction in the amount of industrial waste generated can be accomplished using many different types of source controls such as:

- Production planning and sequencing.
- Process or equipment modification.
- Raw material substitution or elimination.
- Loss prevention and housekeeping.
- Waste segregation and separation.
- Close loop recycling.

An approach to reduce storm water pollution from waste handling and disposal is to assess process activities at the facility and reduce waste generation. The assessment is designed to find situations where waste can be eliminated or reduced and emissions and environmental damage can be minimized. The assessment involves collecting process specific information, setting pollution prevention targets, and developing, screening and selecting waste reduction options for further study. Starting a waste reduction program is economically beneficial because of reduced raw material purchases and lower waste disposal fees. In addition, material tracking systems to increase awareness about material usage can reduce spills and minimize contamination, thus reducing the amount of waste produced.

Spill/Leak Control

Waste can be prevented from contaminating storm water by checking waste management areas for leaking containers or spills. Corroded or damaged containers can begin to leak at any time. Transfer waste from these damaged containers into safe containers. Dumpsters should be covered to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster. Leaking equipment including valves, lines, seals, or pumps should be repaired promptly.

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:

- Vehicles equipped with baffles for liquid waste.
- Trucks with sealed gates and spill guards for solid waste.

Loading or unloading wastes can contaminate storm water when the wastes are lost from the transfer. Loading systems can also be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

Runon/Runoff Prevention

Storm water runon should be prevented from entering the waste management area. Storm water pollution from runon can be prevented by enclosing the area or building a berm around the area. Other alternatives for reducing storm water pollution include:

- Preventing the waste materials from directly contacting rain.

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Additional Information — Waste Handling and Disposal

- Moving the activity indoor after ensuring that all safety concerns such as fire hazard and ventilation are addressed.
- Covering the area with a permanent roof.
- Covering waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.

To avoid tracking materials off-site, the waste management area should be kept clean at all times by sweeping and cleaning up spills immediately. Vehicles should never drive through spills. If necessary, wash vehicles in designated areas before they leave the site, and control the wash water.

Minimizing the runoff of polluted storm water from land application of industrial waste on-site can be accomplished by:

- Choosing a site where:
  - slopes are under 6 percent
  - the soil is permeable
  - there is a low water table
  - it is located away from wetlands or marshes
  - there is a closed drainage system
- Avoiding applying waste to the site:
  - when it is raining
  - when the ground is frozen
  - when the ground is saturated with water
- Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.
- Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.
- Using erosion control techniques
  - mulching and matting,
  - filter fences,
  - straw bales,
  - diversion terracing,
  - sediment basins.
- Performing routine maintenance to ensure the erosion control or site stabilization measures are working.

Examples of Effective Programs

The port of Long Beach has a state-of-the-art database for identifying potential pollutant sources, documenting facility management practices, and tracking pollutants.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Publications Than Can Work For You!; California Department of Toxic Substances Control, Sacramento, CA, 1991 (A list and order form for waste minimization publications from the State).

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

Distribute List, Pollution Prevention Information Clearinghouse, USEPA 1992.

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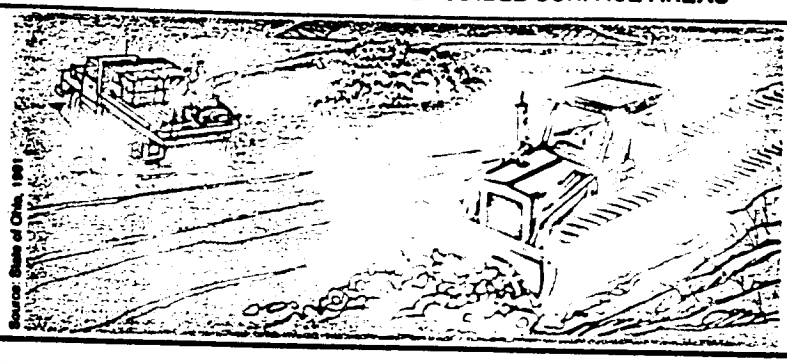
ACTIVITY: CONTAMINATED OR ERODIBLE SURFACE AREAS



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from contaminated or erodible surface areas by leaving as much vegetation on-site as possible, minimizing soil exposure time, stabilizing exposed soils, and preventing storm water runon and runoff.

APPROACH

This BMP addresses soils which are not so contaminated as to exceed criteria (see Title 22 California Code of Regulations for Hazardous Waste Criteria), but the soil is eroding and carrying pollutants off in the storm water.

Contaminated or erodible surface areas can be controlled by:

- Preservation of natural vegetation,
- Re-vegetation,
- Chemical stabilization,
- Removal of contaminated soils, or
- Geosynthetics.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Cost (Capital, O&M)
  - Except for preservation of natural vegetation, each of the above solutions can be quite expensive depending upon the size of the area.
- Maintenance
  - Maintenance should be minimal, except possibly if irrigation of vegetation is necessary.

LIMITATIONS

Disadvantages of preserving natural vegetation or re-vegetating include:

- Requires substantial planning to preserve and maintain the existing vegetation.
- May not be cost-effective with high land costs.
- Lack of rainfall and/or poor soils may limit the success of re-vegetated areas.

Disadvantages of chemical stabilization include:

- Creation of impervious surfaces.
- May cause harmful effects on water quality.
- Is usually more expensive than vegetative cover.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ○ Maintenance
- ○ Training

● High ○ Low

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Additional Information — Contaminated or Erodible Surface Areas

Of interest here are areas within the industrial site that are bare of vegetation and therefore subject to erosion. They may or may not be contaminated from past or current activities. Activity may or may not be occurring in the area of interest. According to the State's General Industrial Activity Storm Water Permit, the SWPPP must include BMPs that deal with these situations. If the area is temporarily bare because of construction, see SC12, Building Repair, Remodeling, and Construction.

Contaminated or erodible surfaces can result from the human activities such as vegetation removal, compacting or disturbing soil, and changing natural drainage patterns. Industries must identify the areas of contaminated or erodible surfaces. The areas may include:

- Heavy activity where plants cannot grow.
- Soil stockpiles.
- Steep slopes.
- Construction areas.
- Demolition areas.
- Any area where soil is disturbed.

The most effective way to control erosion is to preserve existing vegetation. Preservation of natural vegetation provides a natural buffer zone and an opportunity for infiltration of storm water and capture of pollutants in the soil matrix. By preserving stabilized areas, it minimizes erosion potential, protects water quality, and provides aesthetic benefits. This practice is used as a permanent control measure. Vegetation preservation on-site should be planned before disturbing the site. Preservation requires good site management to minimize the impact of construction when construction is underway. Proper maintenance is important to ensure healthy vegetation that can control erosion. Different species, soil types, and climatic conditions will require different maintenance activities such as mulching, fertilizing, liming, irrigation, pruning and weed and pest control. Maintenance should be performed regularly especially during construction phases.

Advantages of preservation of natural vegetation are:

- Can handle higher quantities of storm water runoff than newly seeded areas.
- Increases the filtering capacity because vegetation and root systems are usually dense in preserved natural vegetation.
- Enhances aesthetics.
- Provides areas for infiltration, thus reducing the quantity and velocity of storm water runoff.
- Allows areas where wildlife can remain undisturbed.
- Provides noise buffers and screens for on-site operation.
- Usually requires less maintenance than planting new vegetation.

The measure of choice is to leave as much native vegetation on-site as possible, thereby reducing or eliminating the problem. However, assuming the site already has contaminated or erodible surface areas, there are three possible courses of action:

1. Re-vegetate the area if it is not in use and therefore not subject to damage from site activities. In as much as the area is already devoid of vegetation, special measures are likely necessary. Lack of vegetation may be due to the lack of water and/or poor soils. The later can perhaps be solved with fertilization. Or the ground may simply be too compacted from prior use. Improving soil conditions may be sufficient to support vegetation. If available process wastewater can be used for irrigation, see Construction Best Management Practice Handbook for procedures to establish vegetation.

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2. Chemical stabilization (for example ligno sulfate) can be used as an alternate in areas where temporary seeding practices cannot be used because of season or climate. It can provide immediate, effective, and inexpensive erosion control. Application rates and procedures recommended by the manufacturer should be followed as closely as possible to prevent the product from forming ponds and creating large areas where moisture cannot penetrate the soil. The advantages of chemical stabilization include:
   - Easily applied to the surface.
   - Effective in stabilizing areas.
   - Provides immediate protection to soils that are in danger of erosion.

3. Removal of contaminated soils is a last resort and quite expensive. The level and extent of the contamination must be determined. This determination and removal must comply with State and Federal regulations, permits must be acquired, and fees paid.

4. Geosynthetics include those materials that are designed as an impermeable barrier to contain or control large amounts of liquid or solid matter. Geosynthetics have been developed primarily for use in landfills and surface impoundments, and the technology is well established. There are two general types of geosynthetics: geomembranes(impermeable) and geotextiles(permeable).
   - Geomembranes are composed of one of three types of impermeable materials: elastomers(rubbers), thermoplastics(plastics), or a combination of these two types of materials. The advantages of these materials include: 1) the variety of compounds available, 2) sheeting is produced in a factory environment, 3) polymeric membranes are flexible, and 4) simple installation. The disadvantages include: 1) chemical resistance must be determined for each application, 2) seaming systems may be a weak link in the system, and 3) many materials are subject to attack from biotic, mechanical, or environmental sources.
   - Geotextiles are uncoated synthetic textile products that are not water tight. They are composed of a variety of materials, most commonly polypropylene and polyester. Geotextiles serve five basic functions: 1) filtration, 2) drainage, 3) separation, 4) reinforcement, and 5) armoring.

For more information on geosynthetics, see the reference below.

REFERENCES

Covers for Uncontrolled Hazardous Waste Sites, USEPA, EPA/540/2-85/002, PB87-119483, 1985.

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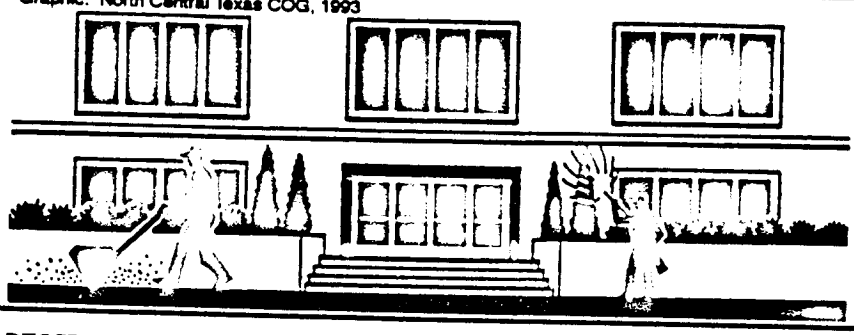
ACTIVITY: BUILDING AND GROUNDS MAINTENANCE

Graphic: North Central Texas COG, 1993



Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from buildings and grounds maintenance by washing and cleaning up with as little water as possible, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the storm water collection system.

APPROACH

- Leaving or planting native vegetation to reduce water, fertilizer, and pesticide needs.
- Careful use of pesticides and fertilizers in landscaping.
- Integrated pest management where appropriate.
- Sweeping of paved surfaces.
- Cleaning of the storm drainage system at appropriate intervals.
- Proper disposal of wash water, sweepings, and sediments.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIRMENTS

- Costs (Capital, O&M)
  - Cost will vary depending on the type and size of facility.
  - Overall costs should be low in comparison to other BMPs.
- Maintenance
  - The BMPs themselves relate to maintenance and do not require maintenance as they do not involve structures.

LIMITATIONS

- Alternative pest/weed controls may not be available, suitable, or effective in every case.

Targeted Constituents

- ● *Sediment*
- ● *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ● *Floatable Materials*
- ● *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

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Additional Information — Building and Grounds Maintenance

Buildings and grounds maintenance includes taking care of landscaped areas around the facility, cleaning of parking lots and pavement other than in the area of industrial activity, and the cleaning of the storm drainage system. Painting and other minor or major repairs of buildings is covered in SC12 (Building Repair, Remodeling, and Construction). Certain normal maintenance activities can generate materials that must be properly disposed. Other maintenance activities can enhance water quality if they are carried out more frequently and/or in a more deliberate fashion.

Pesticide/Fertilizer Management

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. In particular, do not apply these materials during the wet season as they may be carried from the site by the next storm. When irrigating the landscaped areas, avoid over-watering not only to conserve water but to avoid the discharge of water which may have become contaminated with nutrients and pesticides.

It is important to properly store pesticides and application equipment, and to dispose the used containers in a responsible manner, consistent with state regulations. Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.

Written procedures for the use of pesticides and fertilizers relevant to your facility would help maintenance staff understand the "do's" and "don'ts". If you have large vegetated areas, consider the use of integrated pest management (IPM) techniques to reduce the use of pesticides.

Parking/Storm Sewer Maintenance

A parking area that drains to the same storm drainage system as the industrial activity that is to be permitted must also be evaluated for suitable BMPs. Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals such as copper, lead, cadmium, and zinc, as well as the petroleum byproducts of engine combustion. Deposition of air particulates, generated by the facility or by adjacent industries, may contribute significant amounts of pollutants.

The two most appropriate maintenance BMPs are periodic sweeping and cleaning catch basins if they are part of the drainage system. A vacuum sweeper is the best method of sweeping, rather than mechanical brush sweeping which is not as effective at removing the fine particulates.

Catch basins in parking lots generally need to be cleaned every 6 to 12 months, or whenever the sump is half full. A sump that is more than half full is not effective at removing additional particulate pollutants from the storm water. If the storm drain lines have a low gradient, less than about 0.5 feet in elevation drop per 100 feet of line, it is likely that material is settling in the lines during the small, frequent storms. If you have not cleaned the storm drain system for some time, check the lines as well. If they are not cleaned, the catch basins will likely be filled during the next significant storm by material that is washed from the lines. Also, install "turn-down" elbows or similar devices on the outlets of the catch basins; they serve to retain floatables, oil and grease.

Clearly mark the storm drain inlets, either with a color code (to distinguish from process water inlets if you have them) or with the painted stencil of "DO NOT DUMP WASTE". This will minimize inadvertent dumping of liquid wastes.

Sweepings and sediments from these maintenance activities are generally low in metals and other pollutants and therefore can be disposed on-site or to a construction debris landfill. Test the material if there is a reasonable doubt whether metals or other pollutants are present. If concentrations of contaminants are high, it indicates that other BMPs may be needed to eliminate or reduce emissions from the source. If a vactor truck is used to clean the storm drainage system,

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dirty water will be generated. This water should not be discharged to the storm drainage system as it is silt laden and contains much of the pollutants that were removed by the catch basins. The water should be disposed to the process wastewater system, if you have one, or to the public sewer if permission is granted by the local sewer authority. Alternatively, the water can be placed somewhere on the site where it can evaporate.

The cleaning of the paved surfaces and catch basins in the areas of industrial activity has been discussed previously in SC5 (Loading and Unloading of Materials), SC7 (Outdoor Process Equipment Operations and Maintenance), and SC8 (Outdoor Storage of Raw Materials, Products, and Byproducts).

If some employees have cars that are leaking abnormal amounts of engine fluids, encourage them to have the problem corrected.

Examples of Effective Programs

Information on integrated pest management may be obtained from the Bio-Integral Resource Center, P.O. Box 7414, Berkeley, CA 94707, 510-524-2467.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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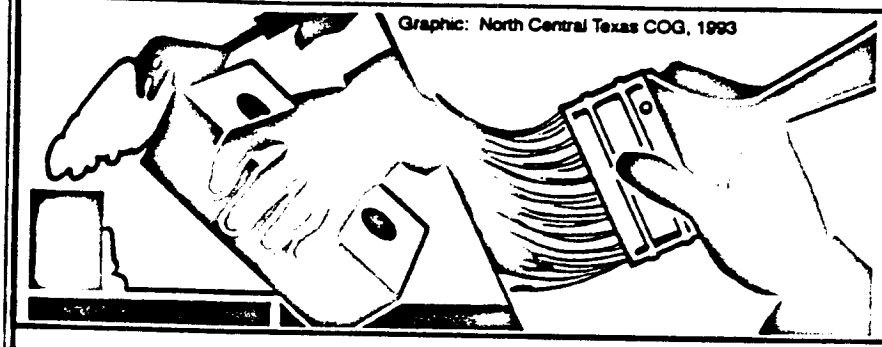
ACTIVITY: BUILDING REPAIR, REMODELING AND CONSTRUCTION



Graphic: North Central Texas COG, 1993

Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from building repair, remodeling, and construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

APPROACH

- Use soil erosion control techniques if bare ground is temporarily exposed. See the Construction Activity Best Management Practice Handbook.
- Use permanent soil erosion control techniques if the remodeling clears buildings from an area that are not to be replaced. See SC10 (Contaminted or Erodible Surface Areas).
- Enclose painting operations, consistent with local air quality regulations and OSHA.
- Properly store materials that are normally used in repair and remodeling such as paints and solvents.
- Properly store and dispose waste materials generated from the activity. See CA20, Solid Waste Management, Construction Handbook.
- Maintain good housekeeping practices while work is underway.

REQUIREMENTS

- Costs (Capital, O&M)
  - These BMPs are generally of low to modest in cost.

LIMITATIONS

- This BMP is for minor construction only. The State's General Construction Activity Storm Water Permit has more requirements for larger projects. The companion "Construction Activity Best Management Practice Handbook" contains specific guidance and best management practices for larger-scale projects.
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.
- Safer alternative products may not be available, suitable, or effective in every case.
- Be certain that actions to help storm water quality are consistent with Cal- and Fed-OSHA and air quality regulations.

Modifications are a common occurrence particularly at large industrial sites. The activity

Targeted Constituents

- ● *Sediment*
- ○ *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ● *Floatable Materials*
- ○ *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

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may vary from minor and normal building repair to major remodeling, or the installation of new facilities on currently open space. These activities can generate pollutants that can reach storm water if proper care is not taken. The sources of these contaminants may be solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos installation.

Good Housekeeping

Proper care involves a variety of mostly common sense, housekeeping actions such as:

- Keep the work site clean and orderly. Removing debris in a timely fashion. Sweep the area.
- Cover materials of particular concern that must be left out, particularly during the rainy season.
- Educate employees who are doing the work.
- Inform on-site contractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Do not dump waste liquids down the storm drain.
- Advise concrete truck drivers to not wash their truck over the storm drain. Have a designated area that does not drain to the storm drain.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed.

Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do.

Painting operations should be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Application equipment that minimizes overspray also helps. Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality. If painting requires scraping or sand blasting of the existing surface, use a ground cloth to collect the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste.

Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100% effective. Dried paint will erode from a surface and be washed away by storms. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer. Properly store leftover paints if they are to be kept for the next job, or dispose properly.

When using sealants on wood, pavement, roofs, etc, quickly clean up spills. Remove excess liquid with absorbent material or rags. If when repairing roofs, small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.

Soil/Erosion Control

If the work involves exposing large areas of soil employ the appropriate soil erosion and control techniques. See the Construction Best Management Practice Handbook. If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in SC10, Contaminated or Erodible Surface Areas.

If a building is to be placed over an open area with a storm drainage system, make sure the storm inlets within the

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building are covered or removed, or the storm line is connected to the sanitary sewer. If because of the remodeling a new drainage system is to be installed or the existing system is to be modified, consider installing catch basins as they serve as effective "in-line" treatment devices. See TC2 (Wet Ponds) in Chapter 5 regarding design criteria. Include in the catch basin a "turu-down" elbow or similar device to trap floatables.

Recycle residual paints, solvents, lumber, and other materials to the maximum extent practical. Buy recycled products to the maximum extent practical..

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

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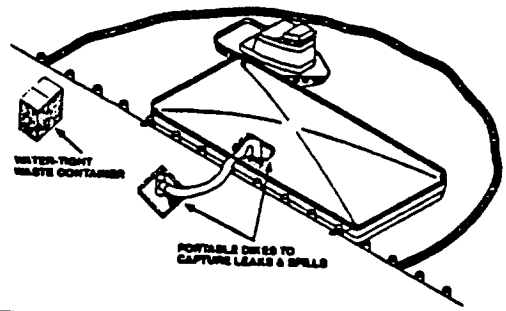
ACTIVITY: OVER-WATER ACTIVITIES



Applications

- Manufacturing
- **Material Handling**
- Vehicle Maintenance
- Construction
- **Commercial Activities**
- Roadways
- **Waste Containment**
- **Housekeeping Practices**

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water and receiving waters from over-water activities by minimizing over-water maintenance, keeping wastes out of the water, cleaning up spills and wastes immediately, and educating tenants and employees.

APPROACH

- Properly dispose of domestic wastewater and ballast water.
- Limit over-water hull surface maintenance to sanding and minor painting.
- Use phosphate-free and biodegradable detergents for hull washing.
- Use secondary containment on paint cans.
- Have available spill containment and cleanup materials.
- Use ground cloths when painting boats on land.
- Use tarps, plastic sheeting, etc. to contain spray paint and blasting sand.
- Properly dispose of surface chips, used blasting sand, residual paints, and other materials. Use temporary storage containment that is not exposed to rain.
- Immediately clean up spills on docks or boats.
- Sweep drydocks before flooding.
- Clean catch basins and the storm drains at regular intervals.
- Post signs to indicate proper use and disposal of residual paints, rags, used oil, and other engine fluids.
- Educate tenants and employees on spill prevention and cleanup.
- Include appropriate language in tenant contracts indicating their responsibilities.
- Marinas should provide wastewater disposal facilities.

REQUIREMENTS

- Cost (Capital, O&M)
  - Most of the BMPs are of low and modest cost. Exceptions are stations for temporary storage of residual paints and engine fluids, and wastewater pumpout facilities.
- Maintenance
  - Keep ample supply of spill cleanup materials.

LIMITATIONS

Private tenants at marinas may resist restrictions on shipboard painting and maintenance. Existing contracts with tenants may not allow the owner to require that tenants abide by new rules that benefit water quality. Even biodegradable cleaning agents have been found to be toxic to fish.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training

● High ○ Low

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Additional Information — Over-Water Activities

Over-water activities occur at boat and ship repair yards, marinas, and yacht clubs, although the later are not required to obtain a permit. Activities of concern include chipping and painting of hulls, on board maintenance of engines, and the disposal of domestic wastewater and ballast water. With few exceptions, BMPs to protect water quality are common sense, low cost changes to normal day-to-day procedures.

Over-water Activity Minimization

Work on boats in the water should be kept to a minimum. Major hull resurfacing should occur on land. Surface preparation over water should be limited to sanding. Painting should be limited to spot work. In marinas, tenant maintenance over water should be such as to not require opening more than a pint size paint can. Paint mixing should not occur on the dock.

Good Housekeeping

When conducting on board maintenance, used antifreeze should be stored in a separate, labeled drum and recycled. Fuel tank vents should have valves to prevent fuel overflows or spills. Boats with inboard engines should have oil absorption pads in bilge areas and they should be changed when no longer useful or at least once a year.

Marina owners should provide temporary storage stations for used engine fluids, paint cans, and other maintenance materials. Signs should be posted at the head of each dock indicating maintenance rules. Marina owners should install a wastewater disposal system, either dockside lines or a pumpout station. Tenant contracts should include language indicating their responsibilities.

When painting on shore, place paint cans in a tray or comparable device that collects spills and drips. Use ground cloths when painting. Use spray guns that minimize overspray; also enclose the area with plastic tarps. Identify a designated area for washing boats. Vacuum sweep work areas frequently. When doing repairs or painting on a tidal grid or similar open "dry dock", use ground cloths to retain chips and spilled paint. The repair yard owner should install signs so that boat owners who are doing their own work know their responsibilities.

Large boat repair yards can implement the above BMPs. There are several additional measures. With regard to dry dock operations: sweep the accessible areas of the dry dock before flooding; and pick up other debris that appears after the ship is floated. Remove floatable debris such as wood. Shipboard cooling and process water discharges should be directed to minimize contact with spent abrasives, paints, and other debris. Look for and repair leaking valves, pipes, hoses, or soil chutes carrying either water or wastewater. Plastic sheeting or other suitable materials should be installed when sandblasting and spray painting.

Use drip pans or comparable devices when transferring oils, solvents, and paints. Regularly clean the shoreside work areas of debris, sandblasting material, etc. Clean catch basins or other parts of the storm drainage system that might accumulate these materials.

Fish Waste

Fish wastes must also be managed properly. Recycling fish wastes back to the water is encouraged when disposal will not result in water quality or public nuisance problems, such as wastes washing up onshore or causing odors or bacteria problems. Fish wastes should not be recycled in any dead end lagoons or other poorly flushed areas. Marina owners should provide fish cleaning stations where waste recycling can occur without adversely affecting water quality.
Note: San Francisco Bay Area boat repair and maintenance facilities. The San Francisco Bay Regional Water Quality Control Board has issued a General Storm Water NPDES Permit to boat yards which work primarily on pleasure vessels less than 65 feet in length. The General Permit requires maintenance of pressure wash containment and recycle or pretreatment system implementation of a Storm Water Pollution Control Plan (SPCP) and a Monitoring Program.

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Additional Information — Over-Water Activities

REFERENCES

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, USEPA, 1992.

General NPDES Permit for Discharges of Storm Water from Boat Repair Facilities, SFBRWQCB, 1992.

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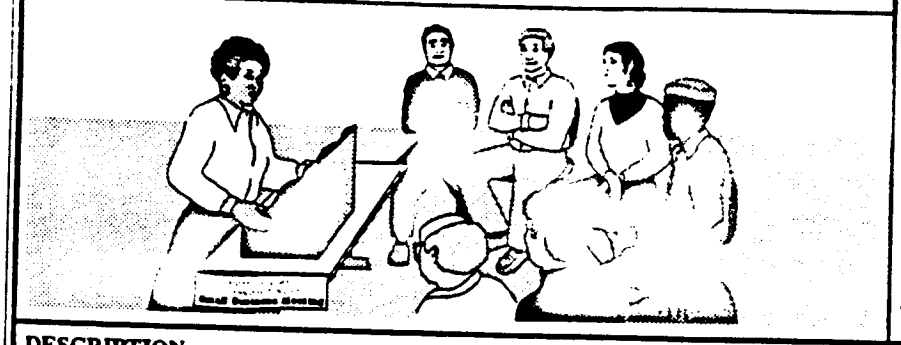
ACTIVITY: EMPLOYEE TRAINING



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

DESCRIPTION

Employee training, like equipment maintenance, is not so much a best management practice as it is a method by which to implement BMPs. This fact sheet highlights the importance of training and of integrating the elements of employee training from the individual source controls into a comprehensive training program as part of a facility's Storm Water Pollution Prevention Plan (SWPPP).

The specific employee training aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approach for assuring employee training in storm water pollution prevention. Accordingly, the organization of this fact sheet differs somewhat from the other fact sheets in this chapter.

OBJECTIVES

Employee training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs);
- Promote employee ownership of the problems and the solutions; and
- Integrate employee feedback into training and BMP implementation.

APPROACH

- Integrate training regarding storm water quality management with existing training programs that may be required for your business by other regulations such as: the Illness and Injury Prevention Program (IIPP) (SB 198) (California Code of Regulations Title 8, Section 3203), the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120), the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112), and the Hazardous Materials Management Plan (Business Plan) (California Health and Safety Code, Section 6.95).
- Businesses, particularly smaller ones that are not regulated by Federal, State, or local regulations, may use the information in this Handbook to develop a training program to reduce their potential to pollute storm water.

LISTING OF INDUSTRIAL ACTIVITIES

Employee training is a vital component of many of the individual source control BMPs included in this chapter. Following is a compilation of the training aspects of the source control fact sheets.

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ACTIVITY — EMPLOYEE TRAINING (Continue)

SC1 Non-Storm Water Discharges to Drains
- Use the quick reference on disposal alternatives (Table 4.1) to train employees in proper and consistent methods for disposal.
- Consider posting the quick reference table near storm drains to reinforce training.

SC2 Vehicle and Equipment Fueling
- Train employees in proper fueling and cleanup procedures.
- The SPCC Plan may be an effective program to reduce the number of accidental spills from fueling.

SC3 Vehicle and Equipment Washing and Steam Cleaning
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.

SC4 Vehicle and Equipment Maintenance and Repair
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
- Paint stencils to remind employees not to pour waste down storm drains.

SC5 Outdoor Loading/Unloading of Materials
- Use a written operations plan that describes procedures for loading and/or unloading.
- Have an emergency spill cleanup plan readily available.
- Employees trained in spill containment and cleanup should be present during loading/unloading.
- Make sure fork lift operators are also properly trained.

SC6 Outdoor Container Storage of Liquids
- Registered and specifically trained professional engineers can identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets for newly installed tank systems.
- Employees trained in emergency spill cleanup procedures should be present when dangerous waste, liquid chemicals, or other wastes are handled.

SC7 Outdoor Process Equipment Operations and Maintenance
- The preferred and possibly most economical action to reduce storm water pollution is to alter the activity. This may mean training employees to perform the activity during dry periods only or substituting benign materials for more toxic ones.

SC8 Outdoor Storage of Raw Materials, Products, and By-Products
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.

SC9 Waste Handling and Disposal
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
- Paint stencils to remind employees not to pour waste down storm drains.

SC10 Contaminated or Erodible Surface Areas
- Training is not a significant element of this best management practice.

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ACTIVITY — EMPLOYEE TRAINING (Continue)

SC11 Building and Grounds Maintenance

- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Written procedures for the use of pesticides and fertilizers relevant to your facility would help maintenance staff understand the "do's" and "don'ts". If you have large vegetated areas, consider the use of integrated pest management (IPM) techniques to reduce the use of pesticides.

SC12 Building Repair, Remodeling, and Construction

- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do.

SC13 Over-Water Activities

- Post signs to indicate proper use and disposal of residual paints, rags, used oil, and other engine fluids.
- Educate tenants and employees on spill prevention and cleanup.
- Include appropriate language in tenant contracts indicating their responsibilities.

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Chapter 5

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5. TREATMENT CONTROL BMPs

INTRODUCTION

This chapter describes specific treatment control Best Management Practices (BMPs) for removing pollutants in storm water from industrial facilities.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Suitable Applications
- Installation/Application Criteria
- Requirements
  - Costs, including capital costs, and operations and maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The side bar presents information on which BMP considerations, targeted constituents, and an indication of the level of effort and costs to implement. The remainder of the fact sheet provides further information on some of all of these topics, and provides references for additional guidelines.

BMP fact sheets are provided for each of the following controls:

Treatment Control BMPs

TC1 Infiltration
TC2 Wet Ponds
TC3 Constructed Wetlands
TC4 Biofilters
TC5 Extended Detention Basins
TC6 Media Filtration
TC7 Oil/Water Separators and Water Quality Inlets
TC8 Multiple Systems

GENERAL PRINCIPLES

There are several general principles that are applicable to all treatment control BMPs.

- **Priority should be given to source control:** Source control BMPs are generally (but not always) less expensive than treatment control BMPs. Also, treatment control BMPs will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding as to the relationship between facility design criteria and performance.

- **Recognize the unique California climate:** With few exceptions most storm water treatment experience has been in "wet" states where vegetation can be maintained without irrigation. In contrast, California's climate is semi-arid with the exception of the north coast. The treatment control BMPs that require vegetative cover may not be practical for many areas of California unless irrigation is provided. Also, design criteria have emerged from research of facilities located in climates where the rainfall season is coincident with the growth of vegetation. However, in California, the wet season does not occur during the primary growth season. Caution must be used in using design criteria that have been developed elsewhere in the nation.

- **Design Storm Size:** It is commonly thought by those unfamiliar with urban runoff quality management that design storms for sizing water quality controls should be the same as those used for the design of drainage facilities. This is not true. The damage done to a receiving water by the pollutant wash-off of a 25 year storm (commonly used to size a

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drainage system) is inconsequential to the potential hydraulic damage. Of concern to water quality control are the small frequent events, smaller than the 1-year storm, that carry the vast majority of runoff and pollutants. There is little or no incremental benefit from sizing facilities to treat the extreme events.

- **Bare and erosive soils may affect treatment control BMPs:** Protection of natural watercourses requires that sediment transport not be altered for the watercourse. Therefore, consideration must be given to transport loads. In addition, many residential developments in California have open space areas covered by native vegetation. Because of the semi-arid climate, the vegetation is thin allowing for erosion during severe storms. These higher than normal sediment loads may adversely impact the performance and maintenance requirements of treatment control BMPs.

- **Consider the characteristics of pollutants in storm water:** The presence and concentration of pollutants is highly variable, both within and between storms. Pollutants come in two forms, particulate and dissolved. Some treatment control BMPs will only remove particulates. Various vegetated BMPs such as wet ponds are purported to remove dissolved pollutants as well as particulates. Vegetated treatment control BMPs have mechanisms that theoretically should also remove both forms, however, the data confirming the theory are limited and sometimes contradictory.

- **Incorporate multiple use objectives:** Opportunities abound to integrate storm water treatment needs with other management objectives such as the use of wet ponds and constructed wetlands for passive recreation, wildlife habitat, flood detention, and ground water recharge.

- **Maintenance is very important:** All of the treatment control BMPs described in Chapter 5 are passive systems, that is, they operate without the need for mechanical or chemical systems. Nonetheless, maintenance is very important for the facilities to operate effectively.

- **Factors to Consider:** Each fact sheet lists seven general factors that are the most common considerations in selecting a treatment control BMP. In every case, all treatment control BMPs must be compatible with existing flood control objectives.

  - Soil: Infiltration systems must be located on suitable soils; vegetation requires good soils; wet pond bottoms require impermeable soils.

  - Area Required: Most BMPs require considerable area, although some can be placed underground.

  - Slope: Certain BMPs cannot be placed on or near steep slopes as the ponding of water or velocity of flow may cause instability or excessive erosion.

  - Water Availability: BMPs using vegetation for pollutant removal may require water during the dry season.

  - Aesthetics and safety: Where visible or accessible to the public, aesthetics or safety can be a concern with some BMPs.

  - Hydraulic Head: A few BMPs require a drop in water elevation which site topography may not provide.

  - Environmental Side Effects: Considerations for mosquito breeding, ground water contamination, as well as opportunities for aquatic wildlife and passive recreation.

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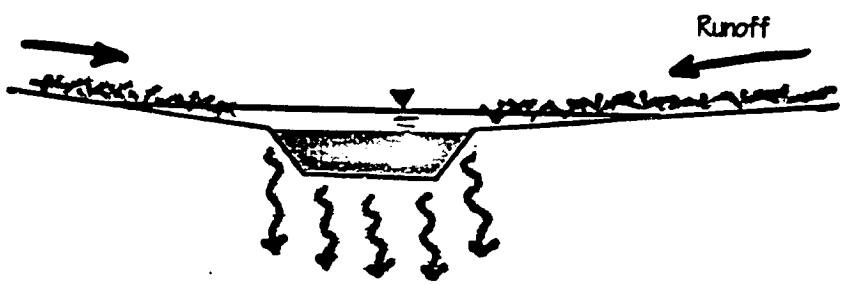
BMP: INFILTRATION



Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

EXPERIENCE IN CALIFORNIA

Infiltration ponds have been used by many local jurisdictions and CalTrans in the Central Valley for about three decades.

SELECTION CRITERIA

- Need to achieve high level of particulate and dissolved pollutant removal.
- Suitable site soils and geologic conditions; low potential for long-term erosion in the watershed.
- Multiple management objectives (e.g., ground water recharge or runoff volume control).

LIMITATIONS

- Loss of infiltrative capacity and high maintenance cost in fine soils.
- Low removal of dissolved pollutants in very coarse soils.
- Not suitable on fill sites or steep slopes.
- Risk of ground water contamination in very coarse soils, may require ground water monitoring.
- Should not use until upstream drainage area is stabilized.
- Infiltration facilities could fall under Chapter 15, Title 23, of California Code of Regulations regarding waste disposal to land.

DESIGN AND SIZING CONSIDERATIONS

- Volume sized to capture a particular fraction of annual runoff.
- Pretreatment in fine soils.
- Emergency overflow or bypass for larger storms.
- Observation well in trenches.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Protect infiltration surface during construction.
- Vegetation of pond sides to prevent erosion.
- Frequent inspection for clogging during construction.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ● Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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BMP: INFILTRATION (Continue)

MAINTENANCE REQUIREMENTS

- Remove sediment at frequency appropriate to avoid excessive concentrations of pollutants and loss of infiltrative capacity.
- Frequent cleaning of porous pavements.
- Maintenance is difficult and costly for underground trenches.

COST CONSIDERATIONS

- Potential for high maintenance costs due to clogging.

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Additional Information — Infiltration

General Information

Where conditions are suitable infiltration systems may be the preferred choice because storm water is placed into the ground thereby reducing excess runoff and providing groundwater recharge.

Infiltration systems include:

- Infiltration basin which is an open surface pond or underground vault (Figure 1A)
- Infiltration trench which is an underground chamber filled with rock, also called a rock well (Figure 1B).
- Dry well or "vertical" infiltration trench (Figure 1C)
- Porous pavement both asphalt and concrete (Figure 1D).
- Concrete grid and modular pavement which are lattice grid structures with grassed, pervious material placed in the openings (Figure 1E).

Infiltration basins are generally used for areas less than five acres but can handle tributary areas up to 50 acres if the soil is very permeable. The other systems are suitable only for small sites of a few acres. Porous pavement and concrete grids should only be used in low traffic areas like parking areas. Studies have shown that porous pavement is strong and will last as long as conventional pavement (Field, et al, 1982; Gburek and Urban, 1980). Experience in Florida and Maryland indicates that concrete porous pavement performs better than porous asphalt. Porous pavements and underground facilities may be favored at industrial sites where land is already needed for business activities.

Infiltration systems should be considered where dissolved pollutants are of concern. However, satisfactory removal efficiencies require soils that contain loam. Coarse soils are not effective at removing dissolved pollutants and fine particulates before the storm water reaches the ground water aquifer.

Local jurisdictions may not feel that infiltration systems are appropriate on industrial sites where spills of hazardous chemicals can occur. However, spill control procedures may provide satisfactory control (Chapter 4). Care should be taken when considering the multiple objectives of using infiltration systems for water quality treatment, ground water recharge, and flood control. Infiltration basins, trenches, and porous pavement can meet storm water detention requirements.

Three concerns with infiltration systems are clogging, accumulation of metals, and ground water contamination. Infiltration systems have been used successfully on sandy soils in the Central Valley of California and Long Island, New York for many years without operational problems. In both instances the primary objectives are ground water recharge and flood control, not water quality treatment.

Problems can be expected with infiltration systems placed in finer soils. The State of Maryland has emphasized these systems for about 10 years where they have been installed in soils with infiltration rates as low as 0.27 inches per hour. A recent survey (Lindsey, et al., 1991) found that a third of the facilities examined (177) were clogged and another 18% were experiencing slow infiltration. Dry wells that treat roof runoff had the fewest failures (4%) and porous pavement the most (77%). Dry wells may have the lowest failure rate because they only handle roof runoff. The primary causes of failure appear to be inadequate pretreatment and lack of soil stabilization in the tributary watershed, as well as poor construction practices (Shaver, pers. comm.). Erosion of the slopes of infiltration ponds was a significant problem in almost half the facilities surveyed. Problems have occurred in the Central Valley with facilities placed on finer soils, as in the case of Modesto. (Tulloch, pers. comm.).

Based on a review of several studies of infiltration facilities in sandy and loamy soils concluded that "monitoring ... has not demonstrated significant contamination ... although highly soluble pollutants such as nitrate and chloride have been shown to migrate to ground water" (USEPA, 1991). However, pollution has been found in ground water where infiltration devices are in coarse gravels (Adophson, 1989; Miller, 1987).

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Additional Information — Infiltration

Site Selection Considerations (infiltration basin)

- Recommended minimum preconstruction infiltration rates have ranged from 0.25 to 4 inches per hour.
- One state (Ecology, 1992) has specified a maximum clay content (30%) and a minimum cation exchange capacity (5 meq).
- Not less than three feet separation from seasonal high ground water, much greater distance if soils are very coarse.
- Avoid steep (25%) slopes or other geologic conditions that would be made unstable by the infiltrating water.
- Not less than four feet separation from bedrock.
- Impact on local groundwater including recharge potential, water quality, etc.

Stahre and Urbonas (1988) have presented a site selection procedure, if the site first passes the above criteria. Presented in Table 1A is a point system. If the site receives less than 20 points it is considered unsuitable; more than 30 points is considered excellent. This procedure is used to enhance infiltration performance and minimize clogging.

Design

The degree of treatment achieved by infiltration is a function of the amount of storm water that is captured and infiltrated over time. This relationship for various areas in California is shown in Appendix D. The figures in Appendix D were developed using the hydrological model STORM.

The procedure to determine the volume of infiltration basin is as follows: (1) select the appropriate figure in Appendix D; (2) determine for the catchment the percentage of impervious area directly connected to the storm drain system; (3) choose a capture goal, and read the required unit basin storage (acre-ft. per acre) required for the infiltration basin (to provide performance similar to the other treatment control BMPs in Chapter 5, a reasonable capture goal for infiltration systems is 80%.); (4) multiply this unit figure times the total acreage of the catchment and convert to cubic feet. When using the above approach to size an infiltration trench, remember to increase the volume of the trench to account for the rock.

To calculate the minimum surface area of the infiltration system obtain the infiltration rate at the site using appropriate techniques. This value is then used in the following equations:

$$A_m = V/D_m \qquad (1)$$

where: A_m = minimum area required (ft^2)
V = volume of the infiltration basin (ft^3)
D_m = maximum allowable basin depth (ft)

The maximum allowable depth is determined from the equation:

$$D_m = 40I/12S \qquad (2)$$

where: I = site infiltration rate in inches per hour
S = safety factor

The safety factor accounts for the uncertainty of whether the infiltration test measures the real infiltration rate. Recommendations have ranged from 2 to 10 (consult your local Soil Conservation Service Office). The coefficient of 40 refers to the recommended drawdown time in hours. This is a reasonable drawdown time, given that the average time between storms during the wet season in California is on the order of 200 hours, except in Northern California where it is about 80 hours. A longer drawdown time may cause anaerobic conditions in the underlying soil or the production of algae during the warmer months that would clog the soil. A shorter drawdown time reduces the volume of the facility, but increases the required surface area. Appendix D contains figures for two drawdown times: 24 and 40 hours. In most of the State, reducing the drawdown time does not significantly reduce the volume.

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Additional Information — Infiltration

Suggested references on the design of porous pavement include Maryland (1984) and Florida (1988).

Additional design considerations

- For basins and trenches, pretreat the storm water to remove the floatables and settleable solids, particularly when placing these systems in finer soils. Pretreatment can be accomplished with any of the other treatment control BMPs in this handbook.

Communities and CalTrans have used infiltration systems in the Central Valley for more than two decades without pretreatment. Clogging has not been a problem with well maintained systems discharging to sands and courser soils, suggesting that pretreatment is of limited value. Pretreatment when infiltrating to finer soils is suggested by the experience of Maryland described previously. An infiltration facility sized only for treatment is much smaller than one sized for flood control and therefore may be more susceptible to clogging. Communities in the Central Valley (Fresno, Modesto) require a retention volume that captures the 100 year event, or about 20,000 ft^3 per impervious tributary acre. In comparison, above Equation (1) will provide a volume in the range of 2,000 ft^3 per impervious acre.

For small systems treating less than a few acres of pavement, pretreatment can be accomplished with a Type 2 catch basin and a submerged outlet. The diameter and depth of the sump should be at least four times the diameter of the outlet pipe to the infiltration system (Lager, et al., 1977). See Figure 1C. The catch basin cover should be stenciled "dump no waste". Vegetated biofilters can also be used although they will not likely be feasible in industrial sites which tend to be fully utilized.

Additional design considerations for basins include:

- Do not locate on fill sites, or on or near steep slopes
- Energy dissipation at inlet to minimize erosion
- Vegetate the slopes for the same reason
- Vegetate the bottom to reduce tendency to clog with fines
- Freeboard of 1 foot
- Side slopes of at least 3:1 for safety, and for ease of mowing (4:1 slopes are prefered)
- Incorporate bypass or overflow for large events
- Provide dedicated access to the basin bottom (minimum 4:1) for maintenance vehicles

Vegetating the slopes and bottom will be difficult unless the facility can be irrigated during the summer. Drought tolerant ground cover species may be more suitable. See TC4 Biofilters for recommended species.

Additional design considerations for trenches include:

- Do not locate on fill sites, or on or near steep slopes
- A 4 inch or 6 inch diameter observation well with locking cap, to check for loss of infiltrative capacity
- 6 inch sand layer or geofabric at the bottom
- Geofabric around trench walls to prevent soils from migrating into the trench rock matrix
- Geofabric 12 inches below ground surface with 3/4 rock placed on top, which serves as filter for coarse solids
- Backfill and filter rock should be clean washed aggregate 1 inch to 3 inches diameter
- Incorporate bypass or overflow for large events
- Provide dedicated access for maintenance vehicles

For porous pavement, experience in Maryland suggest that asphalt pavement has continuous plugging problems and a limited life. Frequent maintenance is required. For drywells where access for maintenance is difficult if not impossible pretreatment of the storm water is highly recommended. Such pretreatment may include biofilters, sumps, etc. Consultation with the local jurisdiction regarding the design of drywells is required.

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Additional Information — Infiltration

Construction

It is very important to protect the natural infiltration rate by using light equipment and construction procedures that minimize compaction. Storm water must not be allowed to enter the facility until all construction in the catchment area is completed and the drainage area is stabilized. If this prohibition is not feasible in particular situations, do not excavate the facility to final grade until after all construction is complete upstream. Leave one foot of native soil in the basin which can be removed in layers as it clogs. Disking the surface frequently during this period may be beneficial. After final grading the final surface should also be disked. With trenches, make sure the rock fill does not become dirty while temporarily stored at the site.

The local jurisdiction may also specify that the infiltration rate of the facility be within a certain percentage of the preconstruction rate before the facility is approved or accepted.

Maintenance

Inspect the facility at least annually and after extreme events. If there is still water in the pond or trench 72 hours after a storm it is time to clean the facility. A concern is restrictions on the disposal of the sediment removed from an infiltration basin due to contamination. Limited studies suggest that this is not a problem, particularly if source-control BMPs are effective. The Fresno Metropolitan Flood Control District found noticeable accumulation of pollutants in the surface layer in infiltration basins that had not been cleaned for about 20 years although the levels were still below toxic thresholds. The basins are now cleaned at least once every three years. Limited studies of the bottom sediments in wet and extended detention ponds indicate that toxicity limits specified by final disposal regulations are not exceeded (see TC2 Wet Ponds).

Pretreatment may reduce maintenance costs by capturing gross settleable solids and floatables in a smaller space that can be more easily cleaned. Maintenance techniques for basins include rototilling, disking and deep ripping.

Porous pavement should be cleaned at least quarterly by vacuum sweeping and high pressure washing.

See Maryland (1984) and Florida (1988) for additional guidance on the design, construction, and maintenance of infiltration systems.

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TABLE 1A. POINT SYSTEM FOR EVALUATING INFILTRATION SITES

1. Ratio between tributary connected impervious area (AIMP) and the infiltration area (AINF):
   - AINF > 2 AIMP
     20 points
   - AIMP < AINF < 2 AIMP
     10 points
   - 0.5 AIMP < AINF < AIMP
     5 points

2. Nature of surface soil layer:
   - Course soils with low ratio of organic material
     7 points
   - Normal humus soil
     5 points
   - Fine grained soils with high ratio of organic material
     0 points

3. Underlaying soils:
   - If the underlaying soils are courser than surface soil, assign the same number of points as for the surface soil layer assigned under item 2 above.
   - If the underlaying soils are finer grained than the surface soils, use the following points:
   - Gravel, sand of glacial till with gravel or sand
     7 points
   - Silty sand or loam
     5 points
   - Fine silt or clay
     0 points

4. Slope (S) of the infiltration surface:
   - S < 0.07 ft/ft
     5 points
   - 0.07 < S < 0.20 ft/ft
     3 points
   - S > 0.20 ft/ft
     0 points

5. Vegetation cover:
   - Healthy natural vegetation cover
     5 points
   - Lawn is well established
     3 points
   - Lawn is new
     0 points
   - No vegetation, bare ground
     -5 points

6. Degree of traffic on infiltration surface:
   - Little foot traffic
     5 points
   - Average foot traffic (park, lawn)
     3 points
   - Much foot traffic (playing fields)
     0 points

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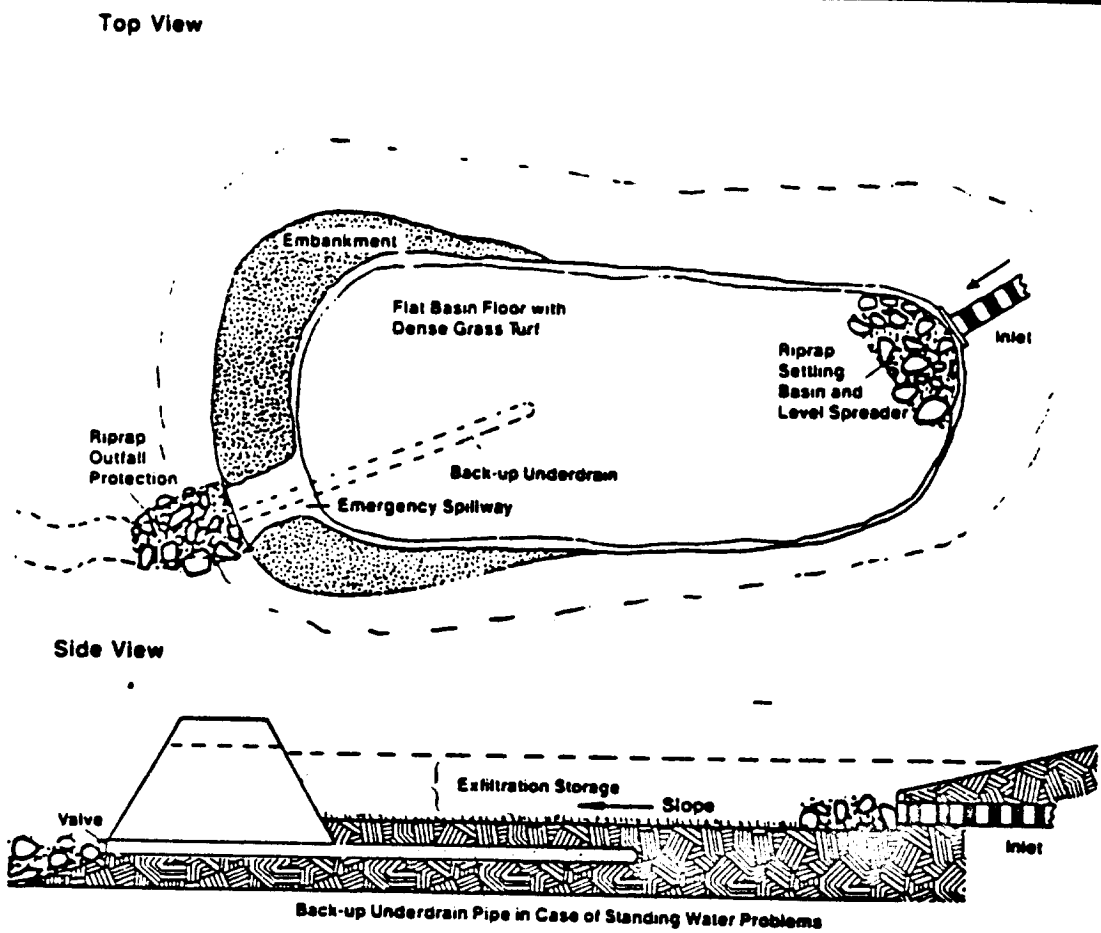
Additional Information — Infiltration



Source: Schueler (1987)

NOTE:

1. Backup underdrain is not used in most applications because plugging occurs in soil above the drain.
2. An infiltration basin can also be excavated (typically 2 to 6 feet deep) as long as the bottom of the basin is 3 feet above high seasonal water table.

FIGURE 1A. INFILTRATION BASIN

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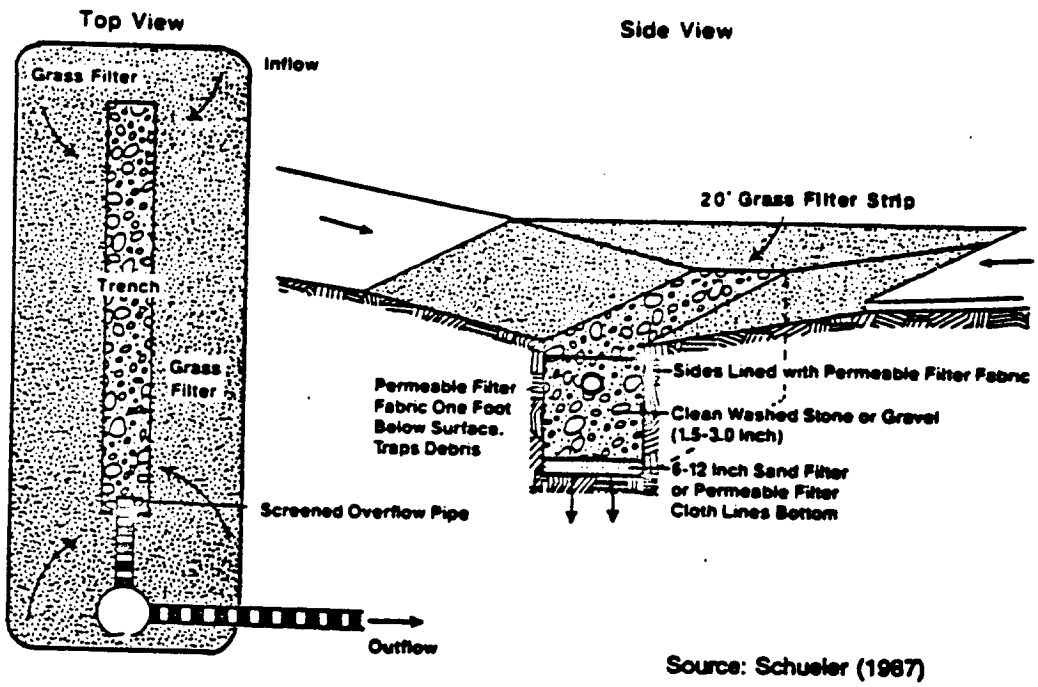

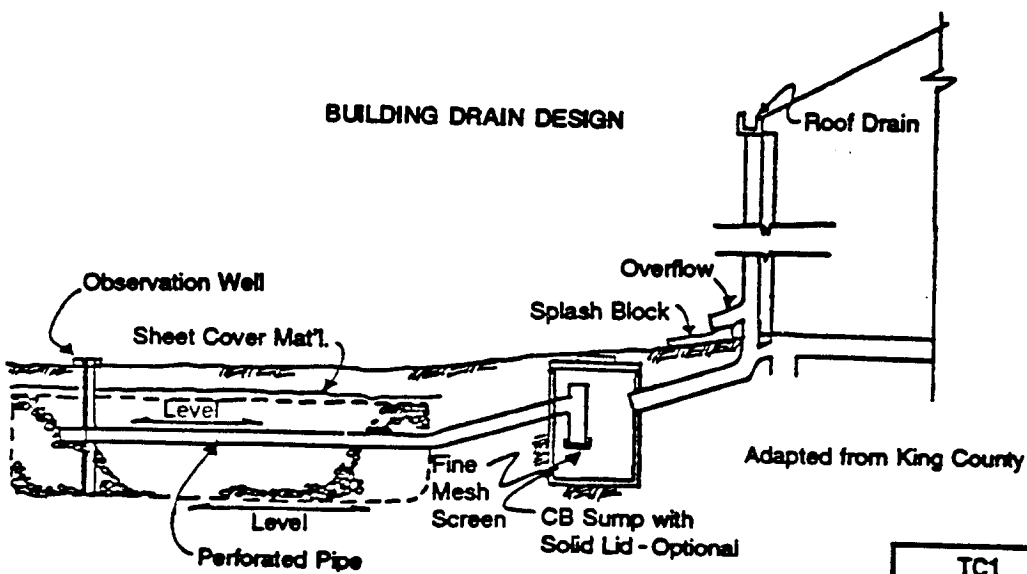

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FIGURE 1B. INFILTRATION TRENCHES

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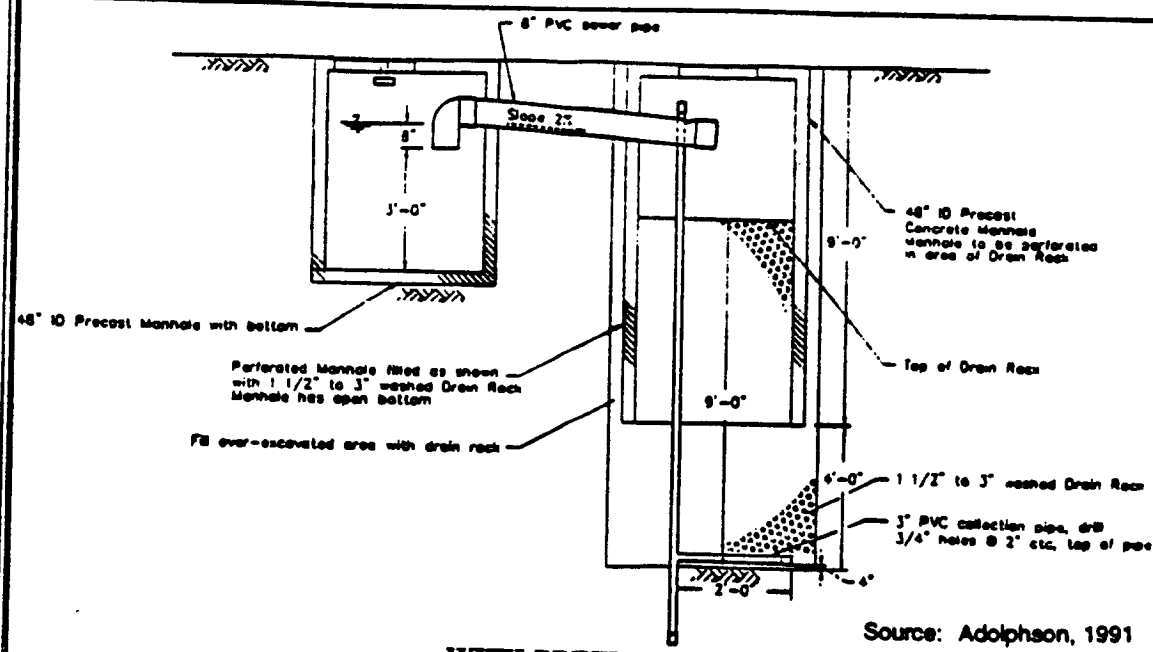
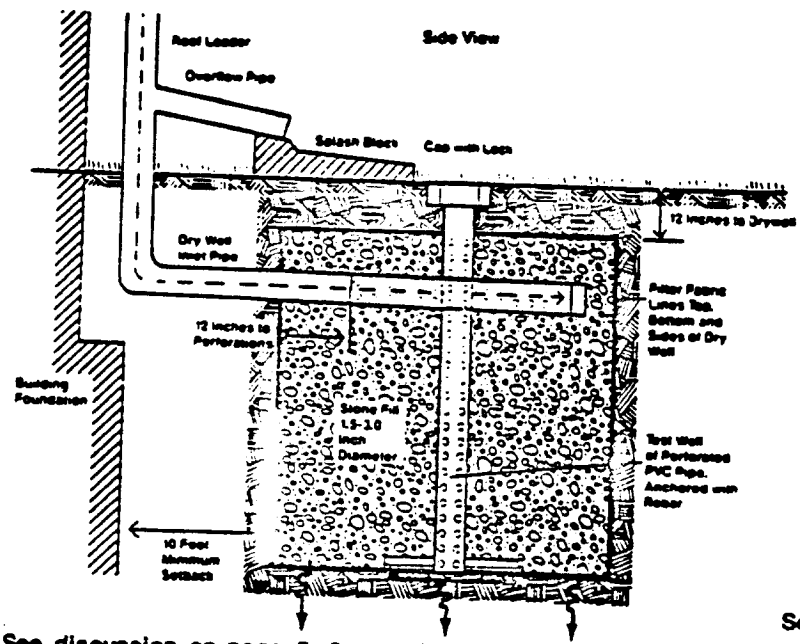


Source: Adolphson, 1991

WITH PRETREATMENT



Source: Schueler, 1987

Note: See discussion on page 5–6 regarding design considerations.

WITHOUT PRETREATMENT

FIGURE 1C. DRYWELL CONFIGURATIONS

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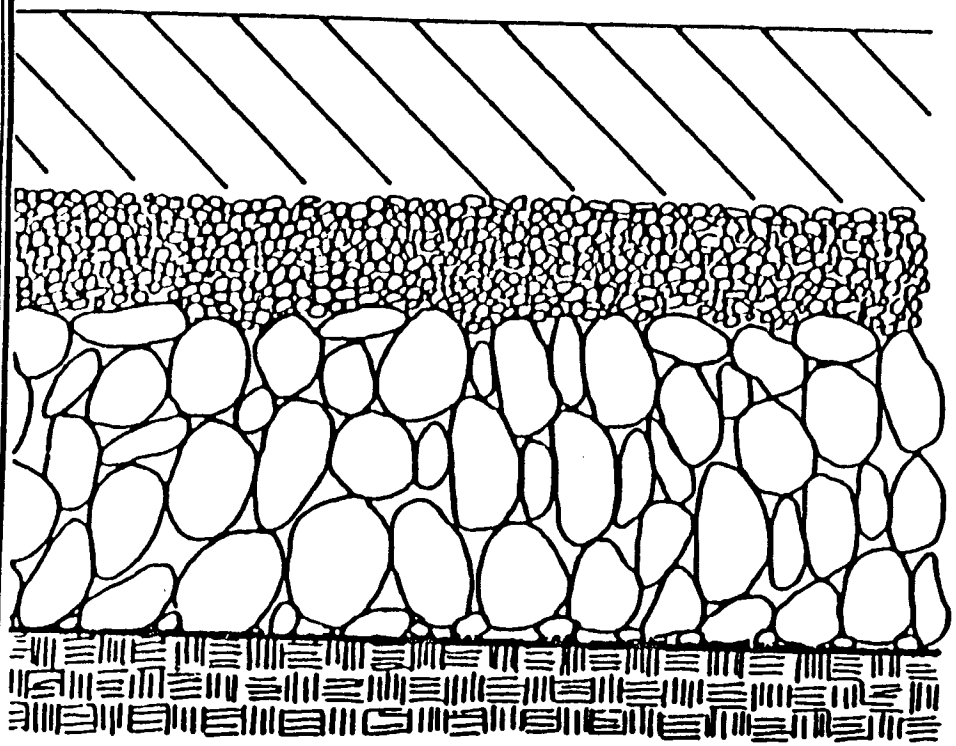

POROUS ASPHALT SURFACE COURSE
1/2" to 3/4" Aggregate
asphaltic mix

2.5 to 4" thickness typical

FILTER COURSE
1/2" Aggretate
2" Thickness

RESERVOIR BASE COURSE
1" to 2" Aggregate
Voids volume is designed for
runoff Retention

Thickness is based on storage
required

FILTER FABRIC

EXISTING SOIL
Minimal compaction to retain
porosity and permeability

Source: City of Rockville, Maryland

FIGURE 1D. POROUS ASPHALT PAVING TYPICAL SECTION

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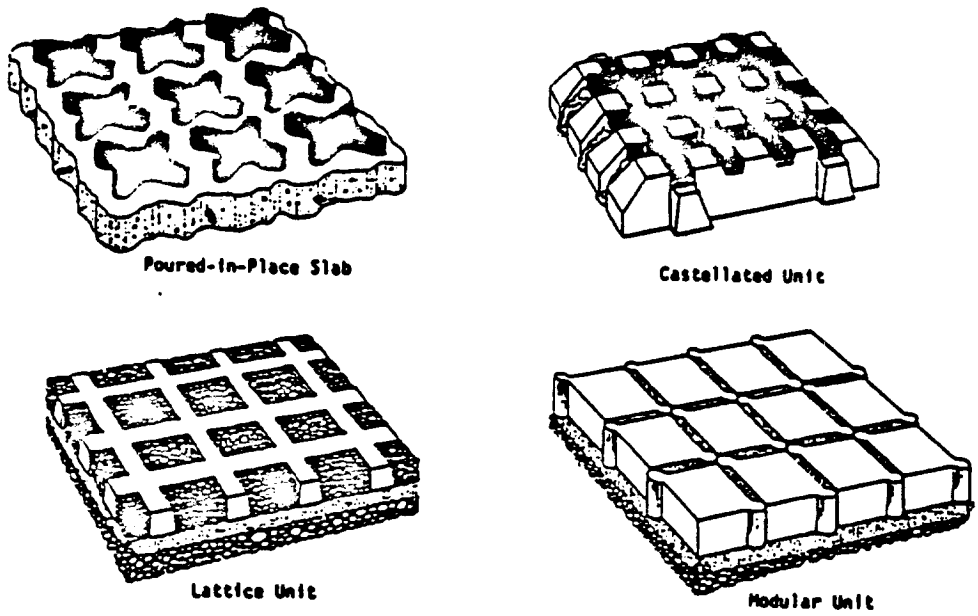

Source: State of Florida

FIGURE 1E. TYPES OF GRID AND MODULAR PAVEMENTS

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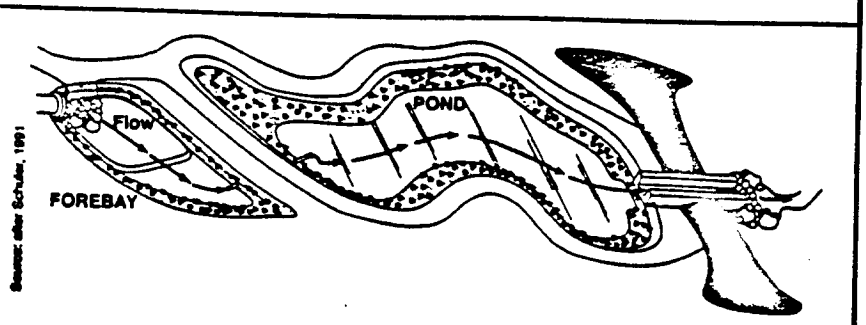
BMP: WET PONDS



Source: after Schueler, 1991

DESCRIPTION

A wet pond has a permanent water pool to treat incoming storm water. An enhanced wet pond includes a pretreatment sediment forebay

CALIFORNIA EXPERIENCE

There are regional flood control basins in California that function like wet ponds or constructed wetlands (TC3).

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation (e.g., bird watching, wildlife habitat).

LIMITATIONS

- Concern for mosquitoes and maintaining oxygen in ponds.
- Cannot be placed on steep unstable slopes.
- Need base flow or supplemental water if water level is to be maintained.
- Infeasible in very dense urban areas.
- In California the wet season is coincident with minimal plant growth.
- Could be regulated as a wetlands or under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.
- Pending volume and depth, pond designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Wet pool volume determined by Figures 2B and C.
- Water depth of 3 to 9 feet.
- Wetland vegetation, occupying 25-50% of water surface area.
- Design to minimize short-circuiting.
- Bypass storms greater than two year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be careful when installing wetland vegetation.

MAINTENANCE REQUIREMENTS

- Remove floatables and sediment build-up.
- Correct erosion spots in banks.
- Control mosquitoes.
- May require permits from various regulatory agencies, e.g. Corps of Engineers.

COST CONSIDERATIONS

- Costs for providing supplemental water may be prohibitive.

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

TC2

Best Management Practices

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Additional Information — Wet Ponds

General

The major features of a wet pond are shown in Figure 2A. It is essentially a small lake with rooted wetland vegetation along the perimeter. The permanent pool of water provides a quiescent volume for continued settling of particulate contaminants and uptake of dissolved contaminants by aquatic plants between storms. The wetland vegetation is present to improve the removal of dissolved contaminants and to reduce the formation of algal mats. However, given the need to minimize the impact on space, it may be cost-effective to use vertical concrete retaining walls which would not allow for emergent vegetation.

The average depth of the wet pool is generally 3 to 9 feet, although greater depths are possible with artificial mixing. The objective is to avoid thermal stratification that could result in odor problems. Gentle artificial mixing may be needed in small ponds because they are effectively sheltered from the wind.

In industrial applications ground water or treated process water will have to be pumped into the facility to maintain the water level. The wet pond could be allowed to dry during the summer months. Allowing the wet pond to dry has not been tried elsewhere but seems feasible since the pond need not operate during the summer months. The major problem with this concept will likely be aesthetics rather than performance.

Wet ponds are of interest where the removal of the dissolved constituent fraction is of concern, particularly nutrients and metals. Dissolved contaminants are removed by a combination of processes: physical adsorption to bottom sediments and suspended fine sediments, natural chemical flocculation, and uptake by aquatic plants. A wet pond with concrete sides and floor would therefore not likely provide any advantage over the non-vegetative treatment control BMPs. The relative importance of each mechanism is not well understood. Very limited data prevents a definitive conclusion as to the effectiveness of wet ponds in removing dissolved contaminants. Reduction in the dissolved fraction of phosphorus and some metals have been observed but this does not necessarily mean it is removed in the pond. It may be incorporated into algae or absorbed onto fine particulate matter which exits the facility in the effluent. If the primary removal mechanism is biological, wet ponds may not be particularly effective in removing dissolved contaminants in California because most storms occur during winter when plant growth is minimal.

Another concept is the extended detention wet pond in which the outlet of the facility is restricted so as to retain a treatment design storm on top of the wet pool for a specified time. It is believed this added measure improves performance. The effect of restricting the outflow is to reduce the overflow rate during the storm increasing the capture of settleable solids. However, the majority of settling occurs between rather than during the storms. The extended detention zone may therefore provide little incremental benefit. If vertical space is available the concept could be employed because the added cost may be nominal. See TC5 Extended Detention Basins on how to determine the extended detention volume.

Design

Two methods have been proposed for the sizing of wet ponds: one predicated on the removal of particulate contaminants only (USEPA, 1986) and one predicated on the removal of phosphorus as well (Florida, 1988; Maryland, 1986). The first method relates the removal efficiency of suspended solids to pond volume. The second method provides a detention time of 14 days based on the wettest month to allow sufficient time for the uptake of dissolved phosphorus by algae and the settling of fine solids where the particulate phosphorus tends to be concentrated. The criterion of 14 days comes from Kast et al., 1983 who observed that in lakes at least 14 days is needed for significant algal growth during the growing season. In much of the United States including Maryland and Florida the growing season is coincident with significant rainfall. But this is not the situation in California where essentially all of the rainfall occurs from November through April. Consequently, the removal of phosphorus and fine solids will not be as high as the literature indicates.

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Additional Information — Wet Ponds

Sizing the Permanent Pool

Figure 2B shows the relationship between performance and the long-term removal efficiency for average conditions in California (USEPA (1986) as adapted in FHWA (1989)). V_b/V_r is the ratio of the volume of the wet pond to the volume of the runoff of the mean storm event from the tributary watershed. The depth of the mean storm for various areas of California is shown in Figure 2C. The recommended performance goal is 80%. The volume of the pond is therefore calculated as follows:

$$V_b = 3S_d A_i 43560/12 = 10890S_dA_i \qquad (1)$$

where: V_b = pond volume (ft^3)
S_d = mean storm depth (inches)
A_i = impervious acres in the tributary watershed

For A_i the engineer may use directly connected impervious acres because it more correctly represents the area being treated and would allow a smaller facility. Although impervious area and directly connected impervious area are not the same, they are reasonable given the uncertainty of the methodology and expected pond performance.

This volume should be compared with the 14 days detention time criterion and the more conservative volume (i.e., larger volume) should be used for sizing.

Adding Detention Storage to the Permanent Pool

Some investigators believe that detention volume added above the permanent pool enhances pool performance. The State of Florida, for example, requires one basin inch of detention storage be added to the permanent pool and be bled down over a 60 hour period. This requirement, however, adds considerably to the size of the basin, and the literature does not indicate that water quality performance is improved. Therefore detention storage should be added only if the pond is to be used for drainage control in addition to water quality control. As with extended detention, consideration should be given to bypassing the facility for flows greater than the two year storm so that bed load is not trapped in the pond.

A perforated riser outlet recommended by the Denver Urban Drainage and Flood Control Districts is illustrated in Figures 2D and 2E. Other outlet concepts are illustrated in TC5, Extended Detention Basins, Figure 5B.

Additional Considerations

- Place wetland vegetation around the pond perimeter and near the outlet.

Rooted vegetation around the pond perimeter serves several functions (Figure 2A). It enhances the removal of dissolved pollutants (see T3, Constructed Wetlands); it may reduce the formation of floating algal mats; it reduces the risk of people falling into the deeper areas of the pond; and, it provides some habitat for insects, aquatic life, and wetland wildlife. The "shelf" for the vegetation should be about 10 feet wide with a water depth of 1 to 2 feet. The total area of the "shelf" should be 25-50% of the water surface area. Vegetation near the exit will assist settling of solids. An alternative is a rock filter which is used in many wastewater oxidation ponds where loss of algae in the effluent is a common problem during the growth season (Rich, L., 1988).

If mesquites are of particular concern, it would be advisable to inhibit the growth of emergent wetland vegetation around the perimeter by using steep slopes, say, 2:1, and by minimizing the amount of pond area that has a depth less than 18". Gambusia (mosquito fish) can also be planted in larger ponds but the water level must be maintained to insure their survival during the dry season.

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Additional Information — Wet Ponds

If placement of wetland vegetation along the perimeter is not feasible consider the use of devices that retain non-rooted wetland species (Limnion, undated; Zirschky, et al, 1980). Non-rooted vegetation is more effective than rooted vegetation in removing dissolved nutrients and metals (see TC3 Constructed Wetlands). The vegetation grows within the device which is periodically removed and cleaned thereby removing the contaminants from the facility. The system developed by Limnion is in use in several artificial lakes in California to control nutrients.

- Except for very small facilities, include a forebay to facilitate maintenance.
- Use side slopes of at least 2:1 or flatter unless vertical retaining walls are used.
- Except for very small facilities, provide access to the forebay (slope of 4:1 or less), to the outlet, and around the pond perimeter for cleaning.

About 10 to 25% of the surface area determined in the above procedure should be devoted to the forebay. The forebay can be distinguished from the remainder of the pond by one of several means: a lateral sill with rooted wetland vegetation, two ponds in series, differential pool depth, rock-filled gabions or retaining wall, or a horizontal rock filter placed laterally across the pond.

- Use energy dissipation at the inlet to avoid erosion, to promote settling in the forebay and to minimize short-circuiting.
- Use a length to width ratio of at least 3:1 to minimize short-circuiting.

Short circuiting must be minimized. This can be accomplished by using a generally rectangular configuration with a length to width ratio of a least 3:1 and by placing the inlet and outlet at opposite ends. The inlet and outlet can be placed at the same end if baffling is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the pond to have an irregular shape, the pond area and volume should be increased to compensate for the dead spaces.

Inlet design may affect a facility's hydraulic efficiency. The traditional approach of deadheading the inlet pipe directly into the pond is not satisfactory. Experience with wastewater treatment indicates that it is best to have multiple inlets spaced equal to the depth of the pond, with a perforated baffle located in front of the inlets at a distance from one to two times the pond depth (Kleinschmidt, 1961). However, this concept is not practical with storm water treatment systems. A possible compromise that should significantly reduce short-circuiting in which the flow is split by a T or Y (Kleinschmidt, 1961) with the horizontal rock filter serving as perforated baffle. A lateral bench with wetland vegetation as shown in Figure 2A should also work. The area between the inlet and the filter becomes the forebay. Placing large rocks at each inlet will dissipate the energy and spread the water more effectively across the forebay.

- Minimize water loss by infiltration through the pond bottom.

To maintain the wet pool to the maximum extent possible excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner.

- Freeboard of 1 foot.
- With earthen walls, place an antiseep collar around the outlet pipe.
- The outlet should incorporate an antivortex device if the facility is large (A 100 year storm must safely pass through or around the device).

The settleable solids concentration of storm water is relatively low, obviating the need for adding depth to the facility for sediment storage.

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Additional Information — Wet Ponds

The sides of an earthen wall should be vegetated to avoid erosion. Drought tolerant groundcover species should be used if irrigation can not occur during the summer. See TC4, Biofilters regarding recommended plant species.

Maintenance

Check at least annually and after each extreme storm event. The facility should be cleaned of accumulated debris. The banks of surface ponds should be checked and areas of erosion repaired. Remove nuisance wetland species and take appropriate measures to control mosquitoes. Solids should be removed when 10 to 15% of the storage capacity has been lost.

Limited studies (Dewberry and Davis, 1990; Meiorin, 1991; Florida, 1991; Livingstone, pers. comm.) of the bottom sediments indicate that toxicity limits specified by final disposal regulations are not exceeded. Concentrations observed by Dewberry and Davis (1990) were less than 1/1000 of toxicity limits. If this problem is occurring it suggests that source control BMPs need to be improved.

If algal blooms are excessive consider alum treatment or the use of devices that retain non-rooted vegetation as discussed above.

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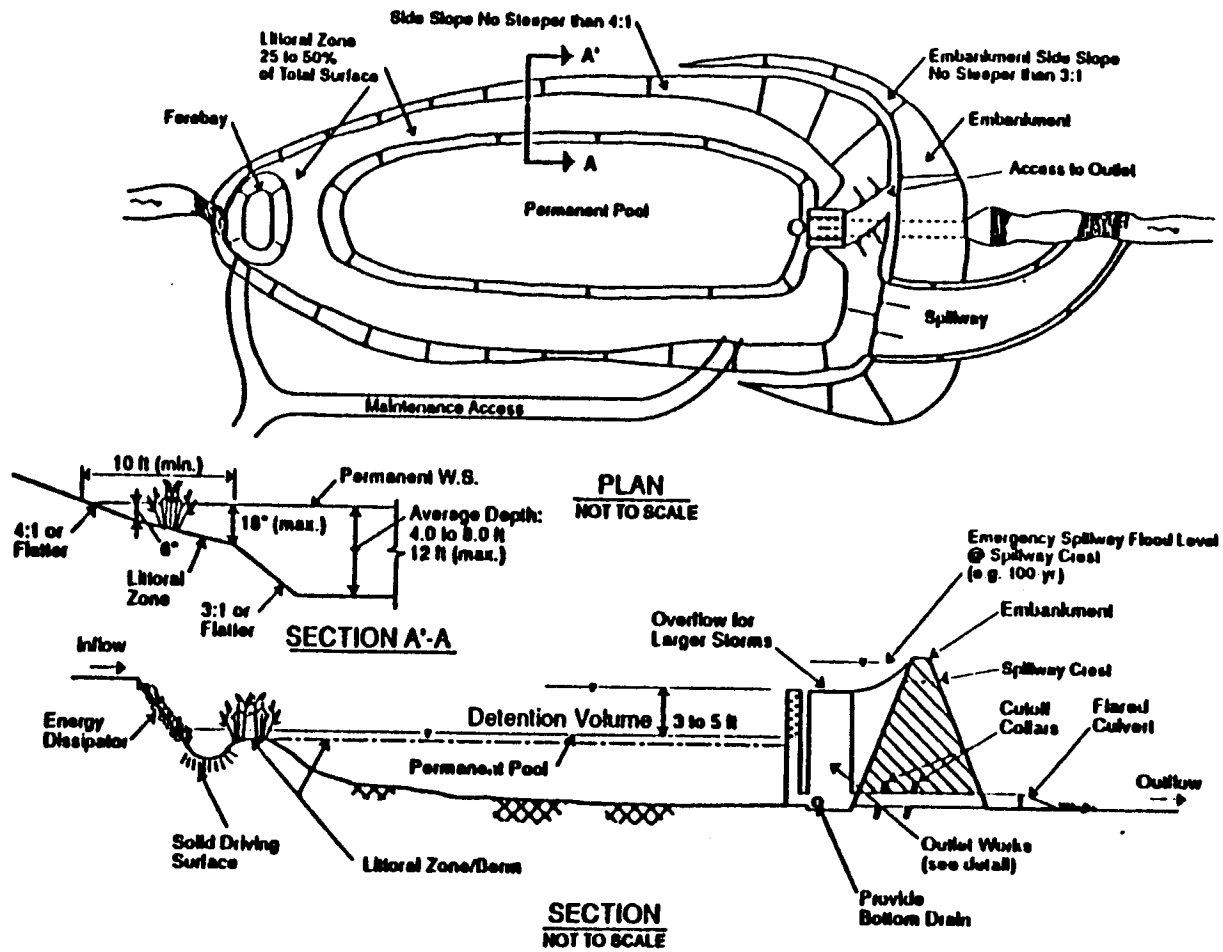

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FIGURE 2A. PLAN AND SECTION OF A WET POND

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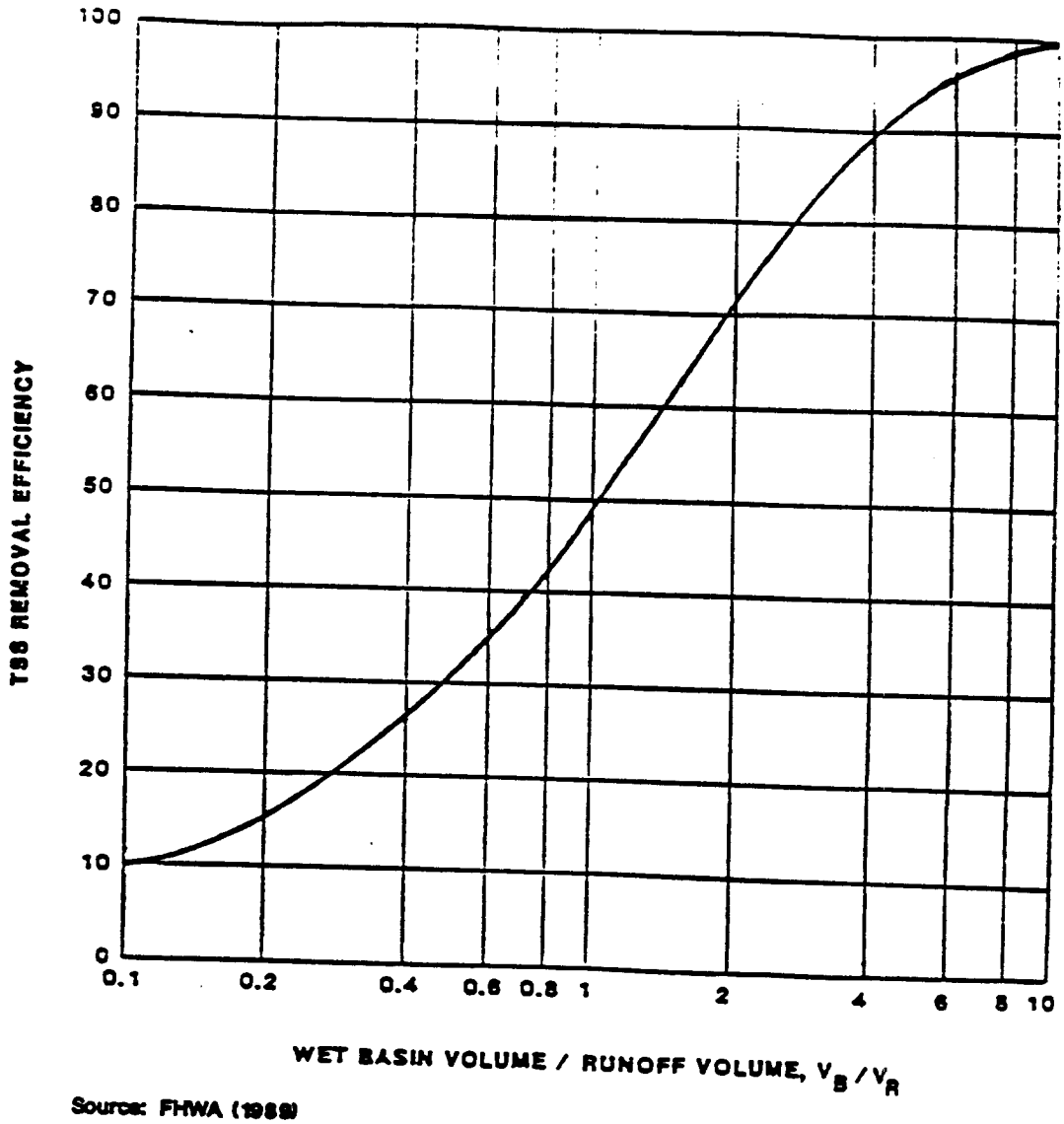

Source: FHWA (1988)

FIGURE 2B. TSS REMOVAL VERSUS V_B/V_R RATIO

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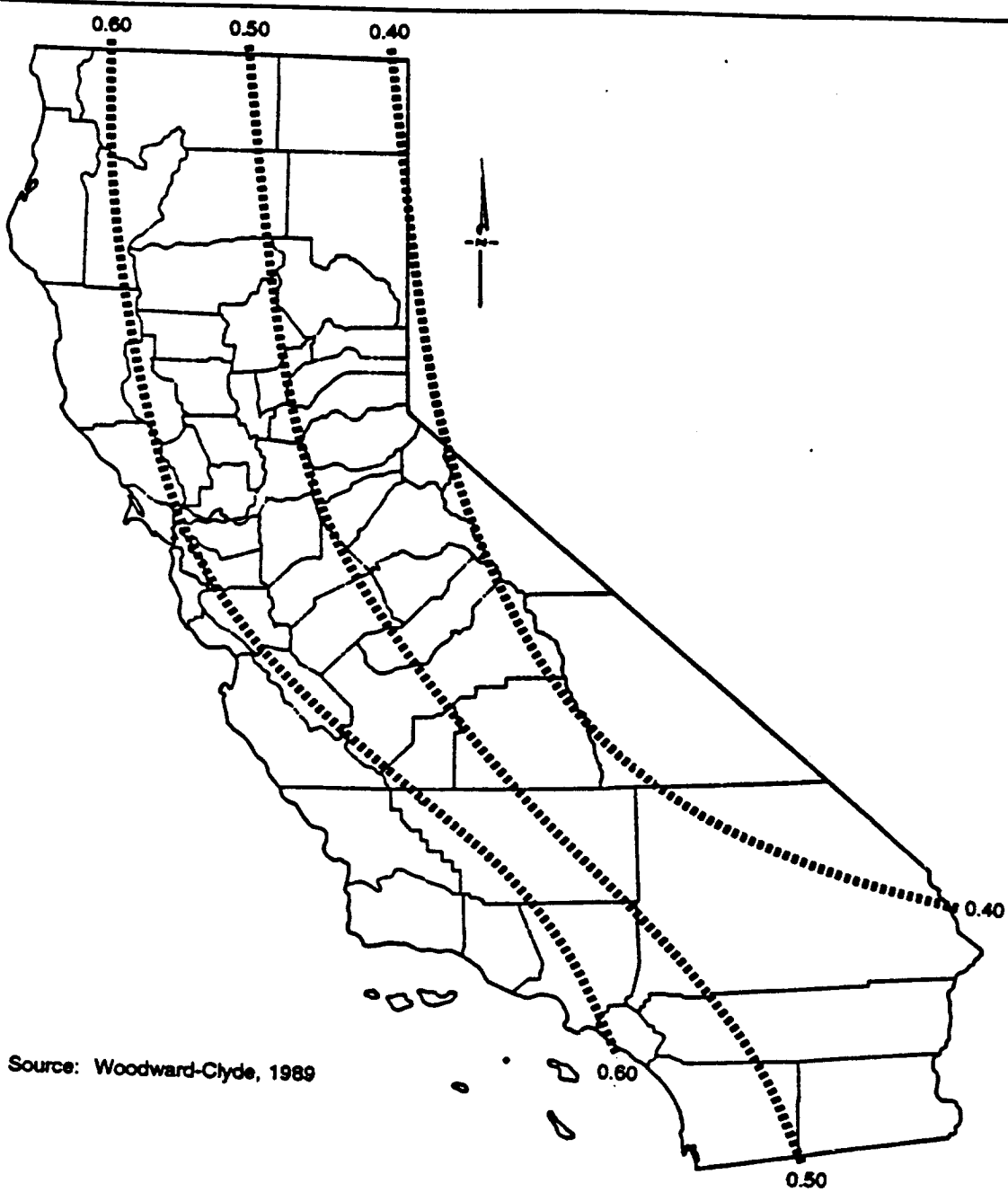

Source: Woodward-Clyde, 1989

FIGURE 2C. AVERAGE STORM EVENT DEPTH (INCHES)

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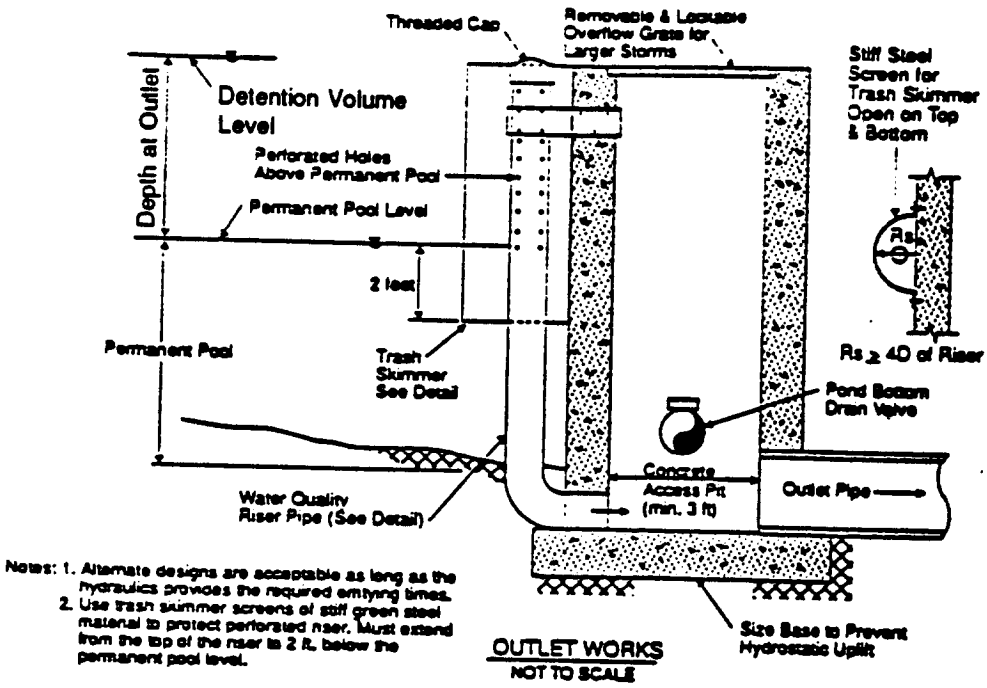
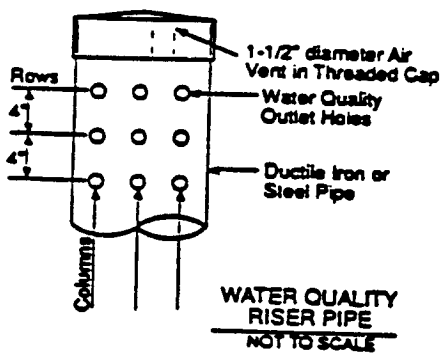


Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emtying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft. below the permanent pool level.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" Dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

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Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, inches			
	1/4"	1/2"	3/4"	1"
4	8	8	–	–
6	12	12	9	–
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area (in. 2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

FIGURE 2D. WATER QUALITY OUTLET FOR A WET POND

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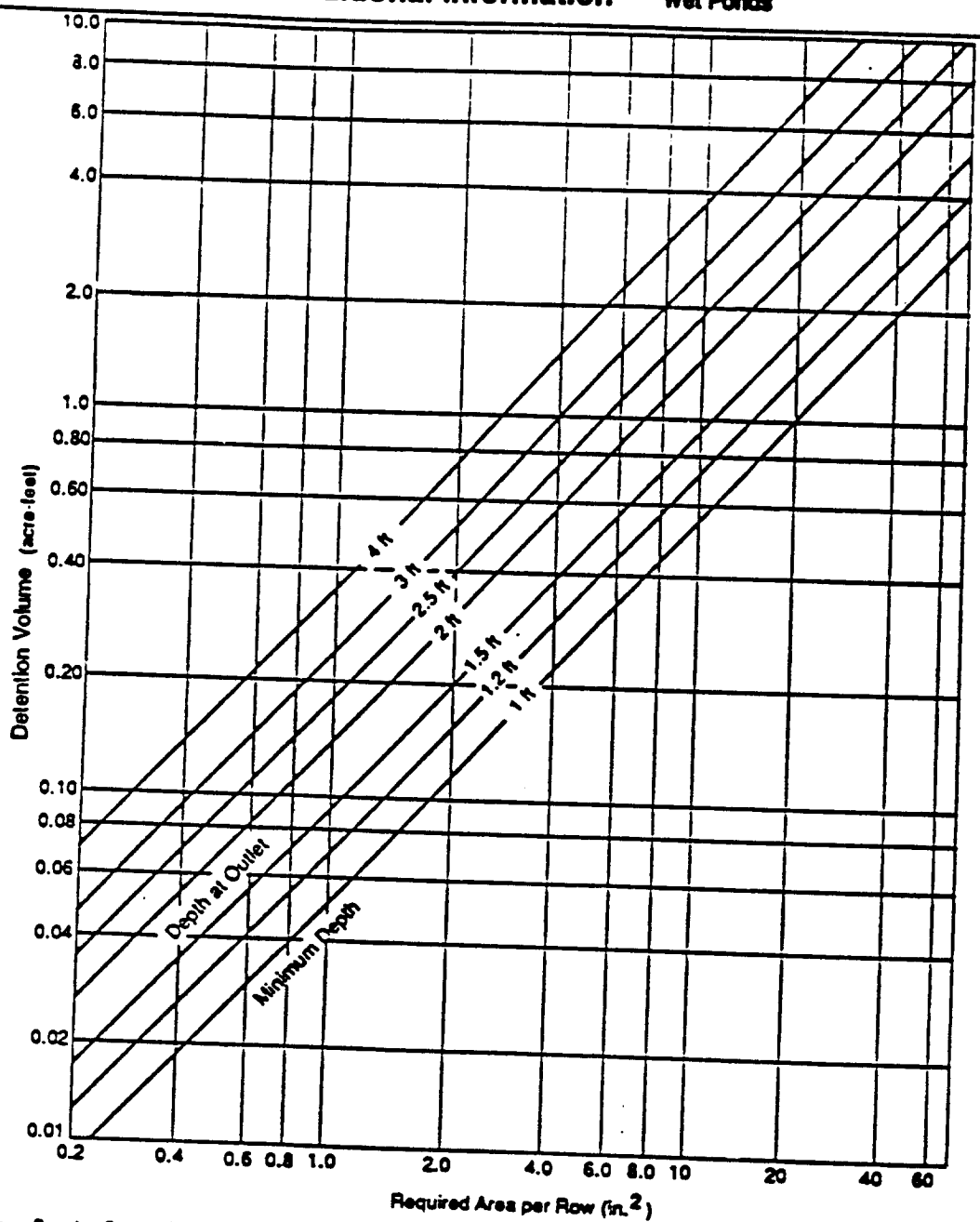

Source: *Douglas County Storm Drainage and Technical Criteria, 1986.*

(Used By Permission, UDFCD, 1992)

FIGURE 2E. WATER QUALITY OUTLET SIZING: WET POND WITH A 12-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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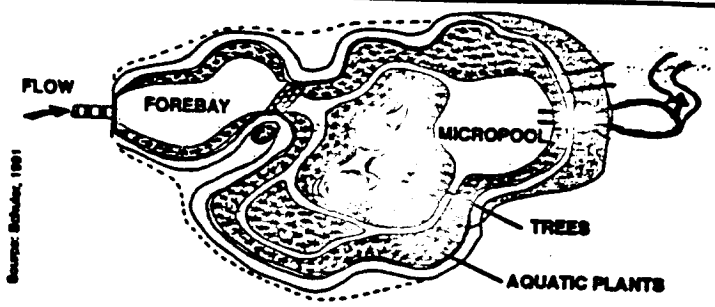
BMP: CONSTRUCTED WETLANDS



Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

EXPERIENCE IN CALIFORNIA

Research facility constructed in Fremont in 1983 by the Association of Bay Area Governments. Several communities (Davis, Orange County) have regional detention ponds that are essentially constructed wetlands.

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation and wildlife.

LIMITATIONS

- Concern for mosquitoes.
- Cannot be placed on steep unstable slopes.
- Need base flow to maintain water level.
- Not feasible in densely developed areas.
- Wet season coincident with minimal plant growth.
- Nutrient release may occur during winter.
- Overgrowth can lead to reduced hydraulic capacity.
- Regulatory agencies may limit water quality to constructed wetlands.
- May be regulated under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.

DESIGN AND SIZING CONSIDERATIONS

- Suitable soils for wetland vegetation.
- Surface area equal to at least 1% and preferably 2% of the tributary watershed.
- Forebay.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Involve qualified wetland ecologist to design and install wetland vegetation.
- Establishing wetland vegetation may be difficult.

MAINTENANCE REQUIREMENTS

- Remove foreign debris and sediment build-up.
- Areas of bank erosion should be repaired.
- Remove nuisance species.
- Control mosquitoes.

Targeted Constituents

- ● Sediment
- ● Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ● Floatable Materials
- ● Oxygen Demanding Substances
- ● Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

TC3

Best Management Practices

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COST CONSIDERATIONS

- Wetlands being shallower than wet ponds may result in larger area requirements.
- Costs for providing supplemental water may be prohibitive.

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Additional Information — Constructed Wetlands

General Information

Although natural wetlands are being used to treat storm water, regulatory agencies do not favor this use, except as a final "polishing" step after treatment by one or more of the treatment control BMPs presented in this chapter. Constructed wetlands, in contrast, are built specifically for treating storm water runoff. They are not wetlands created as mitigation for the loss of natural wetlands. Consequently, there is no intention to replicate the complete array of ecological functions of a wetland (e.g., the presence of wildlife), although it can be done. A constructed wetland is generally one of the more aesthetic than the treatment systems. It is likely that constructed wetlands will be used only in very large industrial sites, but small facilities with concrete retaining walls to conserve space will also likely be effective.

The simplest form of a constructed wetland includes a rectangular basin with a forebay and wetland vegetation area. The deeper forebay (3 to 6 feet) traps floatables and the larger settleable solids, facilitating maintenance as well as protecting the wetland vegetation. Alternatively, a detention pond may be placed before the wetland, to remove settleable solids and to protect the wetland from extreme increases in water elevation. The wetland vegetation is placed in a shallow pool that extends laterally across the basin. Construction of low flow channels through emergent vegetation can cause storm water to short circuit through channels rather than through the wetland vegetation.

Placing rooted wetland species through the majority of the facility adds to the cost, in comparison to a wet pond. However, it is believed by many practitioners that the vegetation improves performance. Placing the vegetation across the facility as illustrated in Figure 3A improves settling of particulates and uptake of dissolved contaminants. As the constructed wetland is shallower than a wet pond, there may be better contact between the water and soil which may be the primary remover of dissolved phosphorus and metals.

The vegetation reduces the effect of wind which can cause significant short-circuiting in a wet pond. Water loss in a wetland may not be greater and possibly less than a wet pond. Evapotranspiration from the plants will be greater in a wetland but evaporation from the water surface may be less because the dense vegetation eliminates the effect of the wind. The net result may be a slower rate of water loss. Conceivably a constructed wetland could be made smaller than a wet pond, given the benefits of the vegetation. But experience is too limited to identify how the size might be altered from what is calculated for a wet pond.

Relying on volunteer plants to cover the vegetated area will delay complete coverage for several years and may allow the invasion of undesirable species or dominance by one or two species such as cattails which tend to flourish in disturbed conditions. Complexity is promoted by varying water depth through the vegetated area rather than keeping the depth uniform. Preferred species to maximize the removal of dissolved metals are Salicornia pacifica (cadmium, copper and lead), Justicia americana (copper), Potamogeton crispus (cadmium), Phragmites communis (zinc), Carex stricta (zinc), and Scirpus lacustris (zinc) (Silverman, 1982).

There is some question as to the incremental benefit of wetland vegetation in California, inasmuch as most of the wet season occurs when the vegetation is dormant. The minimum desirable temperature for cattails, sedges, and bulrushes is 10°C, 14°C, and 16°C, respectively (USEPA, 1988). For most of California, mean temperatures during the winter months are 5 to 10°C; along the south coast they range from 10°C to 15°C. The primary removal mechanisms for dissolved phosphorus and metals are adsorption by the soil and use by non-rooted vegetation. Rooted vegetation obtains nutrients from the soils, not from the water, unless the vegetation is placed in gravel. In contrast non-rooted vegetation removes nutrients and metals from the water (Guntenspergen, et al., 1991). It can be expected that soil adsorption will continue during the winter to some extent. Removal of metals and nutrients by non-rooted vegetation may not occur, or will at least be significantly reduced because of the lack of growth. In contrast, loss will occur from vegetation die-off or dormancy. The net effect over a 12 month period may be that a constructed wetland is no more effective than a wet pond, particularly with regard to the removal of dissolved phosphorus and metals.

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The above concern is partially confirmed by research at the experimental wetland/wet pond in Fremont (Meiorin, 1991). The author states that the "uptake of nutrients ... was low because most storms occurred in winter when plant growth was reduced by ambient temperatures, short day lengths and low light levels". Despite the use of the word "low", phosphorus removal during the winter months was about 50% which is not noticeably better than removal in a wet pond. The removal of nitrogen was negative. Resuspension of plant material and detritus also occurred during the winter.

Despite the concerns, the wetland bottom soils are possibly a more significant mechanism for removing phosphorus and metals. However, the experience with constructed wetlands treating wastewater seems to indicate phosphorus removal occurs in the first two to three years but then removal rates decrease dramatically and have become negative in some cases (Faulkner and Richardson, 1991). This result appears to be due to saturation of the soil and the plants reaching maximum density. However, metals removal may continue. Nitrogen removal does not degrade over time because it is a bacteriological process. This process is very temperature dependent and therefore would be expected to be lower in the winter.

Using gravel as the substrate may be a suitable approach in small facilities. Because the gravel is lacking in nutrients certain emergent species will take their nutrients from the water (Thut, 1988). See Reddy and Smith (1988). Harvesting may also be more practical with this approach.

Of particular concern in many areas of California will be mosquitoes. Thick stands of emergent vegetation provide an ideal breeding habitat. If Gambusia (mosquito fish) are introduced into the facility the design must include a deep pool area where the fish can reside during the dry season. The forebay can serve this function.

Design

In the most comprehensive review to date of wetlands treating storm water, Stecker et al. (1992) found considerable variation in the performance of 26 facilities, both natural and constructed. All were located on large watersheds with mixed land uses, not industrial sites. There appeared to be no relationship between performance and the size (surface area) of the wetland. The surface area of the ten constructed wetlands varied from 0.3% to 12.6% of the tributary area. The removals of suspended solids and phosphorus ranged from 50 to 95% and 37 to 92%, respectively, for nine of the 10 facilities. The smallest facility removed 85% of the suspended solids and 37% of the phosphorus. The authors were unable to relate the variability of performance to any factor of design or operation. Constructed wetlands performed somewhat better than natural wetlands. The only conclusion that might be safely drawn from this study is that a surface area greater than about 1 or 2% of the tributary watershed is not justified, given the uncertainty of any improvement in performance with the increase in size. Lacking, however, are data on the percentage of each watershed that is impervious.

The facility can be sized using the same procedure outlined for Wet Ponds, TC2. However, inasmuch as a wetland is shallower than a wet pond, sizing the wetland for the same V_b/V_r as a wet pond requires considerably more surface area. Given the likely advantages of a constructed wetland over a wet pond, some may consider this to be an unreasonable penalty. It is therefore recommended that surface area of the constructed wetland not exceed that which would be determined for a wet pond.

Additional design considerations include:

- Have 25% to 50% (forebay and afterbay) 3 to 6 feet deep, and remaining area 6 in. to 24 in. deep or as appropriate for the wetland species selected. This geometry should provide satisfactory conditions for wetland wildlife (Adams et al., 1983).
- Side slopes of at least 4:1 to a water depth of 2 feet except on very small facilities where retaining walls may be used to conserve space. If retaining walls are used, the area must be fenced for safety.
- Access for maintenance vehicles to the forebay, the outlet, and around the perimeter.

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- Freeboard of at least 1 foot.
- With earthen contained facilities, install an antiseep collar on the outlet pipe.
- The soils must be suitable for wetland vegetation. If necessary organic soils (18 to 24 in.) must be imported to the site.
- The soil must have an affinity for phosphorus. Soils with aluminum and iron are best. Soils saturated with phosphorus or a metal specie may cause the concentrations of these contaminants to increase in the overlying water.
- Minimize short-circuiting by placing energy dissipators at the inlet, and by having a high length to width ratio.

Short circuiting must be minimized by using a generally rectangular configuration with a length to width ratio of a least 3:1 and by placing the inlet and outlet at opposite ends. The inlet and outlet can be placed at the same end if baffling (islands) is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the wetland to have an irregular shape, the pond area and volume should be increased to compensate for the dead spaces. Energy dissipators and entrance baffles will spread the water laterally across the facility.

- Minimize water loss by infiltration through the wetland bottom.
- Supplemental water may be needed to avoid loss of rooted vegetation during the dry period.

To maintain the wet pool to the maximum extent possible excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner. Wetland vegetation species have evolved to handle the stress of seasonal variations in water availability. However, during the dry season there must be sufficient water to avoid complete desiccation of plant roots. Consequently, constructed wetlands are infeasible in areas where there is a lack of either a baseflow or near-surface ground water during the dry season. Supplemental water such as pumped ground water and treated process wastewater may have to be used.

- A wetland ecologist should prepare the planting design and specifications, and oversee the planting.

Constructed wetlands may not need antivortex and trash rack devices on their outlets like a wet pond because of the rooted vegetation. See TC2, Wet Ponds regarding inlet design. Design concepts for outlet devices are discussed in TC5 Extended Detention Ponds. See Josselyn (1982) regarding wetland plant considerations. Establishing wetland vegetation initially may be difficult and require multiple plantings.

Maintenance

- Check at least annually and after each extreme storm event.
- Remove accumulated foreign debris.
- Repair areas of slope erosion.
- Employ mosquito countermeasures as required by local authorities.
- Clean deposits from the forebay when a loss of capacity is significant, probably every 3 to 5 years depending on the land use (see TC2, Wet Ponds), or when the concentrations of toxicants in the sediments are reaching a level of concern.

There is some question as to whether annual harvesting of rooted vegetation is either practical or effective at reducing seasonal losses of nutrients and prolonging the life of the facility (USEPA, 1988). The benefits of harvesting may depend upon the wetland specie (Suzuki, T. et al., 1991). Placing rooted vegetation in gravel beds rather than soil may make harvesting practical. If harvesting is to be done, it should occur twice per season, in the early summer when nutrient content in the plant material is at its peak, and in the fall before plant dormancy. Given the significant role of the bottom soil in removing metals and phosphorus its replacement may be required, although, probably not more frequently than once every few decades. Cleaning the forebay more frequently is important as noted above.

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Additional Information — Constructed Wetlands

Another consideration is the regulatory implications of removing accumulated material from constructed wetlands. Do such actions require a 404 or other permit? At present, constructed wetlands are excluded from this requirement (Ritchie, 1992).

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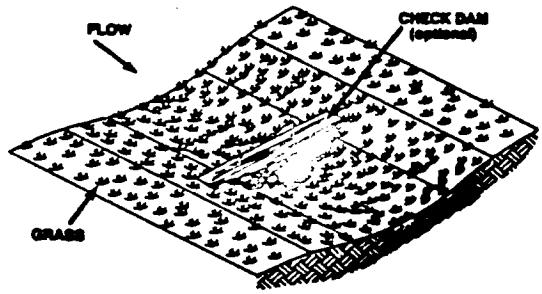
R0034700

BMP: BIOFILTERS



DESCRIPTION

Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

EXPERIENCE IN CALIFORNIA

No biofilters specifically designed to treat storm water have been located. However, instances of "biofilter by happenstance" exist in northern communities (Davis, Sacramento, Turlock, Fresno) where storm water is discharged to a grassed area prior to an inlet or an infiltration area.

SELECTION CRITERIA

- Comparable performance to wet ponds and constructed wetlands.
- Limited to treating a few acres.
- Availability of water during dry season.

LIMITATIONS

- Poor performance has occurred but this appears to be due to poor design.
- May be limited to areas where summer irrigation is feasible.
- Can be difficult to maintain sheet flow in strips.
- Can be difficult to avoid channelization in swales.
- Cannot be placed on steep slope.
- Area required may make infeasible on industrial sites.
- Proper maintenance required to maintain health and density of vegetation.

DESIGN AND SIZING CONSIDERATIONS

- The surface area is defined by Figure 4A.
- The minimum width for a swale is determined by Mannings Equation.
- Minimum length of a strip is 10 feet.
- The longitudinal slope must not exceed 5%.
- Use a flow spreader and energy dissipator at the entrance of a swale.
- Good soils are important to achieve good vegetation cover.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure soils are suitable for healthy vegetation.
- Level cross-section and even longitudinal slope for swales.
- Achieve sheet flow with strips.

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ◒ Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Best Management Practices

R0034701

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Additional Information — Biofilters

A biofilter swale is a vegetated channel that looks similar to, but is wider than, a ditch that is sized only to transport flow. The biofilter swale must be wider to maintain low flow velocities and to keep the depth of the water below the height of the vegetation up to a particular design event. A filter strip is placed along the edge of the pavement (its full length if possible). The pavement grade must be such as to achieve sheet flow to the maximum extent practical along the strip.

Vegetated biofilters will likely see limited application in industrial settings. Strips are most suitable for parking lots which under this general permit do not require consideration unless they drain to a drainage system that also receives flows from the industrial activities of concern. Within the industrial site itself conditions are usually not suitable for locating a grassy area next to a paved area. Typically, the industrial area is paved to the property line. If the storm water passes through a ditch prior to leaving the site it may be possible to widen the ditch into a swale.

The performance of biofilters is probably somewhat less than wet ponds and constructed wetlands because the latter provide treatment both during and between storms. Some researchers have observed poor performance, recommending their use only in combination with other treatment control BMPs. However, most field research on swale performance has been conducted on grassed roadside ditches. A swale must be wider than a traditional roadside ditch, to avoid excessive flow velocities which topples the grass and causes channelization.

The swale bottom must be as level as possible; energy dissipation and a flow spreader should be placed at the entrance to minimize channelization. The pavement must be as level as possible along its boundary with a biofilter strip. The pavement edge should be left clear; that is, no curbs. Parking stall blocks must be open to pass the flow as unhindered as possible. Use of curb cuts in curbs is not a satisfactory approach. The cuts channelize the water and can clog with debris. The performance of strips may be compromised by the failure to achieve sheet flow at the interface between the paved area and the strip.

Turf grass is the preferred vegetation. Figure 4B shows recommendations for seven species of turf grass and one ground cover plant for various areas of California (Youngner, et al., 1962). More recent information in this regard is also shown in Figure 4C (CCAE, 1984). Turf grass will require summer irrigation to remain active. Although it has not been tried it may be possible to allow the grass to become dormant during the summer since the biofilter is only in service during the wet season. The biofilter could be irrigated beginning in October to bring it to a healthy condition prior to the first storms. Ground cover species suitable for a non-irrigation situation may work but, it also has not been tried. The soil must be of a fertility and porosity that allows for healthy vegetation. A porous soil also promotes infiltration. See the references that follow for Agricultural Extensive publications on efficient water use by turf grasses.

If erosion of the swale is of concern because of the difficulty of maintaining a good grass cover, consider the use of concrete grids (see Infiltration Systems) or similar material. Another concept is to use check dams to divide the swale into a series of terraces, reducing the longitudinal slope to perhaps 1%, thereby reducing flow velocities.

Design

Several methods have been proposed to size biofilters (Horner, 1988; FHWA, 1989; IEP, 1991; Tollner, et al., 1976). However, information on the relationship between biofilter area and performance is lacking for urban conditions. Figure 4A uses the method of Horner (1988) with the 2-year storm as the design event, a slope of 3%, and a grass height of 4 inches. A biofilter is sized to treat all storms up to a particular design event. The design event can be relatively small because the aggregate of all small events represents the majority of pollutant runoff. Research in western Washington (Metro, 1992) found that a biofilter sized according to this technique removed 80 percent of the suspended solids and attached pollutants and 50% of the soluble zinc. It was not able to remove dissolved phosphorus or copper.

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Additional Information — Biofilters

Figure 4A is meant for guidance only and should be used with caution in areas where precipitation varies greatly because of terrain.

The design engineer must determine the width of a swale using Manning's Equation and the 2-year rainfall intensity (California, 1976) appropriate to the site. An "n" of 0.20 is recommended (Metro, 1992). The design engineer must also calculate the peak flow of the 100-year event to determine the depth of a swale. Since a width using an "n" of 0.20 is generally wider than what is required of a grass lined channel, channel stability should not be of concern. It is generally not necessary to have a bypass for the extreme events because the minimum width specification combined with the relatively gentle slope avoids excessive velocities. If erosion at extreme events is of concern, consider the above concepts to minimize erosion.

The design engineer can make the swale wider than determined in the above step, with a corresponding shortening of the swale length to obtain the same surface area. However, there is a practical limitation on how wide the swale can be and still be able to spread the flow across the swale width. Splitting the flow into multiple inlets and/or placing a flow spreader near the storm inlet should be incorporated into the design. A concept that may work is to place a level 2"x 12" timber across the width of the swale perhaps 10 feet from the pipe outlet. Place gravel between the outlet and the timber, to within 2 inches or so of the top of the timber. Place large rock immediately near the outlet to dissipate the flow energy; the rock also may help distribute the flow. The timber will function like a weir. Flow spreaders have seen limited application and their effect on performance has not been evaluated.

The problem of spreading the flow across the width of the swale may limit its use to tributary catchments of only a few acres. The minimum width based on using Manning's Equation results in widths of 3 to 12 feet per acre of impervious tributary surface, depending on the location and longitudinal slope.

A minimum length of 10 feet is recommended for biofilter strips. Length here is defined as the measurement in the direction of flow from the adjoining pavement. Lengths of 20 to 50 feet have been recommended by most practitioners perhaps because of the concern that sheet flow cannot be maintained. Wherever room permits a length greater than 10 feet should be used. The short length is recommended in this handbook because space is at a premium at most existing industrial sites: 10 feet should work satisfactory if good sheet flow is maintained and no obstructions such as curbs are placed along the pavement edge.

The type of strip discussed here is not to be confused with the natural vegetated buffer strip used in residential developments to separate the housing from a stream or wetland. As the later type follows the natural contour flow channelization is more likely and lengths of 75 to 150 feet are recommended.

The length of pavement prior to the strip should not exceed a few hundred feet to avoid channelization of large aggregates of runoff along the pavement before it reaches the pavement edge. To avoid channelization, care must be taken during construction to make sure that the cross-section of the biofilter is level and that its longitudinal slope is even. Channelization will reduce the effective area of the biofilter used for treatment and may erode the grass because of excessive velocities.

Maintenance

The facility should be checked annually for signs of erosion, vegetation loss, and channelization of the flow. The grass should be mowed when it reaches a height of 6 inches. Allowing the grass to grow taller may cause it to thin and become less effective. The clippings should be removed.

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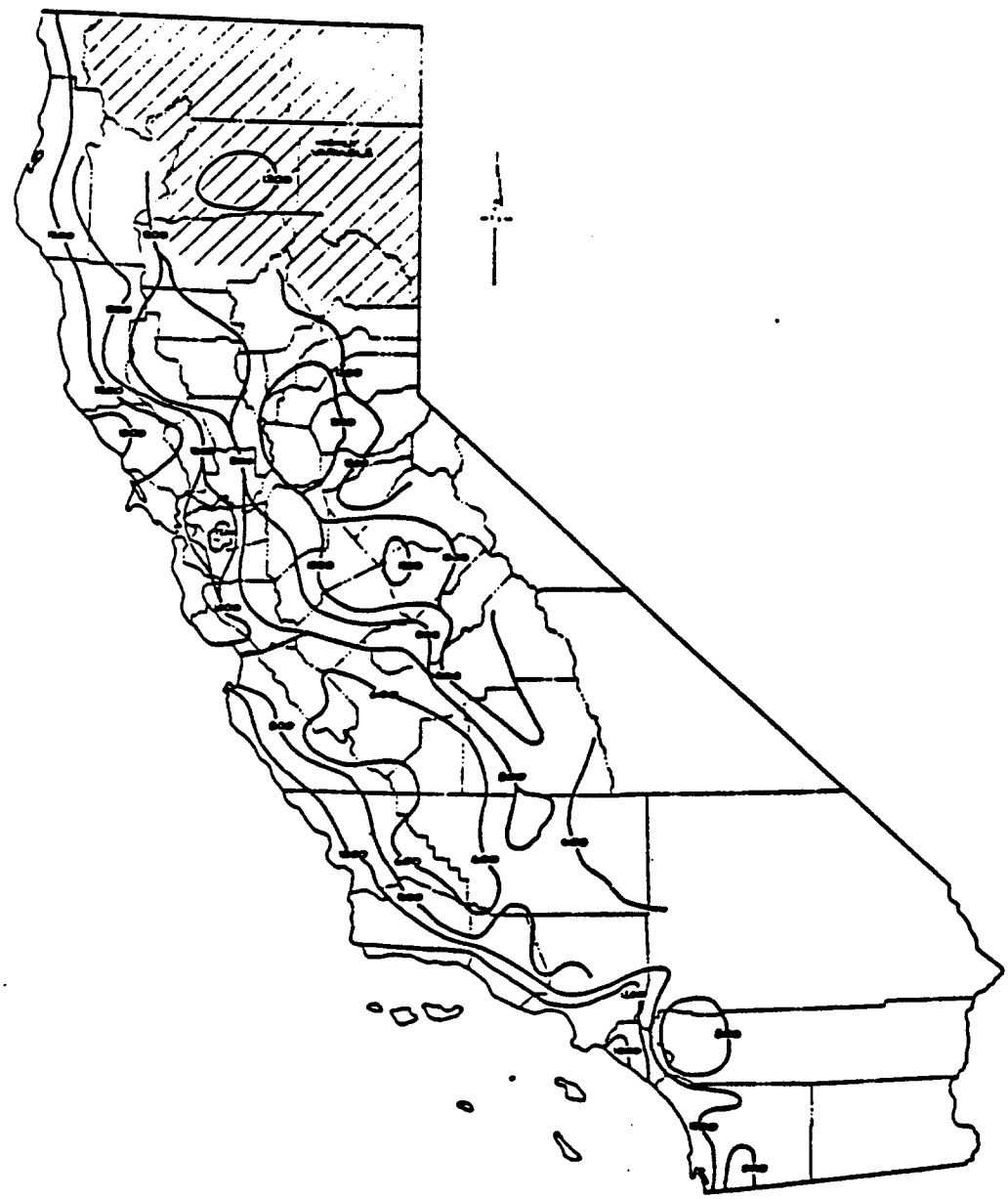

FIGURE 4A. SIZING GUIDELINE FOR BIOFILTERS (SQ. FT./IMPERVIOUS ACRE)

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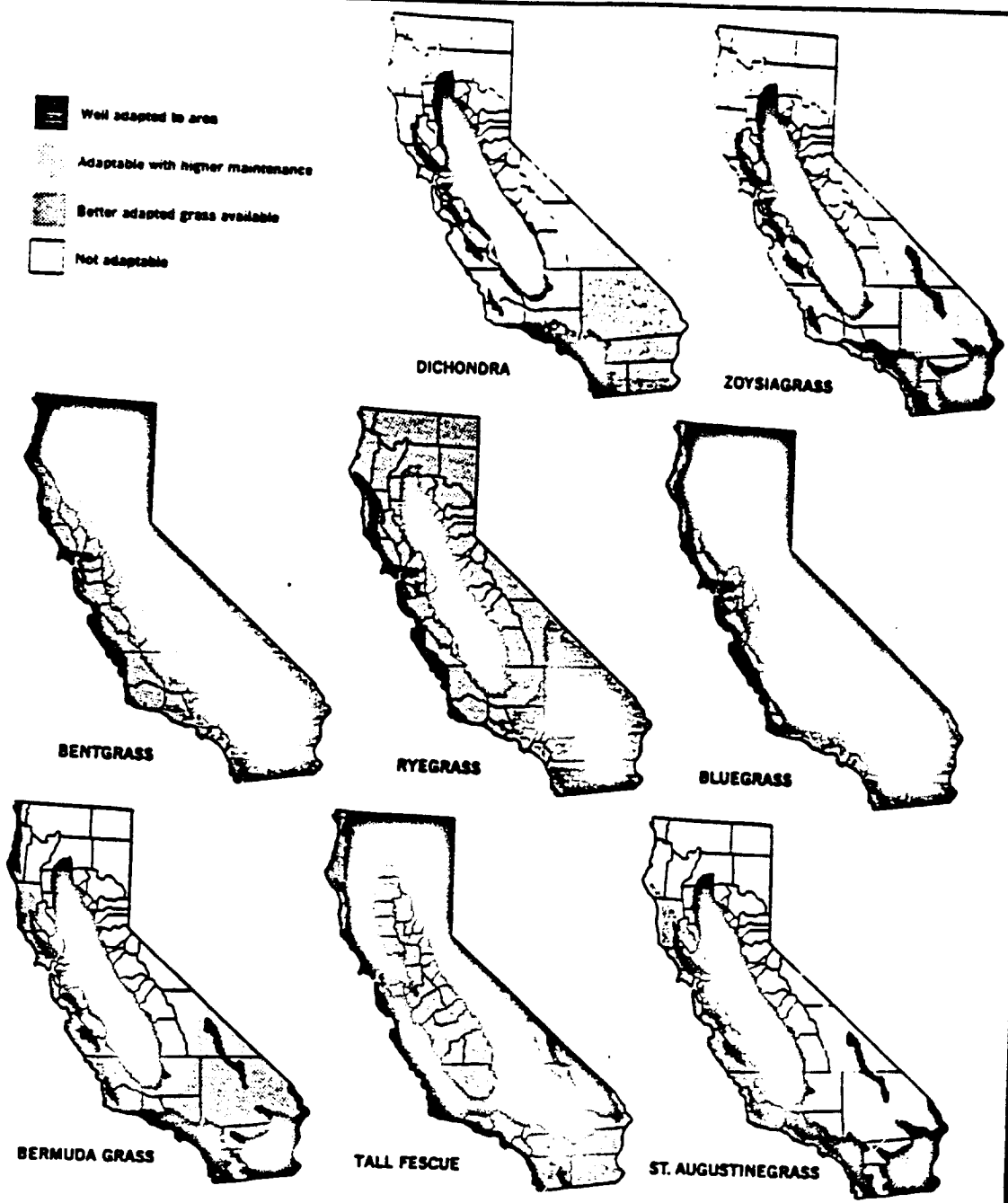

FIGURE 4B. STATE OF CALIFORNIA SHOWING MOST SUITABLE TURF GRASS SPECIES

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Additional Information — Biofilters

COLD TOLERANCE (winter color persistance)

High
- Creeping bentgrass
- Kentucky bluegrass
- Red fescue
- Colonial bentgrass
- Highland bentgrass
- Perennial ryegrass
- Tall fescue
- Weeping alkaligrass
- Dichondra
- Zoysiagrass
- Common bermudagrass
- Hybrid bermudagrass
- Kikuyugrass
- Seashore paspalum
- St. Augustinegrass

Low

HEAT TOLERANCE

High
- Zoysiagrass
- Hybrid bermudagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Dichondra
- Creeping bentgrass
- Kentucky bluegrass
- Highland bentgrass
- Perennial ryegrass
- Colonial bentgrass
- Weeping alkaligrass
- Red fescue

Low

MOWING HEIGHT ADAPTATION

High cut
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Weeping alkaligrass
- St. Augustinegrass
- Common bermudagrass
- Dichondra
- Kikuyugrass
- Colonial bentgrass
- Highland bentgrass
- Zoysiagrass
- Seashore paspalum
- Hybrid bermudagrass
- Creeping bentgrass

Low Cut

DROUGHT TOLERANCE

High
- Hybrid bermudagrass
- Zoysiagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Highland bentgrass
- Creeping bentgrass
- Colonial bentgrass
- Weeping alkaligrass
- Dichondra

Low

MAINTENANCE COST AND EFFORT

High
- Creeping bentgrass
- Dichondra
- Hybrid bermudagrass
- Kentucky bluegrass
- Colonial bentgrass
- Seashore paspalum
- Perennial ryegrass
- St. Augustinegrass
- Highland bentgrass
- Zoysiagrass
- Tall fescue
- Common bermudagrass
- Kikuyugrass

Low

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FIGURE 4C. ADDITIONAL INFORMATION ON THE SUITABILITY OF TURF GRASS SPECIES

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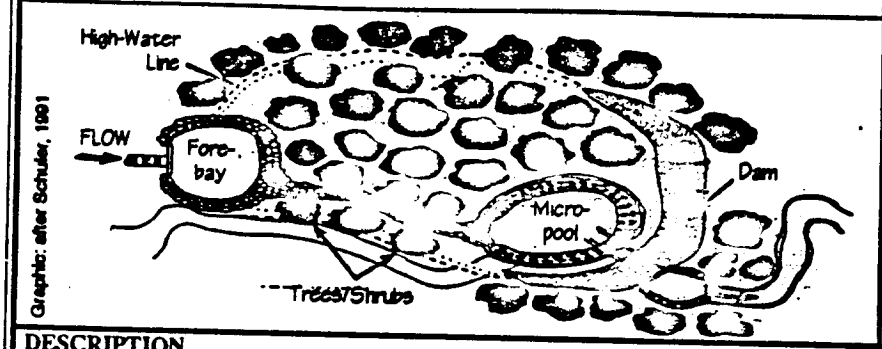
BMP: EXTENDED DETENTION BASINS



Considerations

- Soils
- **Area Required**
- Slope
- Water Availability
- Aesthetics
- **Hydraulic Head**
- Environmental Side Effects

DESCRIPTION

Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

EXPERIENCE IN CALIFORNIA

There are no known basins in California. Hydraulic detention basins may function like extended detention basins if the former has been sized to control the pre-development 2-year event. More liberal standards do not provide sufficient detention time.

SELECTION CRITERIA

- Objective is to remove only particulate pollutants.
- Use where lack of water prevents the use of wet ponds, wetlands or biofilters.
- Use where wet ponds or wetlands would cause unacceptable mosquito conditions.

LIMITATIONS

- May be less reliable than other treatment control BMPs.
- Inability to vegetate banks and bottom may result in erosion and resuspension.
- Limitation of the orifice diameter may preclude use in small watersheds.
- Requires differential elevation between inlet and outlet.
- Pending their volume and depth basin designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Basin volume is sized to capture a particular fraction of the runoff.
- Drawdown time of 24 to 40 hours.
- Shallow basin with large surface area performs better than deep basin with same volume.
- Place energy dissipators at the entrance to minimize bottom erosion and resuspension.
- Vegetate side slopes and bottom to the maximum extent practical.
- If side erosion is particularly severe, consider paving or soil stabilization.
- If floatables are a problem, protect outlet with trash rack or other device.
- Provide bypass or pass through capabilities for 100 year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure the outlet is installed as designed.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ◒ Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ○ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

TC5

Best Management Practices

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BMP: EXTENDED DETENTION BASINS (Continue)

MAINTENANCE REQUIREMENTS

- Check outlet regularly for clogging.
- Check banks and bottom of surface basin for erosion and correct as necessary.
- Remove sediment when accumulation reaches 6-inches, or if resuspension is observed.

COST CONSIDERATIONS

- Generally less expensive than wet ponds and wetlands, but more expensive than biofilters.

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Additional Information — Extended Detention Basins

General

Extended detention ponds and vaults may be particularly appropriate to California where dry weather base flow cannot be used to maintain water levels, as is required for wet ponds and constructed wetlands. These systems are suitable for essentially any size tributary area from an individual commercial development to a large residential area. Surface ponds are less expensive to construct, but underground vaults may be appropriate in commercial developments. Use of concrete retaining walls will reduce the space required by a pond. The basic elements of an extended detention basin are illustrated in Figure 5A. The configuration shown in Figure 5A is most appropriate for large sites.

Extended detention provides a lower removal efficiency than wet ponds and constructed wetlands: the facilities are smaller thereby reducing their effectiveness with particulate pollutants, and they do not have the ability to remove dissolved contaminants. Also, extended detention facilities may be less reliable than constructed wetlands or wet ponds because of the lack of a permanent water pool (See Figure 5A). But if desired, a shallow pool of 1 to 3 feet could be included in the design but this is more of an aesthetic consideration. If irrigation water is available, a thick grass turf on the bottom of the facility may provide some removal of dissolved contaminants, like a vegetated biofilter. See TC4 Biofilters for recommendations on turf grass and groundcover species.

Where irrigation water is not available, there may be concerns about erosion and resuspension of particulate pollutants in surface ponds. This, however, has not been a significant problem in Austin, Texas where sand filters are preceded by dry settling ponds (Hartigan, pers. comm.). However, the design must incorporate several features to minimize the potential for this problem. Drought tolerant vegetation may work but has not been evaluated. Nonvegetative materials may help such as concrete or plastic grids, small riprap, erosion matting, or paving. A paved forebay may facilitate maintenance thereby reducing the material available for resuspension.

The recommended drawdown time of 24 to 40 hours for a full pond is based on very limited laboratory data. A few extended detention ponds have been monitored and generally provide a removal efficiency of 60 to 80% with a drawdown time of about 24 hours. Forty hours is recommended in order to settle out the finer clay particles in California sediment that typically adsorb toxic pollutants.

Design

Determine the volume of the basin using the appropriate figure from Appendix D. The procedure is as follows: (1) select the appropriate figure for your area; (2) determine for the catchment the percentage of impervious area directly connected to the storm drain system; (3) choose a capture goal, and read the required unit volume required for the basin; and (4) multiply this unit volume times the total acreage of the catchment and convert to cubic feet. This volume is also referred to as water quality capture volume shown in Figure 5A. Total impervious acres may be used in lieu of directly connected impervious acres if it is easier to determine the former, although this will result in a larger facility. Although these variations are not equivalent, they are reasonable given the uncertainty of the methodology and expected basin performance.

What should be the capture goal? To achieve an equivalent pollutant capture percentage as a wet pond, 85 to 95 percent of the runoff must be captured and detained. But capture volumes over 85 percent are not cost effective as the capture cases in Appendix D show. Therefore it is recommended that a capture volume of 85 percent be used for determining the detention basin size required. Because of the possibility of resuspension of materials during extreme storms consideration should be given to placing the basin off line, that is, it should have a bypass for the extreme events. Bypassing larger events will also allow the bedload carried by the storm and is necessary for beach replenishment to move downstream.

A drawdown time of 40 hours is recommended in order to settle out the finer clay particles as stated above; however, 24 hours can be used if it can be demonstrated that this rate will remove 80% of the solids. The analysis of runoff using

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the hydrologic model STORM and California precipitation data found that increasing the drawdown time from 24 to 40 hours increased the size of the basin by only about 10% to 20% depending on the location (see Appendix D).

Proper hydraulic design of the outlet is critical to achieving good performance of the detention basin. The two most common outlet problems that occur are: 1) the capacity of the outlet is too great resulting in partial filling of the basin and less than designed for drawdown time and 2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, two alternative outlet types are recommended for use: 1) V-notch wier, and 2) perforated riser. The V-notch wier will not clog, but it is also difficult to maintain small release rates at low heads. The perforated riser if properly designed and gravel packed gives much better control and is recommended over the V-notch wier.

Two different approaches can be used to control the outflow. One is to use a single orifice outlet with or without the protection of a riser pipe. The other is to use the perforated riser itself for discharge control. Both approaches are presented below.

Flow Control Using a Single Orifice

The outlet control orifice should be sized using the following equation (GKY, 1989).

$$a = \frac{2A(H-H_o)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7\times10^{-5})A(H-H_o)^{0.5}}{CT} \qquad (1)$$

where:
- a = area of orifice (ft^2)
- A = average surface area of the pond (ft^2)
- c = orifice coefficient
- T = drawdown time of full pond (hrs.)
- g = gravity (32.2 $ft./sec^2$)
- H = elevation when the pond is full (ft)
- H_o = final elevation when pond is empty (ft)

With a drawdown time of 40 hours the equation becomes:

$$a = \frac{(1.75\times10^{-6})A(H-H_o)^{0.5}}{C} \qquad (2)$$

Assuming an average release rate at one half the pond depth, a common approach in several design manuals, leads to considerable error. If the pond has a significant variation of surface area with depth, do not use Equation (2); consult GKY (1989).

Care must be taken in the selection of "c": 0.60 is most often recommended and used. However, based on actual tests GKY (1989) recommends the following:

c = 0.66 for thin materials, that is, the thickness is equal to or less than orifice diameter

c = 0.80 when the material is thicker than the orifice diameter

Drilling the orifice into an outlet structure that is made of concrete can result in considerable impact on the coefficient, as does the beveling of the edge. The experiments by GKY (1989) were with sharp edged orifices.

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Equation (1) defines the orifice area where a single orifice outlet is used to regulate the detention basin outflow. However, a recent survey of extended detention facilities (Galli, pers. comm.) found the drawdown time of small storms that do not fill the facility to be too short to provide effective treatment. The facilities surveyed were designed for a drawdown time of 24 hours. A 40 hour drawdown may provide sufficient time for the smaller storms. But it may be prudent to take additional steps to be certain that the small storms, which represent the majority of pollution, are effectively treated. One approach would be to check the design analysis to determine if the facility takes at least 24 hours to drain when half full. If not, either modify the design to achieve this objective, or install a two orifice outlet. The lower outlet is sized to drain a half-full facility in 24 hours. The second orifice is placed at the mid-water elevation and is sized in combination with the lower orifice to drain the entire facility in 40 hours. Another approach is to install the outlet about one foot above the bottom of the pond (essentially enlarging the micropool area). This lower area will dry up between storms and will capture much of the volume of small storms and improving pollutant removal.

Three alternative outlet structures are suggested (Figure 5B). The concrete block structure is appropriate for large ponds. The riser pipe is suggested for small to large ponds. Placing the outlet control in the berm or in a manhole located downstream of the facility is most suitable for small ponds.

Recommendations regarding the design of a riser pipe are shown in Table 5A for Austin (1988). Table 5A provides guidance on the location of holes. To prevent clogging of this orifice and the bottom orifices of the riser pipe, wrap the bottom three rows of orifices with geotextile fabric and a cone of one to three inch rock. The holes in the riser pipe should not be modified to achieve a 40 hour drawdown time. Rather, the control orifice should be placed downstream. For small facilities, place the control orifice in a manhole between the pond and the filter as shown in Figure 5B. Use a "T-pipe" (Figure 5B) to submerge the orifice.

TABLE 5A PERFORATED OUTLET RISER PIPE ORIFICES (Austin, 1988)

RISER PIPE DIAMETER	VERTICAL SPACING BETWEEN ROWS (center to center)	NUMBER OF PERFORMATIONS	PERFORATION DIAMETER
6 in.	2.5 in.	9 per row	1 in.
8 in.	2.5 in.	12	1 in.
10 in.	2.5 in.	16	1 in.

Clogging of the bottom holes has been observed in riser pipes in the mid-Atlantic states (MWCOG, 1992) suggesting that the diameter of the riser holes should not be less than 3/4 to 1" (MWCOG, 1992) although a minimum diameter of 2" is now being considered (Galli, pers comm.). However, most of the facilities surveyed had risers without the gravel cone and the outlet holes were modified to provide drawdown control. Modifying the holes in the riser to control the outlet rate reduces the diameter of the holes and increases the risk of clogging. However, gravel packing the riser pipe as shown in Figure 5B.2 and 5C.1 will minimize this risk. Submerging the control orifice as shown in Figure 5B.3 will allow the use of a smaller orifice diameter. One orifice with a diameter of 1/2 inch, or 1 inch to be conservative, allows the use of extended detention for very small catchments. Detention facilities in western Washington use this concept and have not experienced clogging problems.

Flow Control Using the Perforated Riser

For outlet control using the perforated riser as the outflow control, it is recommended that the procedure developed by the Denver Urban Drainage and Flood Control District be used (UDFCD, 1992) as illustrated in Figures 5C and 5D. Figure 5D uses a valve for C_d of 0.65. This design incorporates flow control for the small storms in the perforated riser but also, provides an overflow outlet for large storms. If properly designed, the facility can be used for both water quality and

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drainage control by: 1) sizing the perforated riser as indicated for water quality control; 2) sizing the outlet pipe to control peak outflow rate from the 2 year storm; and 3) using a spillway in the pond berm to control the discharge from larger storms up to the 100 year storm.

Other Design Considerations

- Do not locate on fill sites or on or near steep slopes if is expected that much of the water will exit through the bottom, or modify the bottom to prevent excessive infiltration.
- Energy dissipation at the inlet to minimize erosion
- Vegetate the slopes and bottom for the same reason
- Freeboard of 1 foot
- Side slopes of at least 2:1 unless vertical retaining walls are used
- Incorporate bypass or overflow for large events
- Provide dedicated access to the basin bottom (minimum 4:1) for maintenance vehicles
- With a riser structure, include an anti-vortex device and a debris barrier.

Maintenance

Conduct inspections semiannually and after each significant storm. Remove floatables and correct erosion problems in the pond slopes and bottom. Pay particular attention to the outlet control orifice(s) for signs of clogging. If the orifice is located in a Type 2 catch basin, remove sediments if they are within 18 in. of the orifice plate. Often extended detention basin serve multiple used, e.g. baseball field, resulting in higher maintenance costs.

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Additional Information — Extended Detention Basins

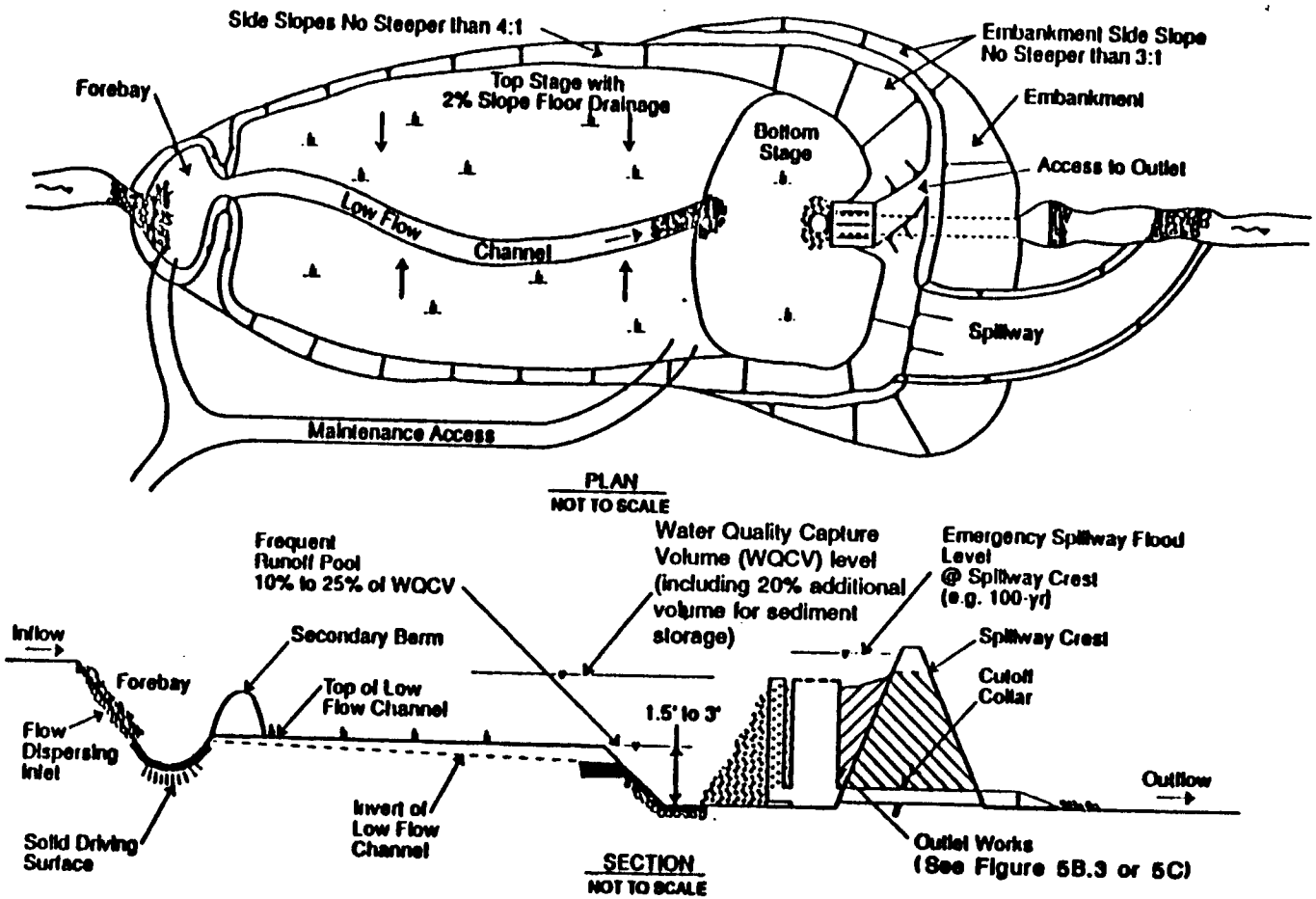

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FIGURE 5A. PLAN AND SECTION OF AN EXTENDED DETENTION BASIN

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FIGURE 5B.1 CONCRETE STRUCTURE

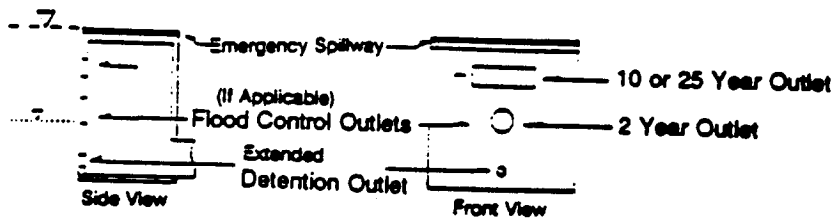

FIGURE 5B.2 RISER PIPE

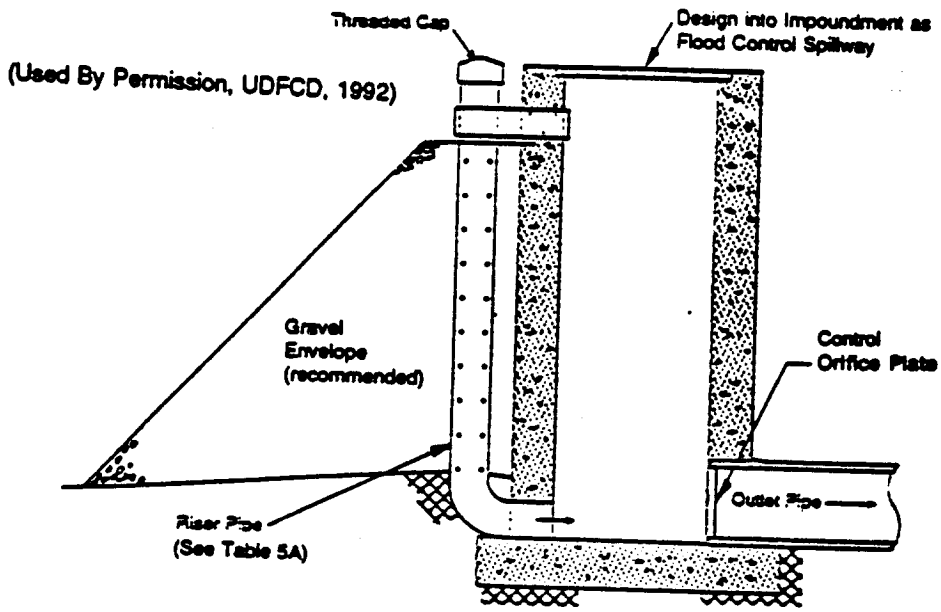

FIGURE 5B.3 CONTROL MANHOLE

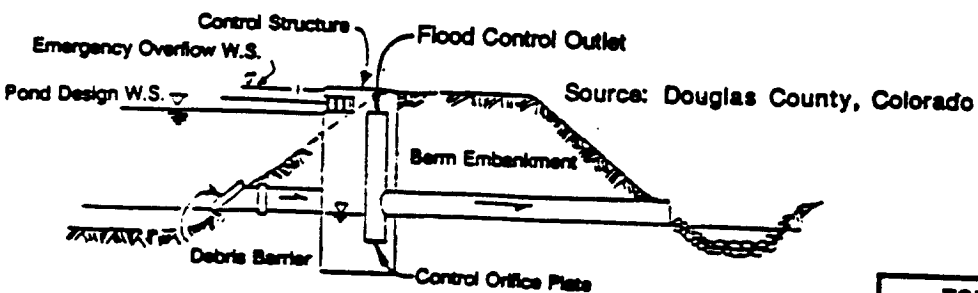

FIGURE 5B. OUTLET CONFIGURATIONS USING SINGLE ORIFICE FOR FLOW CONTROL

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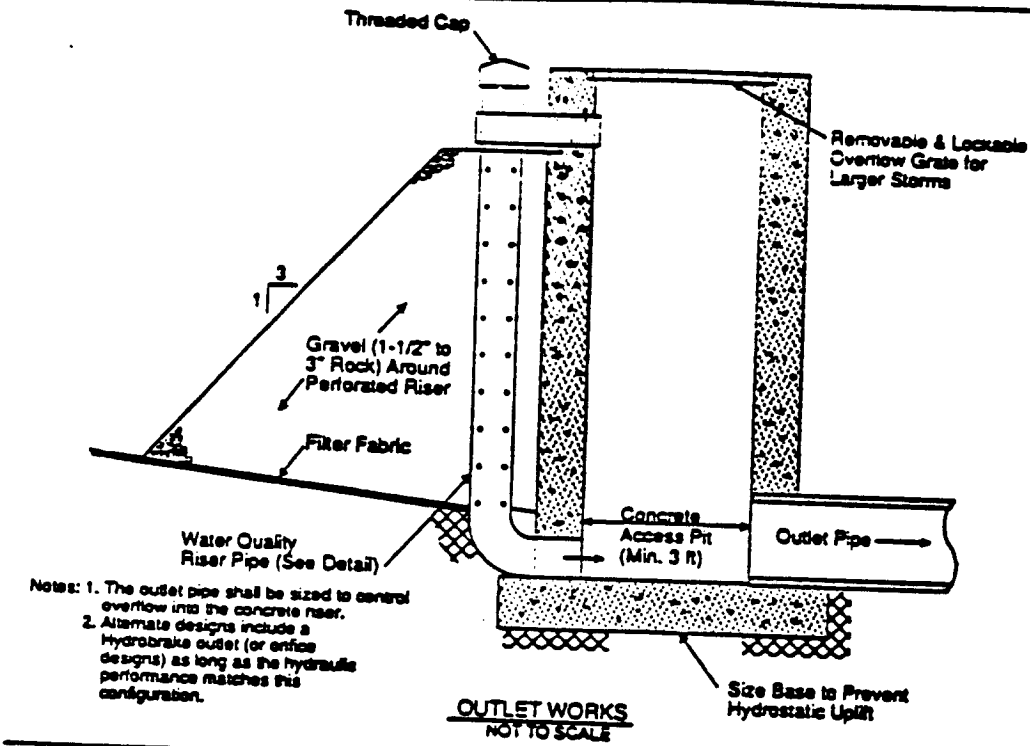
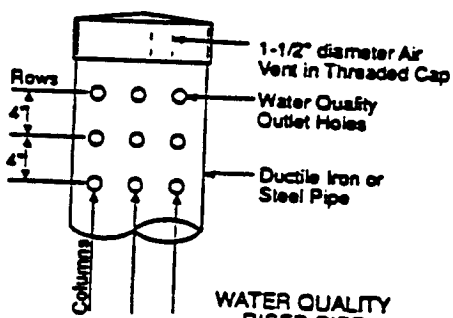


Notes: 1. The outlet pipe shall be sized to control overflow into the concrete riser.
2. Alternate designs include a Hydrobrake outlet (or orifice designs) as long as the hydraulic performance matches this configuration.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, in.			
	1/4"	1/2"	3/4"	1"
4	8	8	–	–
6	12	12	9	–
8	18	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area of Hole (in.2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

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FIGURE 5C. OUTLET CONFIGURATION USING PERFORATED RISER FOR FLOW CONTROL

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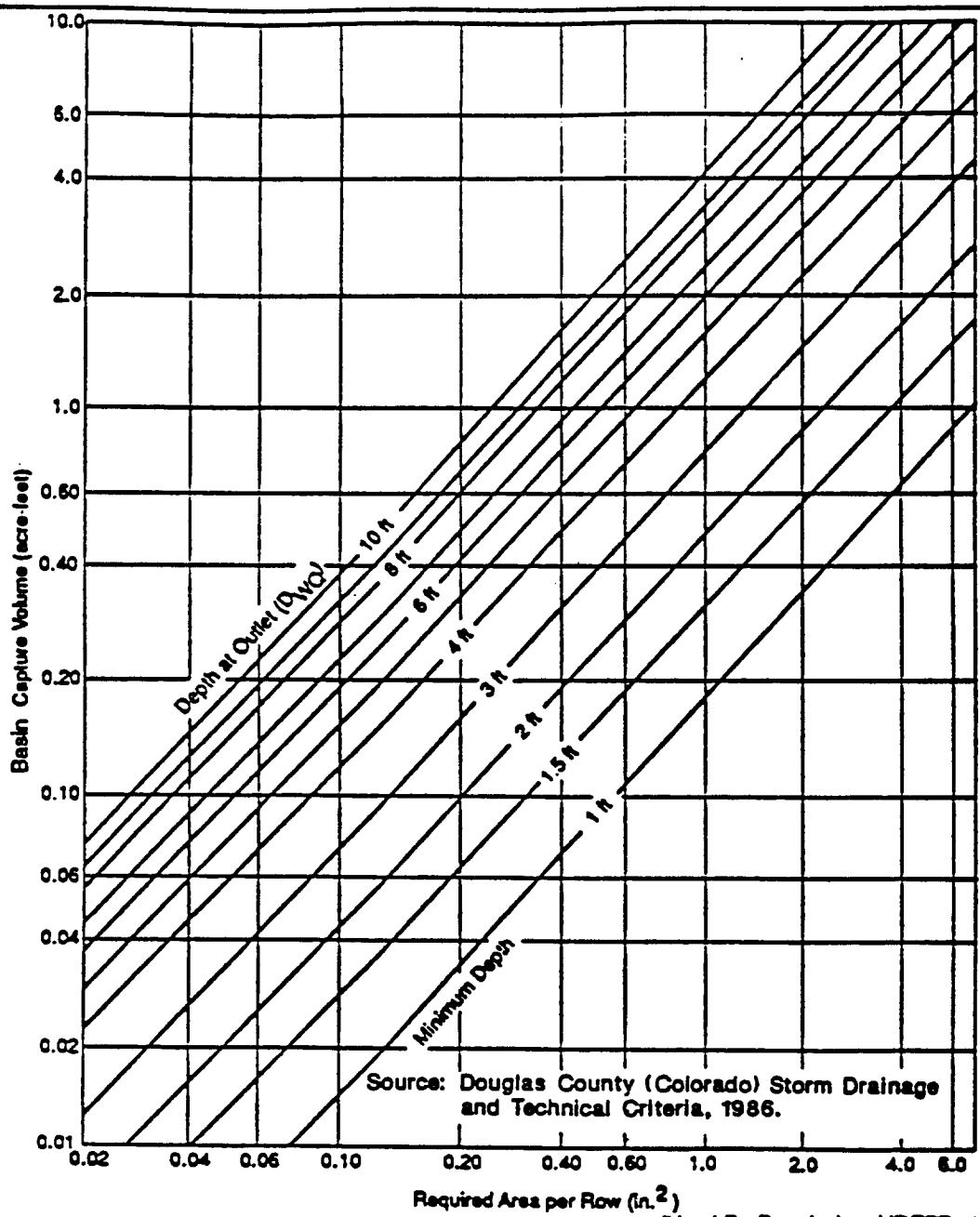

Source: Douglas County (Colorado) Storm Drainage and Technical Criteria, 1986.

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FIGURE 5D. WATER QUALITY OUTLET SIZING: EXTENDED DETENTION BASIN WITH A 40-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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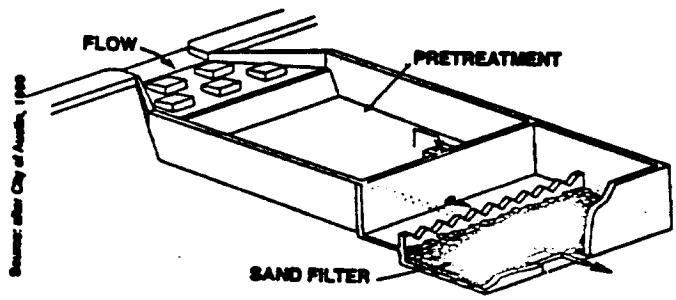
BMP: MEDIA FILTRATION



Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

Consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

EXPERIENCE IN CALIFORNIA

- A tenant at the Port of Long Beach recently installed a sand filter. The City of Los Angeles will soon install several experimental filters.

SELECTION CRITERIA

- Objective is to remove only sediment (particulate pollutants).
- Use where unavailability of water prevents the use of wet ponds, wetlands, or biofilters.
- Can be placed underground.
- Suitable for individual developments and small tributary areas up to about 100 acres.
- May require less space than other treatment control BMPs.

LIMITATIONS

- Filter may require more frequent maintenance than most of the other BMPs.
- Head loss.
- Dissolved pollutants are not captured by sand.
- Severe clogging potential if exposed soil surfaces exist upstream.

DESIGN AND SIZING CONSIDERATIONS

- Settling basin smaller than wet or extended detention basin.
- Spread flow across filter.
- Place filter offline to protect from extreme events.
- Minimize erosion in settling basin.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be certain filter sand is clean and the outlet device from the basin to the filter is level.

MAINTENANCE REQUIREMENTS

- Clean filter surface about twice annually; or more often if watershed is excessively erosive.

COST CONSIDERATIONS

- Filtration system may use less space than other systems.
- Smaller media improves performance but increases maintenance costs.

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ○ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

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Best Management Practices

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Additional Information — Media Filtration

Sand filters may be particularly suitable for industrial sites because the settling basin can be located underground. A sand filter consists of two units: settling basin and the filter. Pretreatment is essential to avoid rapid clogging of the filter. Peat/sand mixture has been used: peat having the ability to remove dissolved contaminants. However, there have been clogging problems (Tomasak, et al., 1987) but this may be due to using the wrong type of peat (Galli, 1990). Limited research indicates that compost made from leaves is very effective at removing dissolved phosphorus and metals, and oil and grease (Stewart, 1989). A new concept is placement of a filter device in a catch basin insert (McPherson, 1992) which may be very well suited for industrial sites.

Field research in the City of Austin, Texas (Austin, 1990) indicates the sand filter has a removal efficiency of suspended solids that is similar to wet ponds and extended detention: 70 to 90%. The observed removal of metals was 20 to 80%, depending on the metal, 20 to 30% for nitrogen, and 50 to 60% for phosphorus. These rates are also similar to wet ponds, which is not expected as a filter does not remove dissolved contaminants. Sand with a diameter smaller than used in Austin would likely improve performance but has not been tried.

The sand filter should be an ideal system for the Central Valley and Southern California. It does not rely on vegetation, and has proven itself in the City of Austin. The sand filter is suitable for tributary areas of a less than an acre to about 50 acres.

Make certain that any soil erosion problems in the site have been corrected (Chapter 4). Experience in Austin indicates that exposed soils during construction "upstream" from the filter can result in pentration of fines into the filter media, resulting in a need to replace the entire filter bed. The system should have a bypass for extreme events.

Alternative configurations

The most experience to date is with surface facilities shown conceptually in Figure 6A. It can be used on catchments up to perhaps 50 acres. Its origin is Austin, Texas where there are now several hundred facilities. The "Austin" filter uses an extended detention basin with a drawdown time of 24 hours. Two other systems are most suitable for small catchments of a few acres. An underground "linear" filter (Figure 6B) is used in Delaware (Shaver, 1991). The filter accepts sheet flow from adjacent pavement. It, therefore, may be ideal for industrial applications. Another underground design (Figure 6C) developed in Washington D.C. (Truong, 1989) is also ideal for developments. It accepts concentrated flow. Both of these underground systems use a wet vault (or water quality inlet, see TC7) as the pretreatment device. The fourth concept is (Figure 6D) is an insert placed in existing catch basins. It should only be used where maintenance staff are available to check the filter frequently and where local flooding will not occur if the filter clogs.

Determining the volume of the pretreatment unit

To size the pretreatment basin refer to the sizing methods for extended detention (TC5). With the sand filter the pretreatment basin need not be as efficient as a full size system. The pretreatment system, however, should be large enough to provide a removal efficiency that avoids rapid clogging of the filter. As yet, there is no clear answer on this question. For now it is suggested that the volume of a wet vault be such as to achieve a removal efficiency of 50 to 60%.

The volume of an pretreatment unit can be decreased by reducing the drawdown time, which results in a lower but acceptable removal efficiency. The facility volume can be determined from TC5 Extended Detention using a drawdown time of 24 hours.

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Additional Information — Media Filtration

Determining the surface area of the filter

The following equation is derived from Austin (1988) for a maximum (full pretreatment basin) filtration time of 24 hours:

$$\text{Filter area (ft}^2) = 3630 S_u AH/K(D+H) \qquad (1)$$

where:
- S_u = unit storage (inches-acre) from Appendix D
- A = area in acres draining to facility
- H = depth (ft) of the sand filter
- D = average water depth (ft) over the filter taken to be one-half the difference between the top of the filter and the maximum water surface elevation
- K = filter coefficient recommended as 3.5 (Austin)

Equation (1) is appropriate for the filter media size recommended by the City of Austin, diameter of 0.02 to 0.04 inches. The filter area must be increased if a smaller media is used (see Austin, Texas (1988)).

Configuring a surface sand filter (City of Austin concept)

Additional design criteria for the settling basin (Austin, 1988):

- For the outlet use a perforated riser pipe, as described in TC5, Extended Detention
- Size the outlet orifice for a 24 hour drawdown
- Energy dissipator at the inlet to the settling basin
- Trash rack at outlets to the filter
- Vegetate slopes to the extent possible (see Vegetated Biofilters)
- Access ramp (4:1 or less) for maintenance vehicles
- One foot of freeboard
- Length to width ratio of at least 3:1 and preferably 5:1
- Sediment trap at inlet to reduce resuspension. One concept is shown in Figure 6E.

Additional design criteria for the filter:

- Use a flow spreader (Figure 6A).
- Use either of two alternative sand bed designs (Figure 6F).
- Use clean sand 0.02 to 0.04 inch diameter.
- Some have placed geofabric on sand surface to facilitate maintenance.
- Underdrains (Figure 6A).
  - Schedule 40 PVC.
  - 4 inch diameter.
  - 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
  - maximum 10 foot spacing between laterals.
  - minimum grade of 1/8" per foot.

Configuring the linear filter

Take the volume for the pretreatment unit and the filter area identified above and configure into a structure similar to that shown in Figure 6B. The structural design in Figure 6B assumes traffic loads over the filter. The structure can be less robust if it is located along the edge of the pavement, away from traffic. Other recommendations (Shaver, 1991):

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- Depth of sand 18"
- Diameter of the outlet pipe should be 6" or less; use multiple outlets if necessary

The filter must be positioned relative to the pavement in a manner that evenly distributes the flow as it enters the sedimentation chamber. Pavement design and construction is therefore critical.

Configuring the wet vault filter

Similarly the volume of the wet vault and filter area are configured into a rectangular unit similar to that shown in Figure 6C. Other considerations for the wet vault include:

- A length to width ratio of at least 3:1 to minimize short-circuiting
- Baffles to reduce entrance velocities and to retain floatables
- Access ports to facilitate maintenance
- Depth of the wet pool of at least 3 feet but not more than 10 feet

Catch basin insert

The catch basin insert filter may be ideal for industrial sites as it can be placed in existing catch basins, and therefore may avoid the need for an "end-of-pipe" facility. The system is illustrated in Figure 6D. It consists of a series of trays. The top tray is a sediment trap. Filter material is placed in the lower trays. Of several materials examined, the most suitable appears to be household fiberglass insulation. Limited tests indicate over 90% removal of metals and oil (McPherson, 1992). As the insert requires frequent attention it should only be used where a maintenance person is located on-site. The insert has a bypass along one side should the filter material clog and is hydraulically designed so as to not compromise the primary purpose of a catch basin, to get storm water into the drain system. The concept shown in Figure 6D is proprietary (Enviro-drain, 1992).

Maintenance

Inspect semiannually, and after major storms. Sediment should be removed from the settling basin when 4 inches accumulates and from the filter when 1/2 inch accumulates, or when there is still water in the basin or over the filter 40 hours after the storm. Remove floatables. Experience in Austin indicates the filter surface must be cleaned about twice each year by raking off the dried sediment. Failure to clean the filter regularly may result in the need to replace the entire media because of penetration of fines into the filter. It is more cost effective over the long term to clean the filter regularly as recommended. If there are open space areas in the tributary that are erosive or if construction is occurring, more frequent cleaning will be necessary. It may be necessary to replace the filter media after construction activity has ceased and the soils are stabilized.

Consult Austin (1988), Truong (1989), and Shaver (1991) for additional design and maintenance criteria.

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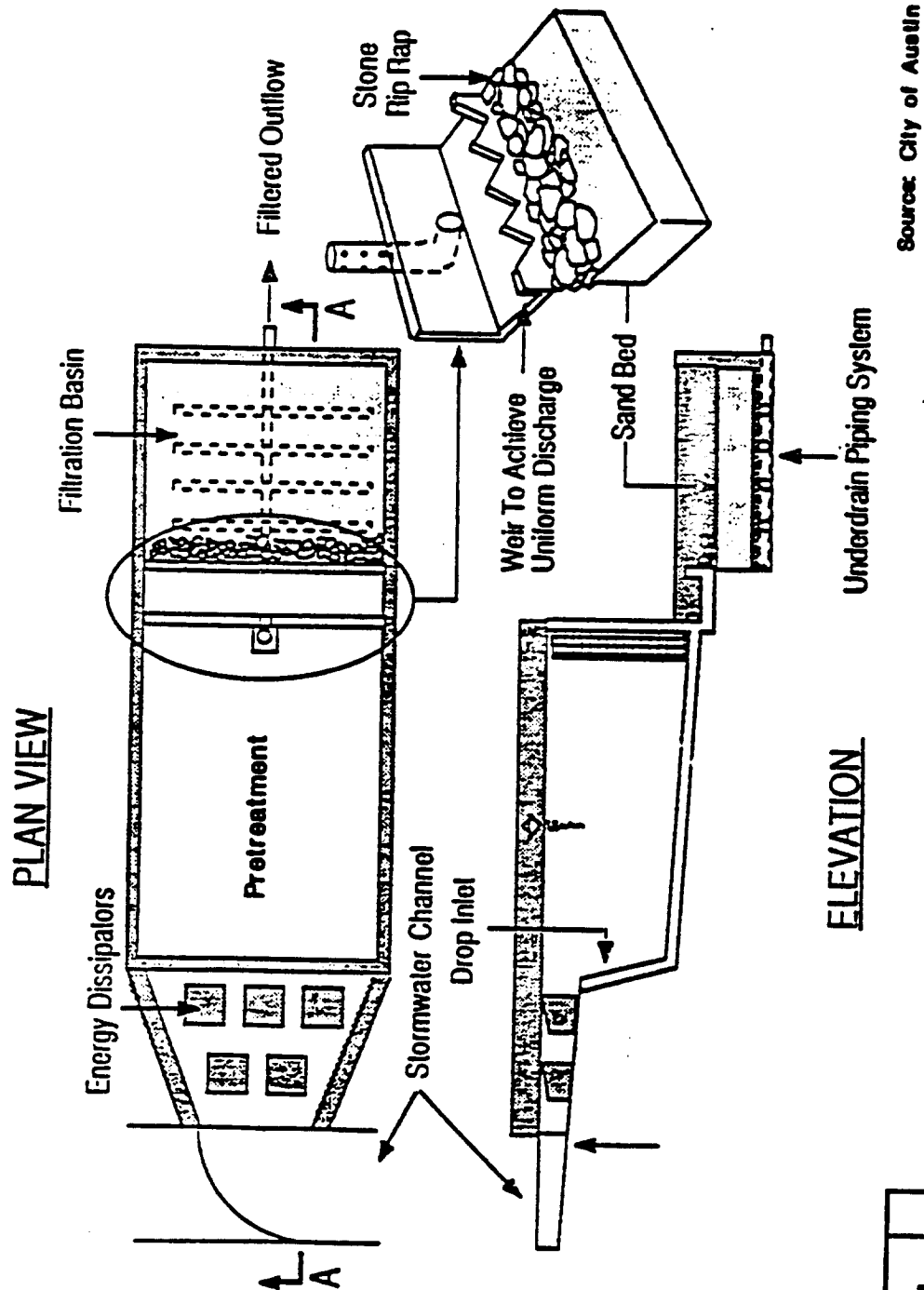

Source: City of Austin

FIGURE 6A. CITY OF AUSTIN SAND FILTER

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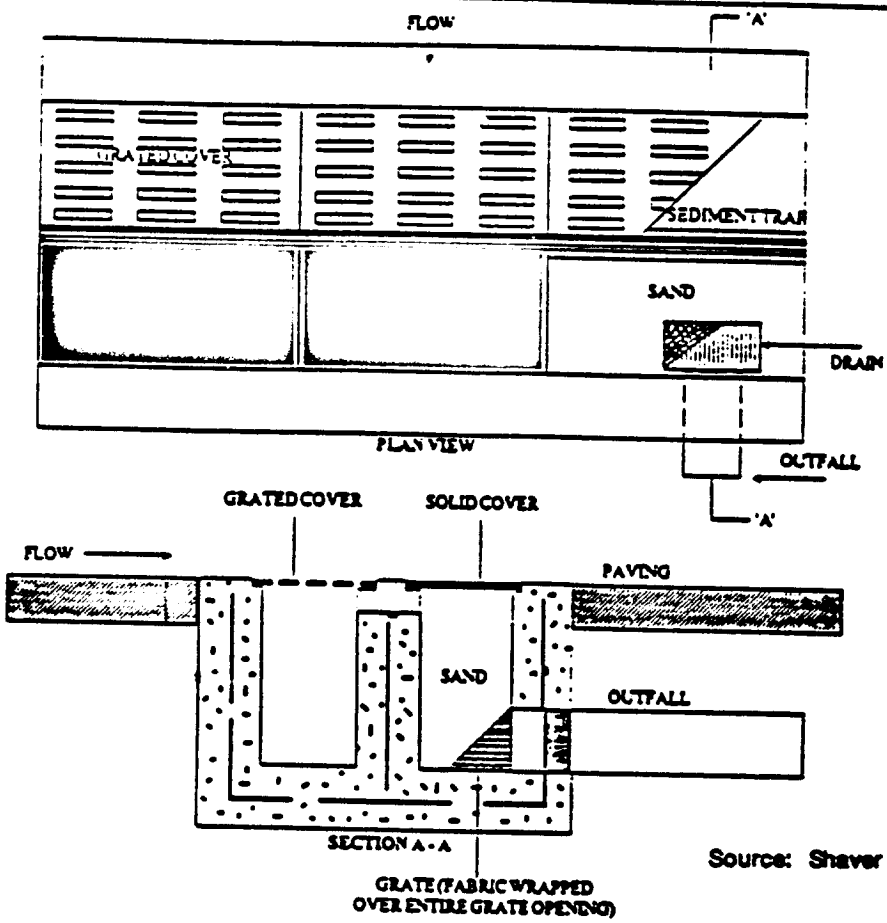
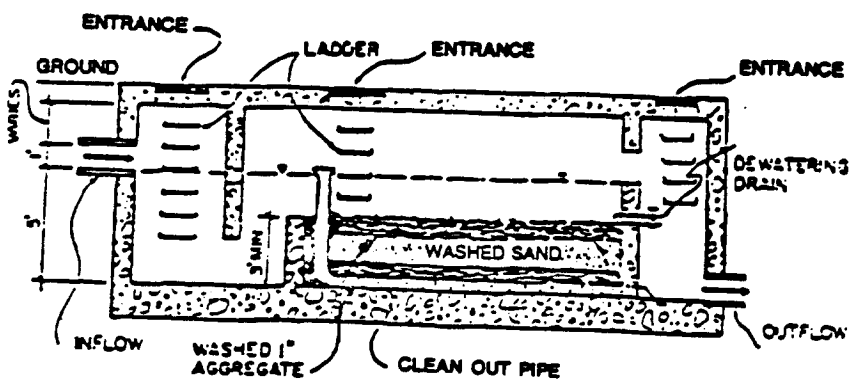


Source: Shaver (1991)

FIGURE 6B. LINEAL SAND FILTER



Source: District of Columbia

FIGURE 6C. VAULT SAND FILTER

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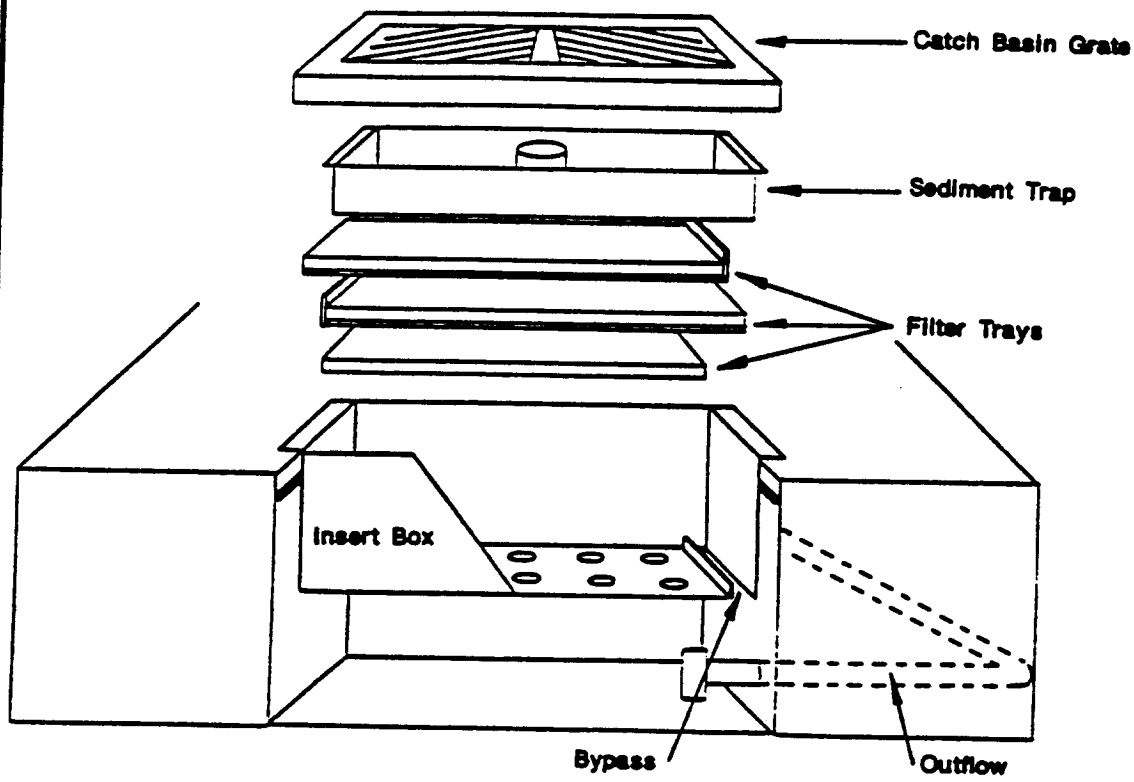

Source: McPherson (1992)

FIGURE 6D. CATCH BASIN FILTER

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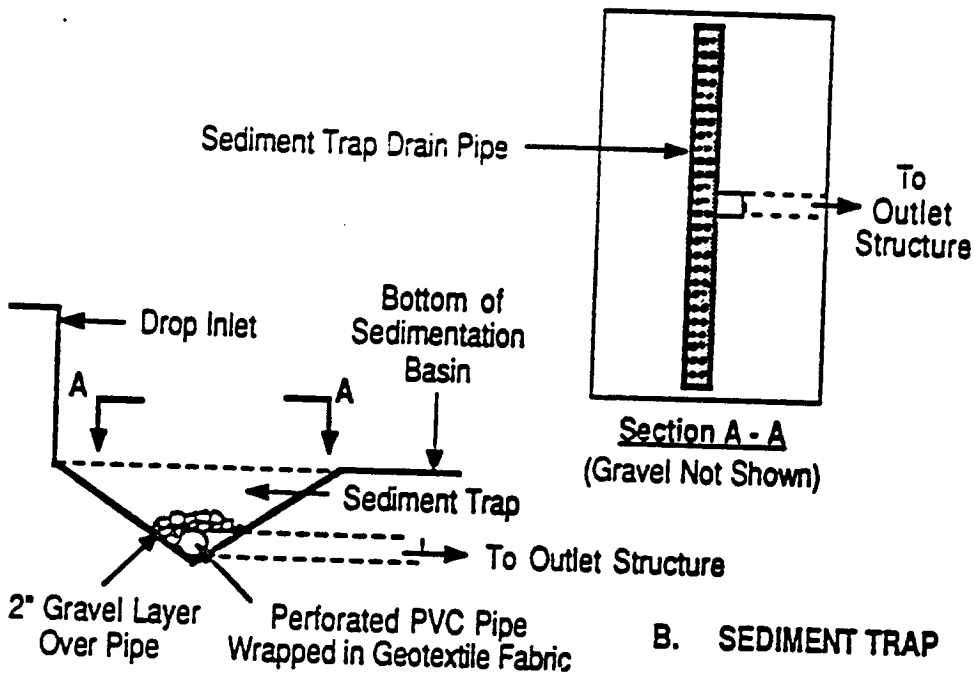

B. SEDIMENT TRAP

Source: City of Austin

FIGURE 6E. EXAMPLE RISER PIPE AND SEDIMENT TRAP DETAILS

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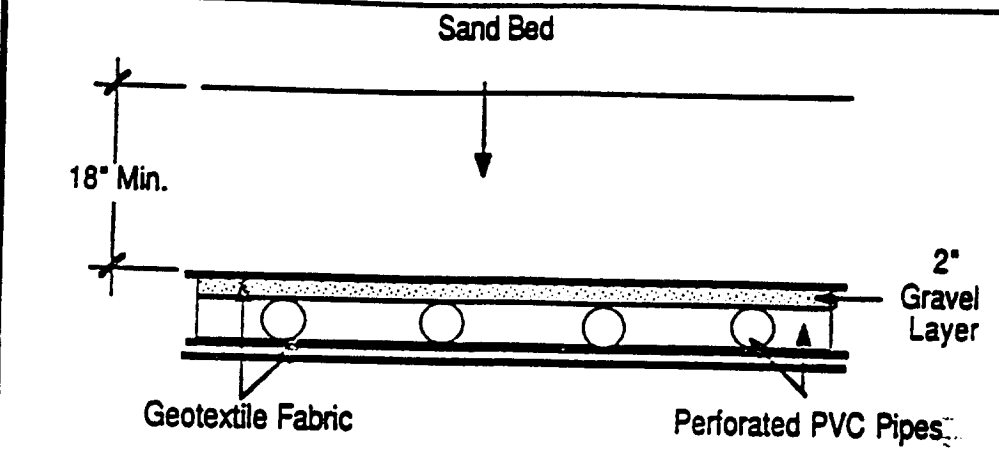
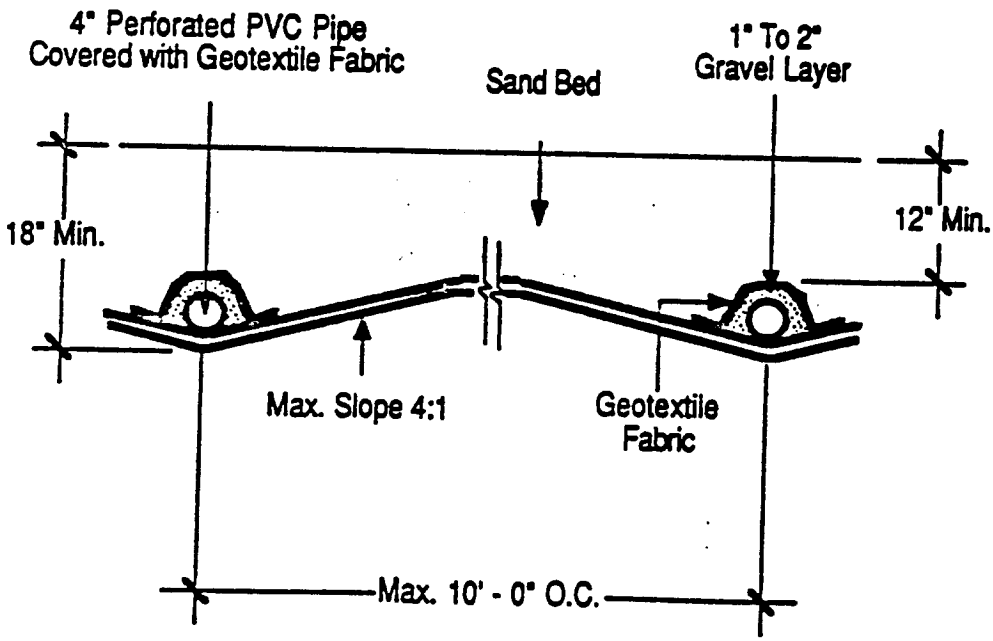


A. SAND BED PROFILE (WITH GRAVEL LAYER)



B. SAND BED PROFILE (TRENCH DESIGN)

Adapted from City of Austin (1989)

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FIGURE 6F. SAND BED FILTRATION CONFIGURATIONS

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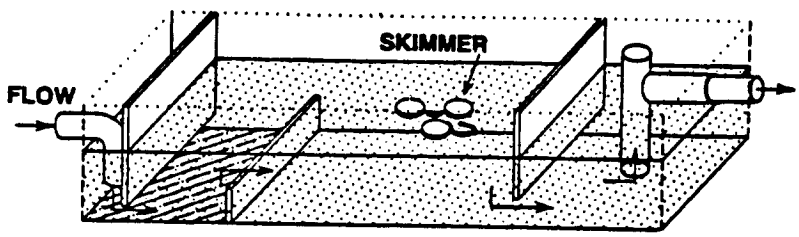
BMP: OIL/WATER SEPARATORS AND WATER QUALITY INLETS



Considerations

- Soils
- **Area Required**
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

DESCRIPTION

Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids. Two general types of oil/water separators are used: conventional gravity separator and the coalescing plate interceptor (CPI).

EXPERIENCE IN CALIFORNIA

Oil/water separators are in use throughout California at industrial sites. Oil/water separators are used at all bulk petroleum storage and refinery facilities. A few jurisdictions require new commercial developments to install separators under certain situations that are environmentally sensitive.

SELECTION CRITERIA

Applicable to situations where the concentration of oil and grease related compounds will be abnormally high and source control cannot provide effective control. The general types of businesses where this situation is likely are truck, car, and equipment maintenance and washing businesses, as well as a business that performs maintenance on its own equipment and vehicles. Public facilities where separators may be required include marine ports, airfields, fleet vehicle maintenance and washing, facilities, and mass transit park-and-ride lots. Conventional separators are capable of removing oil droplets with diameters equal to or greater than 150 microns. A CPI separator should be used if smaller droplets must be removed.

LIMITATIONS

- Little data on oil characteristics in storm water leads to considerable uncertainty about performance.
- Air quality permit (conditional authorization) permit-by-rule from DTSC may be required.

DESIGN AND SIZING CONSIDERATIONS

- Sizing related to anticipated influent oil concentration, water temperature and velocity, and the effluent goal. To maintain reasonable separator size, it should be designed to bypass flows in excess of first flush.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- None identified.

MAINTENANCE REQUIREMENTS

- Clean frequently of accumulated oil, grease, and floating debris.

COST CONSIDERATIONS

- Coalescing plate material is costly but requires less space than the conventional separator.

Targeted Constituents

- Sediment
- Nutrients
- Heavy Metals
- Toxic Materials
- **Floatable Materials**
- Oxygen Demanding Substances
- **Oil & Grease**
- Bacteria & Viruses

- **Likely to Have Significant Impact**
- Probable Low or Unknown Impact

Implementation Requirements

- Capital Costs
- O&M Costs
- Maintenance
- Training

- **High**
- Low

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Additional Information — Oil/Water Separators and Water Quality Inlets

General Information

Oil/water separators will be needed for a few types of industrial sites where activities result in abnormal amounts of petroleum products lost to exposed pavement, either by accidental small spills or normal dripping from the vehicle undercarriage. This will most likely be related to vehicle and mobile equipment maintenance activities. Separators may also be advisable where an area is heavily used by mobile equipment such as loading wharfs at marine ports. Limited data indicates oil/water separators can reduce the oil/grease concentration below 10 mg/l (Lettenmaier, et al. 1985).

Wet ponds, constructed wetlands, and biofilters will remove petroleum products but their reliability is uncertain where high concentrations of petroleum products may occur frequently. Also, BMPs that rely on vegetation may be damaged or become unsightly if high concentrations of oil and grease occur frequently.

The sizing of separators is based upon the rise rate velocity of oil droplet and rate of runoff. However, with the exception of storm water from oil refineries there are no data describing the characteristics of petroleum products in urban storm water that are relevant to design: either oil density and droplet size to calculate rise rate or direct measurement of rise rates. Further, it is known (Silverman, 1982) that a significant percentage of the petroleum products are attached to the fine suspended solids and therefore are removed by settling not flotation. Consequently, the performance of oil/water separators is uncertain.

The basic configurations of the two types of separators are illustrated in Figure 7A. With small installations, a conventional gravity separator has the general appearance of a septic tank, but is much longer in relationship to its width. Larger facilities have the appearance of a municipal wastewater primary sedimentation tank. The CPI separator contains closely spaced plates which enhances the removal efficiency. In effect, to obtain the same effluent quality a CPI separator requires considerably less space than a conventional separator. The angle of the plates to the horizontal ranges from 0° (horizontal) to 60°, although 45° to 60° is the most common. The perpendicular distance between the plates typically ranges from 0.75 to 1 inch. The storm water will either flow across or down through the plates, depending on the plate configuration.

A related system is the water quality inlet illustrated in Figure 7B. It is essentially a conventional gravity separator but without the appropriate geometric configuration (see Design discussion below). Another name for this systems is a wet vault. Water quality inlets have been found to be generally ineffective (Shepp, et al., 1992) because the recommended size (200 to 400 ft^3/acre of tributary) is too small. To be effective, a water quality inlet must have the surface area and volume that is similar to that of conventional separators. They may exhibit odor problems during the summer because of the lack of bacterial degradation of accumulated organic matter and the lack of reaeration of the wet pool. Facilities in Washington D.C. have been observed to have odor but, it has been noticeable only when the system is opened for inspection.

Design of Conventional Separators

The sizing of a separator is based upon the calculation of the rise rate of the oil droplets using the following equation (modified from API, 1990):

$$V_p = 1.79\,(d_p - d_c)d^2 \times 10^{-8}/n \qquad (1)$$

where:
- V_p = rise rate (ft/second)
- n = absolute viscosity of the water (poises)
- d_p = density of the oil (gm/cc)
- d_c = density of the water (gm/cc)
- d = diameter of the droplet to be removed (microns)

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A water temperature must be assumed to select the appropriate values for water density and viscosity from Table 7A. The engineer should use the expected temperature of the storm water during the December-January period. There are no data on the density of petroleum products in urban storm water but it can be expected to lie between 0.85 and 0.95. To select the droplet diameter the engineer must identify an efficiency goal based on an understanding of the distribution of droplet sizes in storm water. However, there is no information on the size distribution of oil droplets in urban storm water. Figure 7C is a size and volume distribution for storm water from a petroleum products storage facility (Branion, undated). The engineer must also select a design influent concentration, which carries considerable uncertainty because it will vary widely within and between storms.

To illustrate Equation 1: if the effluent goal is 10 mg/l and the design influent concentration is 50 mg/l, a removal efficiency of 80% is required. From Figure 7C: this efficiency can be achieved by removing all droplets with diameters 90 microns or larger. Using a water temperature of 10°C gives a water density of 0.998. Using an oil density of 0.898, the rise rate for a 90 micron droplet is 0.0011 feet per second.

It is generally believed that conventional separators are not effective at removing droplets smaller than of 150 microns (API, 1990). Theoretically, a conventional separator can be sized to remove a smaller droplet but the facility may be so large as to make the CPI separator more cost-effective.

Sizing conventional separator (modified from API, 1990).

$$D = (Q/2V)^{0.5} \qquad (2)$$

where: D = depth, which should be between 3 and 8 feet
Q = design flow rate (cfs)
V = allowable horizontal velocity which is equal to 15 times the design oil rise rate but not greater than 0.05 feet per second

If the depth exceeds 8 feet, design parallel units dividing the design flow rate by the number of units needed to reach the maximum recommended depth of 8 feet. Equation (2) is simplified from equations in API (1990) based on a recommended width to depth ratio of 2. The constant in Equation (2) can be changed accordingly if a different ratio is assumed. Some engineers may wish to increase the facility size to account for flow turbulence. See API (1990) for the design procedure.

Then:

- Calculate length, $L = VD/V_p$
- Compute width, $W = Q/(VD)$. This should be 2 to 3 times the depth, but not to exceed 20 feet
- Baffle height to depth ratio of 0.85 for top baffles and 0.15 for bottom baffles
- Locate the distribution baffle at 0.10L from the entrance
- Add one foot for freeboard
- Install a bypass for flows in excess of the design flow

Determining the design flow, Q, requires identification of the design storm. The separator is expected to operate effectively at all flow rates equal to or less than the peak runoff rate of the design storm. The design storm need not be an extreme event, as is typically used in the sizing of flood control facilities. If sized to handle a storm frequency between the 3-month to 1-year event, the facility will effectively treat the vast majority of storm water that occurs over time. All events equal to or less than the 6-month event represents about 90% of the precipitation over time; designing for a 2-year

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event only increases the amount of runoff treated by about 5% (increase from 90% to 95% of rainfall treated). For the design storm selected, calculate the peak runoff rate using the rational method.

Application of the Conventional Oil/Water Separator

Assume that a conventional oil/water separator is to be used to treat runoff from a 1/2 acre parking lot. Assume further it is to be sized to treat runoff from a rainfall rate of 0.50 inches/hr (which translates to a runoff rate of 0.50 cfs/acre when the area is 100 percent impervious.

Using the example above, the computed Vp is 0.0011 ft/sec. Using Equation 2, V =15 x 0.0011= 0.0165 ft/sec which is less than 0.05 ft/sec; thus,

$$D = (Q/2V)0.05 = (1/2 \times 0.05/(2 \times 0.0165)) \times 0.05$$
$$D = 3.8 \text{ ft.}$$

$$L = VD/Vp = 0.0165 \times 3.8/0.0011$$
$$L = 57 \text{ ft.}$$

$$W = Q/(VD) = 0.25/(0.0165 \times 3.8)$$
$$W = 4.0 \text{ ft, since W is less than } 2 \times D\text{, increase width to } W = 3.8 \times 2 = 7.6 \text{ ft.}$$

Thus, a conventional oil/water separator sized to capture runoff from a 0.5 in/hr rainfall on a 1/2 acre parking lot would be:

D = 3.8 ft
W = 7.6 ft
L = 57 ft

Sizing CPI separator

Manufacturers can provide packaged separator units for flows up to several cubic feet per second. For larger flows, the engineer must size the plate pack and design the vault. Given the great variability of separator technology among manufacturers with respect to plate size, spacing, and inclination, it is recommended that the design engineer consult vendors for a plate package that will meet the engineer's criteria. Manufacturer's typically identify the capacity of various standard units. However, the engineer's design criteria must be comparable to that used by the manufacturer in rating its units.

The engineer can size the facility using the following procedure. First identify the expected plate angle, H (as degrees), and calculate the total plate area required, A(ft^2).

$$A = Q/V_p \text{Cosine} H \qquad (3)$$

CPI separators are not 100% hydraulically efficient; ranging from 0.35 to 0.95 depending on the plate design (Aquatrend, undated). If the engineer wishes to incorporate this factor, divide the result from Equation 3 by the selected efficiency.

- Select spacing, S, between the plates, usually 0.75 to 1.5 inch.
- Identify reasonable plate width, W, and length, L.
- Number of plates, N = A/WL.
- Calculate plate volume, P_V(ft^3).

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$$P_V = \frac{(NS + L\,\text{Cosine}H)(WL\,\text{Sine}H)}{12} \qquad (4)$$

- Add a foot beneath the plates for sediment storage.
- Add 6" to 12" above the plates for water clearance so that the oil accumulates above the plates.
- Add one foot for freeboard.
- Add a forebay for floatables and distribution of flow if more than one plate unit is needed.
- Add after bay for collection of the effluent from the plate pack area.
- For larger units include device to remove and store oil from the water surface.

Horizontal plates require the least plate volume to achieve a particular removal efficiency. However, settleable solids will accumulate on the plates complicating maintenance procedures. The plates may be damaged by the weight when removed for cleaning. The plates should be placed at an angle of 45° to 60° so that settleable solids slide to the facility bottom. Experience shows that even with slanted plates some solids will "stick" to the plates because of the oil and grease. Placing the plates closer together reduces the plate volume. However, if debris is expected such as twigs, plastics, and paper, select a larger plate separation distance. Or install ahead of the plates a trash rack and/or screens with a diameter somewhat smaller than the plate spacing.

Recognizing that an oil/water separator also removes settleable solids, it can also be considered a wet vault (TC2). The engineer can use Figure 2B (See TC2) to estimate the efficiency of both the conventional and CPI separators. As Figure 2B does not include the effect of plate technology, a CPI separator should perform considerably better than indicated in Figure 2B for the same V_b/V_r ratio.

See API (1990) for further design concepts for both the conventional and CPI separators.

Maintenance

Check monthly during the wet season and clean several times a year. Always clean in October before the start of the wet season. Properly dispose the oil.

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American Petroleum Institute (API), 1990, "Design and Operation of Oil-Water Separators", Publication 421.

Aquatrend, undated, "Design Manual: Innova Sep Particle Separation System", Shawnee Mission, Kansas.

Branion, R., undated, "Principles for the Separation of Oil Drops from Water in Gravity Type Separators", Department of Chemical Engineering, University of British Columbia.

Lettenmaier, D. and J. Richey, 1985, "Operational Assessment of a Coalescing Plate Oil/Water Separator", Municipality of Metropolitan Seattle.

Metropolitan Washington Council of Governments (MWCOG), March, 1992, "A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone".

Silverman, G, 1982, "Wetlands for Oil and Grease Control", Tech Memo. 87, Association of Bay Area Governments.

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TABLE 7A. WATER VISCOSITIES & DENSITIES

Temperature °C	Temperature °F	Absolute Viscosity (Poises)	Absolute Viscosity (slugs/ft.sec.)	Density (gm/cc)	Density of pure water in air (lbs/ft^3)
0	32.0	0.017921	0.00120424	0.999	62.351
1	33.8	0.017343	0.00116338	0.999	62.355
2	35.6	0.016728	0.00112407	0.999	62.358
3	37.4	0.016191	0.00108799	0.999	62.360
4	39.2	0.015674	0.00105324	1.000	62.360
5	41.0	0.015188	0.00102059	0.999	62.360
6	42.8	0.014728	0.00098968	0.999	62.359
7	44.6	0.014284	0.00095984	0.999	62.357
8	46.4	0.013860	0.00093135	0.999	62.354
9	48.2	0.013462	0.00090460	0.999	62.350
10	50.0	0.013077	0.00087873	0.999	62.345
11	51.8	0.012713	0.00085427	0.999	62.339
12	53.6	0.012363	0.00084870	0.999	62.333
13	55.4	0.012028	0.00080824	0.999	62.326
14	57.2	0.011709	0.00078681	0.999	62.317
15	59.0	0.011404	0.00076631	0.999	62.309
16	60.8	0.011111	0.00074662	0.999	62.299
17	62.6	0.010828	0.00072761	0.999	62.289
18	64.4	0.010559	0.00070953	0.999	62.278
19	66.2	0.010299	0.00069206	0.999	62.266
20	68.0	0.010050	0.00067533	0.998	62.254

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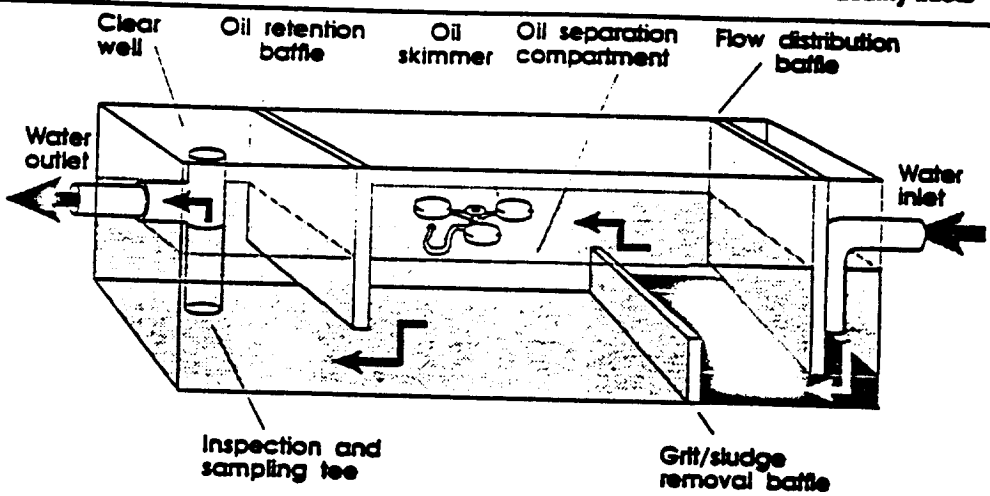
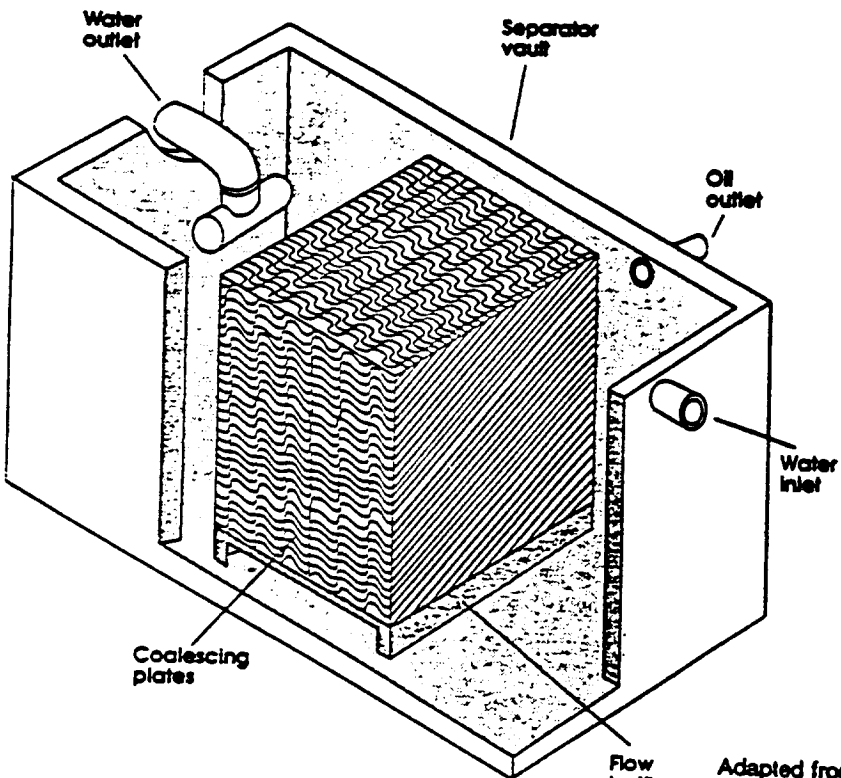


CONVENTIONAL SEPARATOR

Adapted from Romano, 1990



COALESCING PLATE SEPARATOR

Adapted from Romano, 1990

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FIGURE 7A. CONVENTIONAL AND COALESCING PLATE SEPARATORS

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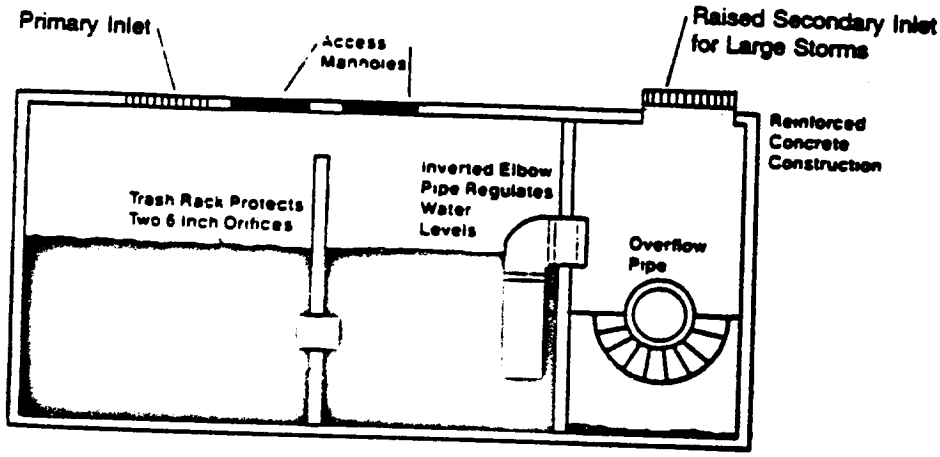

Adapted from Schueler, 1987

NOTE:
1. Size as conventional separator.
2. Design outlet orifice in elbow to limit outflow to the design rate for the unit.

FIGURE 7B. WATER QUALITY INLET

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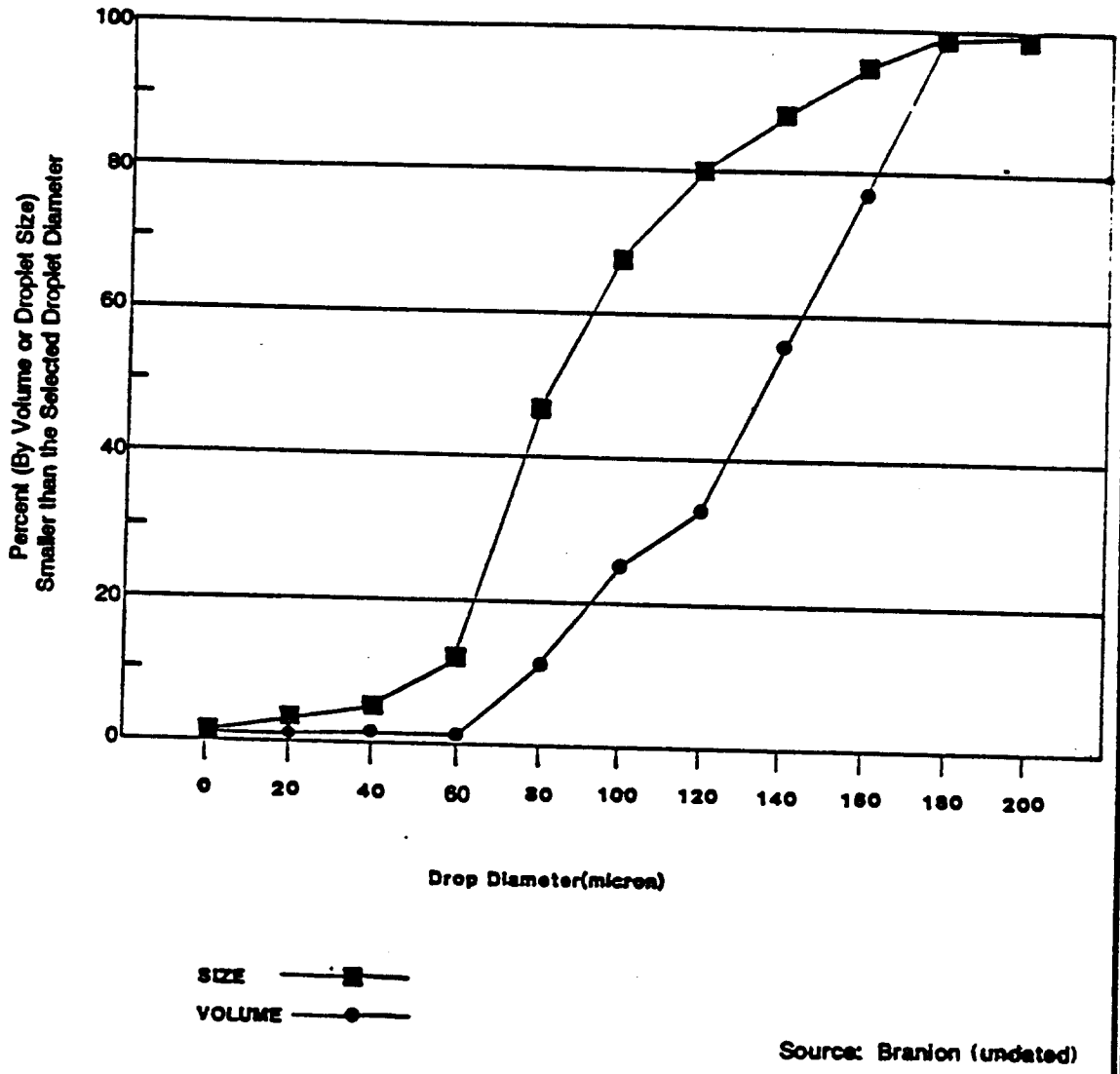

Source: Branion (undated)

FIGURE 7C. SIZE AND VOLUME DISTRIBUTION

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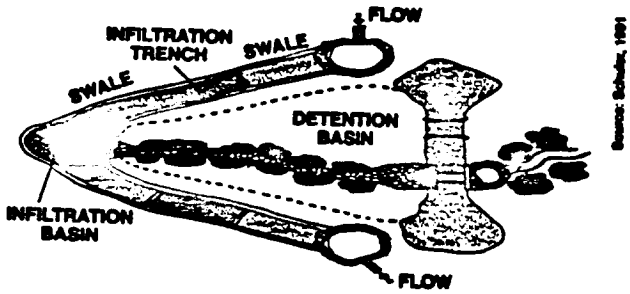
BMP: MULTIPLE-SYSTEMS



Source: Schueler, 1991

DESCRIPTION

A multiple treatment system uses two or more of the preceding BMPs in series. A few multiple systems have already been described: settling basin combined with a sand filter; settling basin or biofilter combined with an infiltration basin or trench; extended detention zone on a wet pond.

EXPERIENCE IN CALIFORNIA

- The research wetlands at Fremont, California are a combination of wet ponds, wetlands, and grass biofilters.

SELECTION CRITERIA

- Need to protect a downstream treatment system
- Enhanced reliability
- Optimum use of the site

LIMITATIONS

- Available space

DESIGN AND SIZING CONSIDERATIONS

- Refer to individual treatment control BMPs

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Refer to individual treatment control BMPs

MAINTENANCE REQUIREMENTS

- Refer to individual treatment control BMPs

COST CONSIDERATIONS

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ● Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ◒ Bacteria & Viruses

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ● O&M Costs
- ● Maintenance
- ○ Training

● High ○ Low

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Additional Information — Multiple-Systems

Multiple systems may occur in series or by stacking vertically. Multiple systems that have been tried or that appear to be feasible are presented below.

Stacked systems

- Extended detention above wet pond: used extensively in the mid-Atlantic states. Recommended by several practioners because of the uncertainty about the performance of wet ponds.
- Wet pond above sand filter: has been tried in Florida and Massachusetts and found wanting due to the clogging of the sand filter by settleable solids.

Series systems

- Extended detention basin - sand filter: standard system in Austin, Texas. Settling basin is needed to avoid excessive maintenance on the sand filter.
- Detention basin - sand filter - wetland: Large system operating in Florida.
- Wet pond - wetland: where an unusually high loading of sediment is expected, a full size wet pond, rather than just a forebay in the wetland, may be desirable to minimize the amount of sediment reaching the wetland where it would be more costly to remove.
- Biofilter - wet pond: Used frequently in the Pacific Northwest, again to enhance reliability.
- Biofilter - infiltration trench: treatment of the storm water before it enters an infiltration system.
- Oil/water separator - wetland or biofilter: oil/water separator used to protect the vegetated treatment system where high concentrations of oil may frequently occur.

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Chapter 6

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6. MEASURING BMP PERFORMANCE

One of the final steps in the preparation of the Storm Water Pollution Prevention Plan (SWPPP) is to develop a program to monitor how well the BMPs are being implemented, and how well they are reducing the amount of pollutants leaving your site in the storm water. The general permit requires that such a program be a component of the SWPPP. The program has the following objectives:

- To monitor the quality of the storm water discharge
- To aid in implementation of the SWPPP
- To measure the effectiveness of the BMPs

To meet these objectives the monitoring effort has these elements:

- Site inspections
- Certification of compliance
- Storm water monitoring
- Record keeping
- Plan review and modifications

SITE INSPECTIONS

The annual inspection as required by the general permit is to be conducted by designated and qualified staff. However, during the first year of implementation, monthly inspections are advisable, with annual inspections thereafter. The inspection should be done under the leadership of the SWPPP Leader, with appropriate members of the Pollution Prevention Team. In addition, the RWQCB or local storm water agency may conduct periodic inspection of the site.

According to the general permit a tracking or follow-up procedure is required to ensure appropriate action has been taken in response to an inspection. This might include meetings by the Pollution Prevention Team, particularly after each inspection. These meetings might take place quarterly during the first year, and annually thereafter, to examine the results of the inspection. This assessment may call for more effort in implementing the BMPs or adjustments to the BMP list.

The results of the inspection and assessment must be written. Include the date of the inspection, the person(s) who performed the inspection, and the observations. Inspection records must be retained for five years.

It is possible that activities may have changed since the last inspection, by type or location. These should be noted. New BMPs and adjustments to the SWPPP may be necessary.

Inactive mining operations are not required to conduct an annual inspection if impracticable, but they must certify compliance as noted below. Facilities subject to effluent limitations, listed in Appendix B, are also not required to conduct annual inspections.

CERTIFICATION OF COMPLIANCE

Except for inactive mining operations and facilities subject to effluent limitations (listed in Appendix A), you must certify, based on the annual inspection, that your facility is in compliance with the requirements of the general permit and the SWPPP. If the inspection indicates you are not in compliance, you are to notify your Regional Water Quality Control Board. The notification is to identify the type(s) of noncompliance, the actions identified to come into compliance, and a time schedule to achieve compliance.

Inactive mining operations are to demonstrate compliance once every three years by a Registered Professional Engineer, who certifies that the SWPPP has been prepared for the facility and implemented in accordance with the permit.

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STORM WATER MONITORING

Each facility must either conduct an individual monitoring plan or participate in a group sampling program. A group monitoring program may be developed either by an entity representing a group of similar facilities or by a local storm water agency which holds its own NPDES permit. According to the general permit, the monitoring plan is to contain the following:

- Rationale for selecting the monitoring methods
- Analytical methods to detect contaminants
- Sampling methods, locations, and frequency
- A quality assurance/quality control program
- Procedure and schedules to evaluate the effectiveness of the monitoring in achieving its objectives

The monitoring is required to verify the presence or absence of pollutants in the storm water.

Also, during the period of October 1 to April 30, you are to:

- Conduct visual inspections of the discharge locations during the first hour of one significant storm event per month to observe the presence of floating and suspended materials, oil and grease, turbidity, discolorations, and odors.

- Collect and analyze samples from at least two storms. Analyze the samples for pH, total suspended solids, specific conductance, and either total organic carbon, or oil and grease.

Testing for non-storm water discharges is to occur at least twice during the dry season of May through September. Refer to SC1 in Chapter 4 on testing procedures.

Refer to Appendix A for more details.

RECORD KEEPING

Records of all annual inspections, compliance certifications, and noncompliance reporting, and Registered Professional Engineer certifications as required, are to be retained on-site for five years.

It is suggested that incidents such as spills, or other episodic releases be kept. Analyzing a history of this information can provide insight into modifying the BMPs. The history may suggest a predominance of spills in particular locations, from particular activities, and/or of particular materials. Efforts may be focused accordingly. Photographs can be useful. Also keep a record of maintenance activities or any other BMPs that are of an "action" nature. It is easy to demonstrate that a BMP that involves a physical change, such as berming or covering, has been accomplished. But actions that relate to good housekeeping can only be demonstrated by record keeping. Keeping a record of catch basin cleaning, for example, also provides insight into how soon it takes for the catch basin sump to refill.

PLAN REVIEW AND MODIFICATIONS

The SWPPP must be revised if an inspection indicates a need to alter the BMPs: drop ineffective BMPs, add new BMPs, or modify a BMP that is to remain in the SWPPP. If there is a new, deleted, or moved activity, modify the SWPPP if this change significantly affects the amount of contaminants in the storm water.

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Appendices

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APPENDIX A

STATE OF CALIFORNIA GENERAL INDUSTRIAL ACTIVITIES STORM WATER PERMIT

STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
PETE WILSON, Governor
STATE WATER RESOURCES CONTROL BOARD
PAUL R. BONDERSON BUILDING
901 P STREET
P. O. BOX 100
SACRAMENTO, CALIFORNIA 95812-0100
(916) 657-0919
FAX: (916) 657-2388

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OCT 15 1992

TO: INTERESTED PARTIES

AMENDED GENERAL INDUSTRIAL ACTIVITIES STORM WATER PERMIT

Enclosed is an updated copy of the General Industrial Activities Storm Water Permit (General Permit) adopted by the State Water Resources Control Board (State Water Board) on November 19, 1991 and amended on September 17, 1992. Dischargers who have not already filed their Notice of Intent (NOI) to comply with the terms of the General Permit and the first annual fee must submit a NOI accompanied by the first annual fee to the State Water Board in order to be covered by this General Permit. The NOI and fee must be sent to the following address:

State Water Resources Control Board
Division of Water Quality
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

The NOI will only be processed if accompanied by the appropriate fee. The fee will be either $250.00 or $500.00. Enclosure 1 describes those areas in which the $250.00 annual fee applies. Dischargers in all other areas of the State must pay the $500.00 annual fee.

Attachment 2 to the Permit lists the nine California Regional Water Quality Control Boards' (Regional Water Boards) addresses and telephone numbers. You should discuss any questions or issues which relate to the implementation of the General Permit with Regional Water Board staff.

The updated General Permit contains amended monitoring and reporting requirements (Section B of the General Permit) that replace the original monitoring and reporting requirements. The new monitoring and reporting requirements have been simplified and now offer several sampling and analysis exemption options. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers (those beginning industrial activity after January 1, 1993) must develop and implement a monitoring program prior to the commencement of industrial activity.

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The amended monitoring and reporting provisions require that group monitoring proposals be submitted to the appropriate Regional Water Board(s) by December 1, 1992 and in subsequent years by August 1. Groups with participants within the boundaries of more than one Regional Water Board must send their group monitoring proposal to the State Water Board's Executive Director for approval to the above address.

Also, we would appreciate it if you would inform other industries similar to your own of the need to obtain a storm water permit. If you know of industries that need to obtain a permit but may be unaware of the State's program, please ask them to call Division of Water Quality staff at the telephone number shown below.

If you have any questions regarding this General Permit, please telephone the industrial activities storm water permit information line at (916) 657-0919.

Sincerely,

Walt Pettit

Walt Pettit
Executive Director

Enclosures (2)

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Enclosure 1

AREAS OF THE STATE IN WHICH THE $250.00 ANNUAL FEE APPLIES

Municipality	Permitted Area
1. Alameda County	The permitted area of the county is the westerly side of the county which drains to San Francisco Bay.
2. Los Angeles County	The permitted area consists of the five hydrologic subbasins which drain into the Pacific Ocean as follows: Santa Monica Bay, Upper Los Angeles River, including Sycamore Channel, Upper San Gabriel River, Lower Los Angeles River, and Lower San Gabriel River, including Santa Clarita Valley. The permit does not cover the cities of Avalon, Lancaster, and Palmdale.
3. Orange County	The permitted area is delineated by the Los Angeles County line on the northwest, the San Bernardino County line on the north and northeast, the Riverside County line on the east, the San Diego County line on the south, and the Pacific Ocean on the southwest.
4. Riverside County	The permitted area is delineated by the San Bernardino County line on the north and northwest, the Orange County line on the west, the San Diego County line on the south, and the Santa Ana/Colorado River Basin Regional Boards' boundary line on the east (mountain crest).
5. Sacramento County	The entire county except for the incorporated City of Isleton.
6. San Bernardino County	The permitted area is delineated by the Santa Ana-Lahontan Regional Board boundary line on the north and northeast, the Santa Ana-Colorado River Basin Regional Board boundary line on the east, the San Bernardino-Riverside

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Municipality	Permitted Area
	County boundary line on the south and southeast, the San-Bernardino-Orange County boundary line on the southwest, and the San Bernardino-Los Angeles County boundary line on the west.
7. San Diego County	The permitted area is delineated by the San Diego County lines on the north and south, the Pacific Ocean on the west, and the San Diego/Colorado River Basin Regional Board boundary on the east (mountain crest).
8. Santa Clara County	The Santa Clara Valley Basin portion of the county containing eleven hydrologic subbasins which discharge into watercourses which in turn flow into South San Francisco Bay.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
901 P STREET
SACRAMENTO, CA 95814

FACT SHEET
FOR
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT (NPDES)
GENERAL PERMIT (AS AMENDED SEPTEMBER 17, 1992) FOR
STORM WATER DISCHARGES ASSOCIATED WITH INDUSTRIAL ACTIVITIES
EXCLUDING CONSTRUCTION ACTIVITIES

BACKGROUND

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, the U.S. Environmental Protection Agency (USEPA) published final regulations that establish application requirements for storm water permits. The regulations require that storm water associated with industrial activity (industrial storm water) that discharges either directly to surface waters or indirectly, through municipal separate storm sewers, must be regulated by a NPDES permit. This includes the discharge of "sheet flow" through a drainage system or other conveyance.

The federal regulations allow authorized states to issue general permits or individual permits to regulate industrial storm water discharges. The State Water Board has elected to issue a statewide general permit that will apply to all industrial storm water discharges requiring a permit except construction activity. A separate statewide general permit has been issued for construction activity. To obtain authorization for continued and future industrial storm water discharge, owners, or operators when the owners do not operate the facility (dischargers), must submit a Notice of Intent (NOI) to be covered by this general permit. This approach is consistent with the four-tier permitting strategy described in federal regulations, i.e., Tier 1, Baseline Permitting. Tier 1, Baseline Permitting, enables the State to begin reducing pollutants in industrial storm water in the most efficient manner possible. Thus, as soon as possible, all dischargers will be required by this general permit to begin implementing practices to prevent storm water pollution. Time will not be lost preparing detailed individual and general permit applications before implementing practices to prevent storm water pollution.

The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for specific industrial groups at this time. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual permit by October 1, 1992. The State Water Board bases this decision on the following factors:

1. USEPA does not allow the states to review and approve the group applications.

2. Review of hundreds of USEPA model permits and preparation of hundreds of group-specific general permits is administratively burdensome and is inconsistent with the State Water Board's long-term permitting strategy.

3. Allowing the group application action in California would result in an inequitable and ineffective storm water permitting program. While group applicants would not be required to implement best management practices (BMPs) to reduce pollutants in storm water discharge until they receive a permit (probably several years), dischargers under the State Water Board's general permit will be required to implement BMPs on October 1, 1992.

4. The State Water Board is providing a group monitoring alternative, somewhat similar to the group application monitoring requirements, that should provide reduced monitoring costs to the dischargers.

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When USEPA issues model permits for any groups, the Regional Water Boards may consider, as appropriate, adopting group permits based upon the USEPA model permits.

The general permit accompanying this fact sheet is intended to regulate industrial storm water discharges. The consolidation of many discharges under one general permit will greatly reduce the otherwise overwhelming administrative burden associated with start up of a new program to regulate industrial storm water discharges. It is also the least costly way for a discharger to obtain a permit and comply with USEPA's regulations. It is expected that as the storm water program develops, the Regional Water Boards will issue individual and general permits which regulate discharges specific either to industrial categories or to watersheds. As new permits are adopted, dischargers subject to those permits will no longer be regulated by this general permit. As permits are reissued for discharges of treated wastewater that are currently regulated by a NPDES permit, Regional Water Boards may include storm water provisions in the revised permit.

This general permit generally requires dischargers to:

1. Eliminate most non-storm water discharges (including illicit connections) to storm water sewer systems;
2. Develop and implement a storm water pollution prevention plan; and
3. Perform monitoring of discharges to storm water sewer systems.

TYPES OF STORM WATER DISCHARGES COVERED BY THIS GENERAL PERMIT

This general permit is intended to cover all new or existing discharges composed entirely of industrial storm water from facilities required by federal regulations to obtain a permit. This includes all facilities that are participating in a group application. The State Water Board notes that officials from USEPA have stated that the regulations include only those facilities which are operated by industries whose primary function is described in the categories listed below. The State Water Board does not agree with this interpretation of the regulations, as the regulations are based on the primary activity at each industrial facility, and not the primary business of the owner or operator of the facility. The State Water Board concludes that, based on its interpretation of the federal regulations, and its duty and authority to protect water quality within California, the general permit must extend to all facilities which are described in the categories below, whether the activity is primary or is auxiliary to the owner or operator of the facility. For example, even though a school district's primary function is education, a facility which it operates for vehicle maintenance of school buses is a transportation facility which is covered by this general permit.

Discharges from facilities and commercial enterprises which are not required by federal regulations to obtain a permit will not be covered by this general permit unless designated by the Regional Water Board.

Discharges requiring a permit are listed by category in 40 Code of Federal Regulations (CFR) Section 122.26(b)(14) (Federal Register, Volume 55 at Pages 48065-66). The facilities can be publicly or privately owned. A general description of these categories are:

1. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR Subchapter N);
2. Manufacturing facilities;
3. Mining and Oil and Gas facilities;
4. Hazardous waste treatment, storage, or disposal facilities;
5. Landfills, land application sites, and open dumps that receive industrial waste;
6. Recycling facilities such as metal scrap yards, battery reclaimers, salvage yards, automobile yards;
7. Steam electric generating facilities;
8. Transportation facilities;
9. Sewage treatment plants;
10. Construction activity (covered by a separate general permit); and
11. Certain facilities if materials are exposed to storm water.

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For the most part, these facilities are identified in the federal regulations by Standard Industrial Classification (SIC). Attachment 1 to the general permit contains a more detailed description including SIC codes of industries to be regulated.

Category 1 Dischargers

Facilities that currently fall within Category 1 are explained as follows:

1. Facilities Subject to Storm Water Effluent Limitations Guidelines

The following categories of facilities currently have storm water effluent limitations guidelines for at least one of their subcategories. They are cement manufacturing (40 CFR Part 411); feedlots (40 CFR Part 412); fertilizer manufacturing (40 CFR Part 418); petroleum refining (40 CFR Part 419); phosphate manufacturing (40 CFR Part 422); steam electric power generation (40 CFR Part 423); coal mining (40 CFR Part 434); mineral mining and processing (40 CFR Part 436); ore mining and dressing (40 CFR Part 440); and asphalt emulsion (40 CFR Part 443). A facility that falls into one of these general categories should examine the effluent guidelines to determine if it is categorized in one of the subcategories that have storm water effluent guidelines. If a facility is classified as one of those subcategories, that facility is subject to the standards listed in the CFR for that category, and is subject to this general permit. This general permit contains additional requirements (see Section B.7) for facilities with storm water effluent limitations guidelines.

2. Facilities Subject to New Source Performance Standards

Most effluent limitations guidelines listed in 40 CFR Subchapter N contain New Source Performance Standards (NSPS). A facility that is subject to a NSPS as defined for that particular effluent limitations guideline is subject to this general permit. The definition of a new source varies based on the publication date of the particular effluent limitations guideline.

The following categories of 40 CFR Subchapter N facilities currently do <u>not</u> have NSPS. All other categories have at least one subcategory with NSPS.

Oil and Gas Extraction (40 CFR Part 435)
Mineral Mining and Processing (40 CFR Part 436)
Gum and Wood Chemicals Manufacturing (40 CFR Part 454)
Pesticide Chemicals (40 CFR Part 455)
Explosives Manufacturing (40 CFR Part 457)
Photographic (40 CFR Part 459)
Hospital (40 CFR Part 460)

3. Facilities Subject to Toxic Pollutant Effluent Standards

If any toxic pollutant as defined in Tables II and III of Appendix D to 40 CFR Part 122 is limited in an effluent limitations guideline to which the facility is subject (including pretreatment standards), then the facility is subject to this general permit. The following categories of facilities currently have toxic pollutants effluent standards for at least one subcategory:

Textile mills (40 CFR Part 410)
Electroplating (40 CFR Part 413)
Organic chemicals, plastics, and synthetic fibers (40 CFR Part 414)
Inorganic chemicals (40 CFR Part 415)

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Petroleum refining (40 CFR Part 419)
Iron and steel manufacturing (40 CFR Part 420)
Nonferrous metals manufacturing (40 CFR Part 421)
Steam electric power generating (40 CFR Part 423)
Ferroalloy manufacturing (40 CFR Part 424)
Leather tanning and finishing (40 CFR Part 425)
Glass manufacturing (40 CFR Part 426)
Rubber manufacturing (40 CFR Part 428)
Timber products processing (40 CFR Part 429)
Pulp, paper, and paperboard (40 CFR Part 430)
Metal finishing (40 CFR Part 433)
Pharmaceutical manufacturing (40 CFR Part 439)
Ore mining and dressing (40 CFR Part 440)
Pesticide chemicals (40 CFR Part 455)
Photographic processing (40 CFR Part 459)
Battery manufacturing (40 CFR Part 461)
Metal molding and casting (40 CFR Part 464)
Coil coating (40 CFR Part 465)
Porcelain enameling (40 CFR Part 466)
Aluminum forming (40 CFR Part 467)
Copper forming (40 CFR Part 468)
Electrical and electronic components (40 CFR Part 469)
Nonferrous metals forming and metal powders (40 CFR Part 471)

Facilities that are only listed in Category 1 because they have toxic pollutant effluent standards but which are not required to be permitted under Category 11 (because they have no exposure to materials handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery) are not subject to this general permit. Facilities that are subject to NSPS or storm water effluent limitations guidelines are subject to this general permit regardless of whether they have exposure or not.

USEPA has ongoing rulemaking that may affect certain industrial categories in 40 CFR Subchapter N during the term of this general permit. These include, but are not limited, to the following:

Organic chemicals, plastics, and synthetic fibers
Pesticides manufacturing
Pesticides formulating and packaging
Centralized Waste Treatment, Phase 1
Pharmaceutical manufacturing
Metal Products and Machinery, Phase 1
Coastal oil and gas extraction
Offshore oil and gas extraction
Pulp, paper, and paperboard

Dischargers that are affected by these rulemakings must comply with the new federal regulations and may be subject to the requirements of this general permit.

Category 5 Dischargers

Inactive or closed landfills, land application sites, and open dumps that have received industrial wastes (Category 5) may be subject to this general permit unless the storm water discharges from the sites are already regulated by a NPDES permit issued by the appropriate Regional Water Board. Owners or operators of closed

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landfills that are regulated by waste discharge requirements (WDRs) may be required to comply with this general permit. In some cases, it may be appropriate for closed landfills to be covered by the State Water Board's General Construction Activity Storm Water Permit during closure activities. The appropriate Regional Water Board should be contacted for this determination.

Category 11 Dischargers

Dischargers in Category 11 that believe they are not subject to this general permit because of no exposure should conduct a facility inspection and document that the following minimum conditions have been met:

1. All illicit connections to the storm drainage system have been eliminated;

2. All materials are completely contained at all times;

3. All unhoused equipment associated with industrial activity is not exposed to storm water; and

4. All emissions from stacks or exhaust systems and emissions of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

Dischargers should evaluate all direct and indirect pathways of exposure. Dischargers are not required to submit this documentation but are advised to keep the above documentation on site.

In a recent ruling, the Ninth Circuit Court of Appeals invalidated the exemption granted by USEPA for storm water discharges from facilities in Category 11 that do not have exposure and remanded the regulation to USEPA for further action. The State Water Board, at this time, is not requiring storm water discharges from facilities in Category 11 that do not have exposure to be covered by this general permit. Instead, the State Water Board will await future USEPA or court action clarifying the types of storm water discharges that must be permitted. If necessary, the State Water Board will reopen the general permit to accommodate such a clarification.

TYPES OF DISCHARGES NOT COVERED BY THIS GENERAL PERMIT

- CONSTRUCTION ACTIVITY: Discharges from construction activity of five acres or more, including clearing, grading and excavation. A separate general permit was adopted on August 20, 1992 for this industrial category.

- FACILITIES LOCATED IN SANTA CLARA COUNTY WHICH DRAIN TO SAN FRANCISCO BAY: The San Francisco Bay Regional Water Board has adopted a general permit for discharges from facilities located in Santa Clara County which drain to San Francisco Bay.

- FACILITIES COVERED BY INDIVIDUAL PERMITS: While it is the intent of the State Water Board, in order to reduce administrative burden, to regulate most discharges of industrial storm water by this general permit, dischargers may choose to apply for an individual NPDES Permit. Permit application requirements are set forth in the USEPA regulations at 40 CFR Section 122.21.

- FACILITIES WHICH HAVE NPDES PERMITS CONTAINING STORM WATER PROVISIONS: The NPDES permits for some industrial waste water discharges already contain requirements regulating storm water. These discharges are in compliance with storm water regulations and will not be regulated by this general permit. When the existing permit for such discharges expires, a Regional Water Board may authorize coverage under this permit, or another general permit, or issue a new permit consistent with the new federal and State storm water requirements.

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- FACILITIES DETERMINED INELIGIBLE BY REGIONAL WATER BOARDS: Regional Water Boards may determine that discharges from a facility or groups of facilities, otherwise eligible for coverage under this general permit, have potential water quality impacts that may not be addressed by this general permit. In such cases, a Regional Water Board may require such dischargers to apply for and obtain an individual permit or a different general permit. Interested persons may petition the appropriate Regional Water Board to issue individual permits. The applicability of this general permit to such discharges will be terminated upon adoption of an individual permit or a different general permit.

- FACILITIES WHICH DO NOT DISCHARGE STORM WATER TO WATERS OF THE UNITED STATES: The discharges from the following facilities are not required to obtain a permit:

  1. FACILITIES THAT DISCHARGE STORM WATER TO MUNICIPAL SANITARY SEWER SYSTEMS: Facilities that discharge storm water to municipal sanitary sewer systems or combined sewer systems are not required by federal regulations to obtain a storm water permit or to submit a NOI to comply with this general permit. (It should be noted that many municipalities have sewer use ordinances that prohibit storm drain connections to their sanitary sewers.)

  2. FACILITIES THAT DO NOT DISCHARGE STORM WATER TO SURFACE WATERS OR SEPARATE STORM SEWERS: Dischargers that capture all industrial storm water runoff from their facilities and treat and/or dispose of it with their process waste water, and dischargers that dispose of their industrial storm water to evaporation ponds, percolation ponds, or combined sewer systems, are not required to obtain a storm water permit. To avoid liability, the discharger should be certain that a discharge of industrial storm water to surface waters will not occur under any circumstances.

- LOGGING ACTIVITIES: Logging activities described under SIC 2411.

- MINING AND OIL AND GAS FACILITIES: Oil and gas facilities that have not released storm water resulting in a discharge of a reportable quantity (RQ) for which notification is or was required pursuant to 40 CFR Parts 110, 117, and 302 at any time after November 19, 1988 are not required to be permitted unless the industrial storm water discharge contributed to a violation of a water quality standard. Mining facilities that discharge storm water that does not come into contact with any overburden, raw materials, intermediate product, finished product, by-product, or waste product located at the facility are not required to be permitted. These facilities must obtain a storm water permit if they have a new release of storm water resulting in a discharge of a RQ.

- FACILITIES ON INDIAN LANDS: Discharges from facilities on Indian lands will be regulated by the USEPA.

NOTIFICATION REQUIREMENTS

Dischargers of facilities described in the section entitled "Types of Storm Water Discharges Covered by This General Permit", must obtain a permit to discharge storm water. A NOI must be submitted for each individual facility to obtain coverage. Certification of the NOI signifies that the discharger intends to comply with the provisions of the general permit.

Dischargers that do not submit a NOI for facilities must submit an application for an individual permit. USEPA's regulations (40 CFR 122.21 (a)) exclude dischargers covered by a general permit from requirements to submit permit applications. The NOI requirements of this general permit are intended to establish a mechanism which can be used to establish a clear accounting of the number of dischargers complying with the general permit, their identities, the nature of operations at the facilities, and location.

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Dischargers of existing facilities in California were required to obtain coverage by submitting a completed NOI no later than March 30, 1992. Dischargers of new facilities (those beginning operations after March 30, 1992) must submit a NOI 30 days prior to the beginning of operations. The NOI must be sent to the following address:

California State Water Resources Control Board
Division of Water Quality
P. O. Box 1977
Sacramento, CA 95812-1977
Attention: Storm Water Permitting Unit

Facilities that do not obtain coverage under this general permit or by an individual NPDES permit for a discharge of industrial storm water, by the appropriate deadlines, will be in violation of the Clean Water Act and the California Water Code. There are substantial penalties which can be pursued by the State or Regional Water Boards, USEPA, or by private citizens for violation of these laws. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late. In general, late filers should develop and implement their SWPPP and Monitoring Plan no more than 30 days following submittal of their late NOI. Dischargers that cannot develop and implement these plans within 30 days should notify the appropriate Regional Water Board.

DESCRIPTION OF GENERAL PERMIT CONDITIONS

Prohibitions

This general permit authorizes the discharge of industrial storm water from industrial facilities that are required to obtain industrial storm water permits. This general permit prohibits most non-storm water discharges (including illicit connections) and discharges containing hazardous substances in storm water in excess of reportable quantities established at 40 CFR 117.3 and 40 CFR 302.4. Allowable non-storm water discharges are discussed below under the heading Storm Water Pollution Prevention Plan (SWPPP).

Effluent Limitations

Permits for discharges of industrial storm water must meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require control of pollutant discharges that use best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to reduce pollutants, and any more stringent controls necessary to meet water quality standards.

USEPA regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories. For these facilities, the numeric effluent limitations constitute BAT and BCT for the specified pollutants, and must be met to comply with this general permit.

For storm water discharges from facilities not among the ten industrial categories listed in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. The reasons why establishment of numeric effluent limitations is not feasible are discussed in detail in State Water Board Orders No. WQ 91-03 and WQ 91-04. Therefore, the effluent limitations contained in this general permit are narrative and include best management practices (BMPs).

These effluent limitations constitute compliance with the requirements of the Clean Water Act.

The narrative effluent limitations in this general permit include prohibitions against most discharges of non-storm water. They require dischargers to control and eliminate the sources of pollutants in storm water through the development and implementation of storm water pollution prevention plans. The plans must include

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best management practices, which may include treatment of storm water discharges along with source reduction, which will constitute BAT and BCT and will achieve compliance with water quality standards. If water quality standards are not met, the appropriate Regional Water Board may specify any additional effluent limitations necessary to meet the specific standards.

Storm Water Pollution Prevention Plans (SWPPP)

This general permit requires development and implementation of SWPPP emphasizing storm water BMPs. This approach provides the flexibility necessary to establish controls which can appropriately address different sources of pollutants at different facilities. Existing dischargers must develop and implement a SWPPP by October 1, 1992. New dischargers must submit a NOI, and develop and implement a SWPPP prior to commencement of operations.

All dischargers must prepare, retain on site, and implement a SWPPP. The SWPPP has two major objectives: (1) to help identify the sources of pollution that affect the quality of industrial storm water discharges; and (2) to describe and ensure the implementation of practices to reduce pollutants in industrial storm water discharges.

The SWPPPs are considered reports available to the public under Section 308(b) of the Clean Water Act. Required elements of a SWPPP are: (1) source identification, (2) practices to reduce pollutants, (3) an assessment of potential pollution sources, (4) a materials inventory, (5) a preventive maintenance program, (6) spill prevention and response procedures, (7) general storm water management practices, (8) employee training, (9) recordkeeping, and (10) elimination of unpermitted non-storm water discharges to the industrial storm water system. Elimination of non-storm water discharges is a major element of the SWPPP. Non-storm water discharges include a wide variety of sources including illicit connections (i.e., floor drains), improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges can contribute a significant pollutant load to receiving waters. Measures to control spills, leakage, and dumping can often be addressed through BMPs. Non-storm water discharges and industrial storm water mixed with non-storm water prior to discharge should be covered by a separate NPDES Permit.

There are many discharges that may occur at a facility that are not related to industrial activity (i.e., air conditioning condensate, fire control water line testing, landscaping overflow, etc.). It is not the intent of this Permit to prohibit all non-industrial-related discharges. Non-industrial-related discharges may be appropriate if they:

1. Are not subject to local Regional Water Board permitting requirements.
2. Do not contain significant quantities of industrial-related pollutants.
3. Are infeasible to eliminate.
4. Are identified and addressed in the SWPPP and monitoring program.
5. Are in compliance with local municipal storm water permittee requirements.

Monitoring Program

The general permit requires development and implementation of a monitoring program. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers must develop and implement a monitoring program prior to commencement of operations, but no earlier than January 1, 1993. The objectives of the monitoring program are to (1) demonstrate compliance with the permit, (2) aid in the implementation of the SWPPP, and (3) measure the effectiveness of the BMPs in removing pollutants in industrial storm water discharge.

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All dischargers (with the exception of inactive mining operations) are required to:

1. Perform visual observations during the dry and wet seasons. Dry season observations are required to verify that non-storm water discharges have been eliminated. Wet season observations are required to aid dischargers in evaluating the effectiveness of the SWPPP.

2. Conduct an annual inspection to determine compliance with this general permit.

3. Perform or participate in a sampling and analysis program. Analysis must include pH, total suspended solids (TSS), total organic carbon (TOC), specific conductance, toxic substances, and other pollutants which are likely to be present in storm water discharges in significant quantities. Dischargers subject to federal storm water effluent limitations guidelines in 40 CFR Subchapter N must also sample and analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N.

Dischargers are not required to collect samples or perform visual observations during adverse climatic conditions. Sample collection and visual observations are required only during scheduled facility operating hours or within two hours after scheduled facility operating hours. Visual observations are required only during daylight hours. Dischargers that are unable to collect any of the required samples or visual observations because of the above circumstances must provide documentation to the Regional Water Board in their annual report.

Dischargers may be exempt from performing sampling and analysis if they: (1) do not have areas of industrial activity exposed to storm water, (2) receive certification from a local agency which has jurisdiction over the storm sewer system that the discharger has developed and implemented an effective SWPPP and should not be required to sample, or (3) receive an exemption from the appropriate Regional Water Board. Dischargers must always perform sampling and analysis for any pollutant specified in storm water effluent limitations guidelines.

Local agencies that wish to provide certifications to dischargers within their jurisdiction should develop a certification program that clearly indicates the certification procedures and criteria used by the local agency. At a minimum, these programs should include site inspections, a review of the dischargers' SWPPP, and a review of other records such as monitoring data, receiving water data, etc. It is recommended that the certification program be sent to the local Regional Water Board for review and comment prior to implementation.

Group Monitoring

Each discharger may either perform sampling and analysis individually or participate in a group sampling program. A group monitoring program may be developed either by an entity representing a group of similar facilities or by a local agency which holds a storm water permit for a municipal separate storm sewer system, for industrial facilities within its jurisdiction. The entity or local agency responsible for the group monitoring program must perform sampling at a minimum of 20 percent of the facilities within the group (and at least four dischargers in a group of less than 20 dischargers). The facilities selected for sampling must be representative of all the facilities in the group. Dischargers subject to federal effluent limitations guidelines in 40 CFR Subchapter N must individually sample and analyze for pollutants listed in the appropriate federal regulations.

Facilities within a group may be located within the jurisdiction of more than one Regional Water Board. Multi-Regional Water Board groups must receive the approval of the State Water Board Executive Director (with the concurrence of the appropriate Regional Water Boards). Groups may request variance from the minimum 20 percent (and a minimum of four facilities for groups of less than 20 dischargers) with adequate justification. As a minimum, the justification should: (1) explain the need for the variance, and (2) show that the variance, if approved, will result in representative monitoring data.

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Each entity or local agency responsible for group sampling must: (1) ensure that the monitoring is done correctly, (2) recommend appropriate BMPs to reduce pollutants in storm water discharges from group participants, and (3) evaluate and report the monitoring data to the appropriate Regional Water Board(s).

All group monitoring plans are subject to Regional Water Board(s) review. Consistent with the four-tier permitting strategy described in the federal regulations, the Regional Water Board(s) will evaluate the data and results from group monitoring to establish future permitting decisions. As appropriate, Regional Water Board(s) may terminate or require substantial amendment to the group monitoring plans, dependent, in part, on the group's overall success in meeting the objectives of the Permit.

The State Water Board recognizes that the group monitoring option will result in fewer facilities monitored. The State Water Board believes that this is a desirable trade-off for the following reasons:

1. Review of monitoring data from all individual facilities is administratively burdensome.

2. Monitoring of fewer facilities, but with more parameters and better quality control, will result in more accurate and meaningful monitoring data.

3. Group monitoring is consistent with USEPA's four-tier permitting strategy.

4. As no numeric limits are specified in the Permit (with the exception of 40 CFR Subchapter N facilities), implementation of a SWPPP, performance of visual monitoring, and performance of an annual inspection are consistent with the minimum monitoring requirements of the CWA.

5. Data from group monitoring programs will be indicative of the effectiveness of BMPs to control pollution in storm water discharge. Additional BMPs, useful to the entire group, may be developed from the monitoring data.

6. A large percentage of dischargers are small businesses which do not have the regulatory sophistication, organizational structure, or resources to conduct an adequate individual monitoring program.

Retention of Records

The discharger is required to retain records of all monitoring information, copies of all reports required by this permit, and records of all data used to complete the NOI, for a period of five years from the date of measurement, report, or application. This period may be extended by the State and/or Regional Water Boards. All records are public documents.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
WATER QUALITY ORDER NO. 91-13-DWQ (AS AMENDED BY WATER QUALITY ORDER NO. 92-12-DWQ)
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT NO. CAS000001

WASTE DISCHARGE REQUIREMENTS (WDRS)
FOR
DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES
EXCLUDING CONSTRUCTION ACTIVITIES

The State Water Board finds that:

1. Federal regulations for storm water discharges were issued by the U.S. Environmental Protection Agency on November 16, 1990 (40 Code of Federal Regulations (CFR) Parts 122, 123, and 124). The regulations require specific categories of facilities, which discharge storm water associated with industrial activity (storm water), to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate industrial storm water pollution.

2. This general permit shall regulate discharges of storm water from specific categories of industrial facilities identified in Attachment 1, excluding discharges covered by existing NPDES permits which already include provisions regulating discharges of storm water, discharges from construction activities, or discharges determined ineligible for coverage by this general permit by the California Regional Water Quality Control Boards (Regional Water Boards). Attachment 2 contains the addresses and telephone numbers of each Regional Water Board office.

3. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual general permit by October 1, 1992. The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for industrial groups at this time.

4. This general permit does not preempt or supersede the authority of local agencies to prohibit, restrict, or control discharges of storm water to storm drain systems or other watercourses within their jurisdictions, as allowed by State and federal law.

5. To obtain authorization for continued and future storm water discharge pursuant to this general permit, owners, or operators when the owners does not operate the facility (dischargers), must submit a Notice of Intent (NOI) and appropriate fee to the State Water Board. Dischargers who submit a NOI and appropriate fee are authorized to discharge storm water under the terms and conditions of this general permit.

6. If an individual NPDES general permit is issued to a discharger otherwise subject to this general permit, or an alternative general permit is subsequently adopted which covers storm water discharges regulated by this general permit, the applicability of this general permit to such discharges is automatically terminated on the effective date of the individual general permit or the date of approval for coverage under the subsequent general permit.

7. Effluent limitations, and toxic and effluent standards established in Sections 208(b), 301, 302, 303(d), 304, 306, 307, and 403 of the Federal Clean Water Act (CWA), as amended, are applicable to storm water discharges regulated by this general permit.

8. This action to adopt a NPDES general permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

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9. The State Water Board adopted the California Ocean Plan on March 22, 1990, and the California Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan on April 11, 1991. In addition, the Regional Water Boards have adopted and the State Water Board has approved Water Quality Control Plans (Basin Plans).

   Discharges regulated by this general permit must be in compliance with the water quality standards in these Plans, and subsequent amendments thereto. The State Water Board shall, by April 1996, determine what further actions are appropriate to ensure that discharges subject to this general permit are in compliance with the numerical objectives in the Inland Surface Waters Plan and the Enclosed Bays and Estuaries Plan.

10. Federal regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories.

11. For facilities which do not have established numeric effluent limitations for storm water discharges in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. This is due to the large number of discharges and the complex nature of storm water discharges.

12. Implementation of the provisions of this general permit constitutes compliance with BAT/BCT requirements, and with requirements to achieve water quality standards.

13. Best Management Practices (BMPs) to control and abate the discharge of pollutants in storm water discharges are authorized where numeric effluent limits are infeasible and the BMPs are reasonably necessary to achieve compliance with effluent limitations or water quality standards.

14. Following adoption of this general permit, the Regional Water Boards shall enforce the provisions of this general permit including the monitoring and reporting requirements.

15. Following public notice in accordance with State and Federal law and regulations, the State Water Board, in a public hearing held September 3, 1991, heard, considered, and responded to all comments pertaining to this general permit.

16. This Order is a NPDES general permit in compliance with Section 402 of the Clean Water Act and shall take effect upon adoption by the State Water Board.

IT IS HEREBY ORDERED that all dischargers that file a NOI indicating their intention to be regulated under the provisions of this general permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of material other than storm water, which are not otherwise regulated by a NPDES permit, to a storm sewer system or waters of the nation are prohibited.

2. Storm water discharges for those facilities listed in Category I of Attachment 1 of this general permit shall not exceed the numeric effluent limitations as specified in Federal Regulations (40 CFR Subchapter N). Dischargers subject to those regulations who do not have or are unable to obtain copies of the pertinent regulations from other sources (e.g., Government Printing Office) should contact the:

   State Water Resources Control Board
   Division of Water Quality
   P.O. Box 1977
   Sacramento, CA 95812-1977
   Attn: Storm Water Permitting Unit

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3. Storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

4. Storm water discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

B. RECEIVING WATER LIMITATIONS:

1. Storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. Storm water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters Plan, Enclosed Bays and Estuaries Plan, or the applicable Regional Water Boards' Basin Plan.

C. PROVISIONS

1. All dischargers must submit an NOI and appropriate fee for each facility covered by this general permit in accordance with Attachment 3: Notice of Intent--General Instructions.

2. All dischargers must develop and implement a Storm Water Pollution Prevention Plan for each facility covered by this general permit in accordance with Section A: Storm Water Pollution Prevention Plan.

3. All dischargers must develop and implement a Monitoring and Reporting Program Plan for each facility covered by this general permit in accordance with Section B: Monitoring Program and Reporting Requirements.

4. Feedlots as defined in 40 CFR Part 412 that are in full compliance with Section 2560 to Section 2565, Title 23, California Code of Regulations (Chapter 15) will be in compliance with all effluent limitations and prohibitions contained in this general permit. Feedlots must comply with any Regional Water Board WDRs or NPDES general permit regulating their storm water discharge. Feedlots that comply with Chapter 15, however, must perform monitoring in compliance with the requirements of Provisions 5(c) and 16 of Section B: Monitoring Program and Reporting Requirements.

5. All dischargers must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or other water courses under their jurisdiction, including applicable requirements in municipal storm water management programs developed to comply with NPDES general permits issued by the Regional Water Boards to local agencies.

6. All dischargers must comply with the standard provisions and reporting requirements for each facility covered by this general permit contained in Section C: Standard Provisions.

7. This general permit will expire on November 19, 1996. Upon reissuance of the NPDES general permit by the State Water Board, the facilities subject to this reissued general permit are required to file a revised NOI.

D. REGIONAL WATER BOARD AUTHORITIES

1. Following adoption of this general permit, Regional Water Boards shall:

(a) Implement the provisions of this general permit, including, but not limited to, reviewing storm water pollution prevention plans, reviewing group monitoring plans, reviewing monitoring reports, conducting compliance inspections, and taking enforcement actions.

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(b) Issue general permits as they deem appropriate to individual dischargers, categories of dischargers, or dischargers in a geographic area. Upon issuance of such general permits by a Regional Water Board, the affected dischargers shall no longer be regulated by this general permit. The new general permits may address additional storm water pollution prevention plan requirements, more stringent effluent limitations, or additional monitoring and reporting program requirements.

2. Regional Water Boards may provide guidance to dischargers on Storm Water Pollution Prevention Plan and Monitoring Program implementation.

CERTIFICATION

The undersigned, Administrative Assistant to the State Water Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 19, 1991 (as amended by Water Quality Order No. 92-12-DWQ).

AYE: W. Don Maughan
Edwin H. Finster
Eliseo M. Samaniego
John P. Caffrey

NO: None

ABSENT: None

ABSTAIN: None

Maureen Marché

Maureen Marché
Administrative Assistant to the Board

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Section A: STORM WATER POLLUTION PREVENTION PLAN

1. A storm water pollution prevention plan (SWPPP) shall be developed and implemented for each facility covered by this general permit. The SWPPP shall be designed to comply with BAT/BCT and be certified in accordance with the signatory requirements of Standard Provision C.9. For existing facilities (and new facilities beginning operations before October 1, 1992), a SWPPP shall be developed and implemented no later than October 1, 1992. For facilities beginning operations after October 1, 1992, a SWPPP shall be developed prior to submitting a NOI and implemented when the facility begins operations. The SWPPP shall be retained onsite and made available upon request of a representative of the Regional Water Board and/or local storm water management agency (local agency) which receives the storm water discharge.

2. The Regional Water Board and/or local agency may notify the discharger when the SWPPP does not meet one or more of the minimum requirements of this Section. Within 30 days of notice, the discharger shall submit a time schedule that meets the minimum requirements of this section to the Regional Water Board and/or local agency that requested the changes. After making the required changes, the discharger shall provide written certification that the changes have been made.

3. The discharger shall amend the SWPPP whenever there is a change in construction, operation, or maintenance which may effect the discharge of significant quantities of pollutants to surface water, ground waters, or the local agency's storm drain system. The SWPPP should also be amended if it is in violation of any conditions of this general permit, or has not achieved the general objectives of controlling pollutants in storm water discharges.

4. The SWPPP shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from the facility. The SWPPP shall include, at a minimum, the following items:

   a. A map extending approximately one-quarter mile beyond the property boundaries of the facility, showing: the facility, general topography surface water bodies (including known springs and wells), and the discharge point where the facility's storm water discharges to a municipal storm drain system or other water body. The requirements of this paragraph may be included in the site map required under the following paragraph if appropriate.

   b. A site map showing:

      i. The storm water conveyance and discharge structures;

      ii. An outline of the storm water drainage areas for each storm water discharge point;

      iii. Paved areas and buildings;

      iv. Areas of pollutant contact, actual or potential;

      v. Location of existing storm water structural control measures (i.e., berms, coverings, etc.);

      vi. Surface water locations;

      vii. Areas of existing and potential soil erosion; and

      viii. Vehicle service areas.

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c. A narrative description of the following:

i. Significant materials that have been treated, stored, disposed, spilled, or leaked in significant quantities in storm water discharge after November 19, 1988;

ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharge;

iii. Material loading, unloading, and access areas;

iv. Existing structural and non-structural control measures (if any) to reduce pollutants in storm water discharge;

v. Industrial storm water discharge treatment facilities (if any);

vi. Methods of on-site storage and disposal of significant materials; and

vii. Outdoor storage, manufacturing, and processing activities including activities that generate significant quantities of dust or particulates.

d. A list of pollutants that are likely to be present in storm water discharge in significant quantities, and an estimate of the annual quantities of these pollutants in storm water discharge.

e. An estimate of the size of the facility (in acres or square feet), and the percent of the facility that has impervious areas (i.e., pavement, buildings, etc.).

f. A list of significant spills or leaks of toxic or hazardous pollutants to storm water that have occurred after November 19, 1988. This shall include:

i. Toxic chemicals (listed in 40 CFR Part 372) that have been discharged to storm water as reported on USEPA Form R.

ii. Oil or hazardous substances in excess of reportable quantities (see 40 CFR Part 110, 117 or 302).

g. A summary of existing sampling data (if any) describing pollutants in storm water discharge.

3. The SWPPP shall describe the storm water management controls appropriate for the facility. The appropriate controls shall reflect identified potential sources of pollutants at the facility. The description of the storm water management controls shall include:

a. Storm Water Pollution Prevention Personnel. Identify specific individuals (and job titles) who are responsible for developing, implementing, and revising the SWPPP.

b. Preventive Maintenance. Preventive maintenance involves inspection and maintenance of storm water conveyance system devices (i.e., oil/water separators, catch basins, etc.) and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

c. Good Housekeeping. Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

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d. Spill Prevention and Response. Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, and clean-up equipment and procedures should be identified, as appropriate. Internal reporting procedures for spills of significant materials shall be established.

e. Storm Water Management Practices. Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants to storm water discharges in significant quantities, additional storm water management practices to remove pollutants from storm water discharge shall be implemented.

f. Erosion and Sediment Controls. The SWPPP shall identify measures to reduce sediment in storm water discharges.

g. Employee Training. Employee training programs shall inform all personnel responsible for implementing the SWPPP. Training should address spill response, good housekeeping, and material management practices. Periodic dates for training should be identified.

h. Inspections. All inspections, visual observations and sampling as required by Section B, shall be done by trained personnel. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to these activities.

6. Non-storm water discharges to storm water conveyance systems shall be eliminated prior to implementation of this SWPPP. The SWPPP shall include a certification that non-storm water discharges have been eliminated and a description of any tests for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Such certification may not always be feasible if the discharger a) must make significant structural changes to eliminate the discharge of non-storm water discharges to the industrial storm water conveyance system, or b) has applied for, but not yet received, an NPDES general permit for the non-storm water discharges. In such cases, the discharger must notify the appropriate Regional Water Board prior to implementation of the SWPPP that non-storm water discharges cannot be eliminated. The notification shall include justification for a time extension and a schedule, subject to modification by the Regional Water Board, indicating when non-storm water discharges will be eliminated. In no case shall the elimination of non-storm water discharges exceed three years from the NOI submittal date.

7. The SWPPP may incorporate, by reference, the appropriate elements of other program requirements (i.e., Spill Prevention Control and Countermeasures (SPCC) plans under Section 311 of the CWA, Best Management Programs under 40 CFR 125.100, etc.).

8. The SWPPP is considered a report that shall be available to the public under Section 308(b) of the CWA.

9. The SWPPP shall include the signature and title of the person responsible for preparation of the SWPPP and include the date of initial preparation and each amendment, thereto.

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Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

[Note: This Section was modified by Order No. 92-12-DWQ adopted by the State Water Board on September 17, 1992.]

1. Implementation

A monitoring program shall be developed and implemented for each facility covered by this general permit. It shall be certified in accordance with the signatory requirements contained in Standard Provision C.9. A description of the monitoring program shall be retained on site and made available upon request of a representative of the Regional Water Board and/or local agency which receives the storm water discharge.

2. Schedule

For existing facilities (and new facilities beginning operations before January 1, 1993), a monitoring program must be developed and implemented no later than January 1, 1993. For facilities beginning operations after January 1, 1993, a monitoring program shall be developed and implemented concurrent with commencement of industrial activities.

3. Objectives

The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

a. Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in this general permit.

b. Ensure practices at the facility to control pollutants in storm water discharges are evaluated and revised to meet changing conditions.

c. Aid in the implementation of the Storm Water Pollution Prevention Plan required by Section A of this general permit.

d. Measure the effectiveness of best management practices (BMPs) in removing pollutants in storm water discharge.

4. General Requirements for Monitoring Programs

The monitoring program shall contain:

a. Rationale for selection of monitoring methods.

b. Identification of the analytical methods to detect pollutants in storm water discharge.

c. Description of the sampling methods, sampling locations, and frequency of monitoring.

d. A quality assurance/quality control program to assure that:

i. All elements of the monitoring program are conducted; and

ii. All monitoring is conducted by trained personnel.

e. Procedures and schedules by which the effectiveness of the monitoring program in achieving the objectives above can be evaluated.

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5. Specific Requirements for Monitoring Programs

The monitoring program shall document the elimination or reduction of specific pollutants, resulting from the implementation of the SWPPP required by Section A of this general permit.

a. Annual Site Inspection

Except for certain inactive mining operations (See Section B.8), all dischargers shall:

i. Conduct a minimum annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity and to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the general permit or whether additional control measures are needed. A record of the annual inspection must include the date of the inspection, the individual(s) who performed the inspection, and the observations.

ii. Certify, based on the annual site inspection, that the facility is in compliance with the requirements of this general permit and its SWPPP. The certification and inspection records must be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. Any noncompliance shall be reported in accordance with Section B.17.

b. Dry Season Observations

No less than twice during the dry season (May through September), all dischargers shall observe and/or test for the presence of non-storm water discharges at all storm water discharge locations. At minimum, all dischargers shall conduct visual observations of flows to determine the presence of stains, sludges, odors, and other abnormal conditions. Dye tests, TV line surveys, and/or analysis and validation of accurate piping schematics may be conducted if appropriate. Records shall be maintained of the description of the method used, date of testing, locations observed, and test results.

c. Wet Season Visual Observations

During the wet season (October through April), all dischargers shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharge[1/] to observe the presence of floating and suspended materials, oil and grease, discolorations, turbidity, and odor, etc. Feedlots (subject to federal effluent limitations guidelines in 40 CFR Part 412) that are in compliance with Sections 2560 to 2565, Article 6, Chapter 15, Title 23, California Code of Regulations, shall, instead, conduct monthly inspections of their containment facilities to detect leaks and ensure maintenance of adequate freeboard.

d. Sampling and Analysis

During the wet season (October through April), dischargers (unless exempted per Section B.9 below) shall collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge. The samples should be analyzed for:

1/ "Significant storm water discharge" is a continuous discharge of storm water for approximately one hour or more.

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i. pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC). Oil and grease (O&G) may be substituted for TOC; and

ii. Toxic chemicals and other pollutants that are likely to be present in storm water discharge in significant quantities.

6. Toxic Pollutant Analysis Reduction

Samples shall be analyzed for toxic chemicals and other pollutants as identified in Sections B.5.d.ii for at least two consecutive sampling events. If toxic chemicals or other pollutants are not detected in significant quantities after two consecutive sampling events, the facility may eliminate that toxic chemical or pollutant from future sampling events. A discharger may analyze for alternative representative parameters (e.g., whole effluent toxicity) as a substitute for the toxic chemicals and other pollutants identified in Section B.5.d.ii as long as the discharger submits the alternative monitoring procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

7. Facilities Subject to Federal Storm Water Effluent Limitations Guidelines

Facilities subject to federal storm water effluent limitations guidelines are defined in Attachment 1 of the general permit. In addition to the requirements in Section B.5 above, these facilities must collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge.

a. Analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N;

b. Estimate or calculate the volume of effluent discharged from each outfall;

c. Estimate or calculate the mass of each regulated pollutant as defined in the appropriate category of 40 CFR Subchapter N; and

d. Identify the individual(s) performing the estimates or calculations in accordance with Subsections b and c above.

8. Inactive Mining Operations

Inactive mining operations are defined in Attachment 1 of this general permit. Where annual facility inspections, wet season visual observations, dry season observations, and sampling as required by Section B.5 are impracticable, inactive mining operations may instead obtain certification once every three years by a Registered Professional Engineer that a SWPPP has been prepared for the facility and is being implemented in accordance with the requirements of this general permit. By means of these certifications, the engineer, having examined the facility and being familiar with the provisions of this general permit, shall attest to the SWPPP which has been prepared in accordance with good engineering practices. Dischargers which cannot obtain a certification because of noncompliance must notify the appropriate Regional Water Board and, upon request, the local agency which receives the storm water discharge in accordance with Section B.17.

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9. Sampling and Analysis Exemptions

A discharger is not required to collect and analyze samples in accordance with Section B.5.d if the discharger certifies that the facility meets all of the conditions set forth below in Section B.9.a, if the discharger obtains the local agency certification described in Section B.9.b, or if the discharger obtains a Regional Water Board exemption as described in Section B.9.d. A discharger who is not required to comply with Section B.5.d monitoring requirements is still required to comply with all other monitoring program and reporting requirements. If exempted from Section B.5.d monitoring requirements, dischargers subject to federal storm water effluent guidelines in 40 CFR Subchapter N must still comply with the provisions of Section B.7 above.

a. Self-Certification

The certification must state that areas of industrial activity are not exposed to storm water, including manufacturing, processing, and material handling areas and areas where material handling equipment, raw materials, intermediate products, final products, waste materials, byproducts, and industrial machinery are stored. (See definition of "storm water associated with industrial activity" in Attachment 4 to this general permit.) Exposure includes both direct contact with storm water and the possible release of industrial pollutants into storm water (e.g., spills or leaks). In order to demonstrate that these areas are not exposed to storm water, the following minimum conditions must be met:

i. All illicit (unpermitted) connections to the storm drainage system are eliminated;

ii. All materials must be completely contained at all times;

iii. All unhoused equipment associated with industrial activity is not exposed to storm water; and

iv. All emissions from stacks or air exhaust systems and emission of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

b. Certification by Local Agency

A local agency which has jurisdiction over the storm sewer system or other water course which receives storm water discharge from the discharger's facility has certified in writing that the discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

c. Submittal of Sampling Exemption Certifications

Dischargers must submit sampling exemption certifications to the appropriate Regional Water Board by December 1, 1992 for the 1992-93 wet season and by August 1 for subsequent years. Unless otherwise instructed by the Regional Water Boards, dischargers who file a sampling exemption certification are exempt from Section B.5.d.

d. Exemptions by Regional Water Board

A Regional Water Board may grant an exemption to Section B.5.d monitoring requirements if it determines that a discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

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10. Group Monitoring

Group monitoring may be done in accordance with the following requirements:

a. A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers (entity) regulated by this general permit or by a local agency which holds a NPDES general permit (local agency permittee) for a municipal separate storm sewer system. Participants in a group monitoring plan may discharge storm water within the boundaries of a single Regional Water Board or within the boundaries of multiple Regional Water Boards (with State Water Board approval).

b. At least 20 percent of the dischargers who are members of a group (and at least 4 dischargers in a group of less than 20 dischargers) must collect and analyze samples in accordance with Section B.5.d. The entity or local agency permittee may request that fewer member dischargers be allowed to collect and analyze, but reasons for this exception must be stated in the group monitoring plan (Section B.10.e.v.). The entity or the local agency permittee shall select facilities from which samples are collected and analyzed which best represent the overall quality of the group members' storm water discharges.

c. The entity or the local agency permittee must have the authority to levy fees against the participating dischargers in the group or be able to otherwise pay for the implementation of the group monitoring plan.

d. The entity or the local agency permittee is responsible for:

   i. Developing and implementing the group monitoring plan;

   ii. Evaluating and reporting group monitoring data;

   iii. Recommending appropriate BMPs to reduce pollutants in storm water discharges;

   iv. Submitting a group monitoring plan to the appropriate Regional Water Board(s) and State Water Board, no later than December 1, 1992 and August 1 in subsequent years; and

   v. Revising the group monitoring plan as instructed by the Regional Water Board or the State Water Board Executive Director.

e. The group monitoring plan shall:

   i. Identify the participants of the group by name and location;

   ii. Include a narrative description summarizing the industrial activities of participants of the group and explain why the participants, as a whole, are sufficiently similar to be covered by a group monitoring plan;

   iii. Include a list of significant materials stored or exposed to storm water and material management practices currently employed to diminish contact of these materials with storm water discharge;

   iv. Identify and describe why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of processes used or materials managed. To the extent possible, representative facilities with the most extended scheduled facility operating hours should be selected;

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v. If an exception to the requirement that at least 20 percent of the dischargers in a group (and at least 4 dischargers in a group of less than 20 dischargers) is requested, explain why such an exception is necessary, and how the proposed monitoring will be representative of the entire group; and

vi. Contain all items specified in Section B.4 above.

f. Sampling and analysis must comply with the applicable requirements, including Sections B.5.d, B.6, B.7, and B.11 through 17.

h. Unless otherwise instructed by the Regional Water Board or the State Water Board Executive Director, the group monitoring plan shall be implemented by January 1, 1993 and, in subsequent years, at the beginning of the wet season.

i. Upon approval of the State Water Board Executive Director, a group may perform representative monitoring which includes dischargers within the boundaries of more than one Regional Water Board area.

j. Upon approval by the appropriate Regional Water Board, a group within a single Regional Water Board area may perform representative monitoring.

k. All dischargers participating in an approved group monitoring plan that have not been selected to perform sampling are required to comply with all other monitoring program and reporting requirements in Sections B.5.a, b, and c.

l. If any group includes members which are subject to federal storm water effluent limitations guidelines, each of those members must perform the monitoring described in Section B.7, and submit the results of the monitoring to the appropriate Regional Water Board in the discharger's annual monitoring report.

11. <u>Sample Locations</u>

Samples shall be collected from all locations where storm water is discharged. Samples must represent the quality and quantity of storm water discharged from the facility. If a facility discharges storm water at multiple locations, the discharger may sample a reduced number of locations if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

12. <u>Sampling Procedure</u>

Sampling shall consist of a grab sample from a storm event that produces significant storm water discharge that is preceded by at least three (3) working days of dry weather. The grab sample should be taken during the first thirty minutes of the discharge. If collection of the grab sample during the first 30 minutes is impracticable, the grab sample can be taken as soon as practicable thereafter, and the discharger shall explain in the annual monitoring report why the grab sample could not be taken in the first 30 minutes. A discharger may select alternative monitoring procedures (e.g., composite sampling) as long as the discharger has submitted the proposed procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

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13. **Visual Observation and Sample Collection Exceptions**

a. When a discharger is unable to collect any of the required samples or perform visual observations due to adverse climatic conditions (drought, extended freeze, dangerous weather conditions, etc.), a description of why the sampling or visual observations could not be conducted, including documentation of all significant storm water discharge events, must be submitted along with the annual monitoring report.

b. Dischargers are required to collect samples and perform visual observations only if significant storm water discharges commence during scheduled facility operating hours[2/], or within two hours following scheduled facility operating hours. Dischargers are required to perform visual observations only within daylight hours. If dischargers do not collect samples or perform visual observations during a significant storm water discharge due to these exceptions, the discharger shall include documentation in the annual monitoring report.

14. **Standard Methods**

All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this general permit or by the Regional Water Board. All metals shall be reported as total metals. All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Dischargers may conduct their own laboratory analyses only if the discharger has sufficient capability (qualified employees, laboratory equipment, etc.) to adequately perform the test procedures.

15. **Records**

Records of all storm water monitoring information and copies of all reports required by this general permit shall be retained for a period of at least five years from the date of the sample, observation, measurement, or report.

These records shall include:

a. The date, place, and time of site inspections, sampling, visual observations, and/or measurements;

b. The individual(s) who performed the site inspections, sampling, visual observations, and/or measurements;

c. Flow measurements or estimates (if required);

d. The date and time of analyses;

e. The individual(s) who performed the analyses;

2/ "Scheduled facility operating hours" are the time periods when the facility is staffed to conduct any function related to industrial activity, including routine maintenance, but excluding time periods where only emergency response, security, and/or janitorial services are performed.

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f. The analytical techniques or methods used and the results of such analyses;

g. Quality assurance/quality control results;

h. Dry season observations and wet season visual observation records (see Sections B.5.b & c);

i. Visual observation and sample collection exception records (see Section B.13);

j. All calibration and maintenance records of on-site instruments used; and

k. All original strip chart recordings for continuous monitoring instrumentation.

16. Annual Report

All dischargers shall submit an annual report by July 1 of each year to the Executive Officer of the Regional Water Board responsible for the area in which the facility is located and to the local agency (if requested).

The report shall include a summary of visual observations and sampling results, the certification required in Section B.5.a.ii, and information as required in Section B.13. The report shall be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. The first report will be due July 1, 1993.

17. Noncompliance Reporting

Dischargers who cannot certify compliance in accordance with Section B.16 above and/or who have had other instances of noncompliance must notify the appropriate Regional Water Board and/or, upon request, the local agency that receives the storm water drainage. The notifications shall identify the type(s) of noncompliance, describe the actions necessary to achieve compliance, and include a time schedule, subject to the modifications by the Regional Water Board, indicating when compliance will be achieved. Noncompliance notifications must be submitted within 30 days of identification of noncompliance.

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Section C: STANDARD PROVISIONS

1. Duty to Comply

The discharger must comply with all of the conditions of this general permit. Any general permit noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action; for general permit termination, revocation and reissuance, or modification; or denial of a general permit renewal application.

The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this general permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

This general permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a general permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any general permit condition.

If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this general permit, this general permit shall be modified, or revoked and reissued to conform to the toxic effluent standard or prohibition, and the discharger so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the general permitted activity in order to maintain compliance with the conditions of this general permit.

4. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this general permit which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this general permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems, installed by a discharger when necessary to achieve compliance with the conditions of this general permit.

6. Property Rights

This general permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

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7. Duty to Provide Information

The discharger shall furnish the Regional Water Board, State Water Board, USEPA, or local storm water management agency within a reasonable time specified by the agencies, any requested information to determine compliance with this general permit. The discharger shall also furnish, upon request, copies of records required to be kept by this general permit.

8. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, USEPA, and local storm water management agency upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this general permit;

b. Have access to and copy at reasonable times, any records that must be kept under the conditions of this general permit;

c. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment) that are related to or may impact storm water discharge; and

d. Sample or monitor at reasonable times for the purpose of ensuring general permit compliance.

9. Signatory Requirements

a. All Notices of Intent submitted to the State Water Board shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of the facility if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. The principal executive officer of a Federal agency includes the chief executive officer of the agency, or the senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. Regional Administrators of USEPA).

b. All reports, certification, or other information required by the general permit or requested by the Regional Water Board, State Water Board, USEPA, or local storm water management agency shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above and retained as part of the Storm Water Pollution Prevention Plan.

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(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

(3) If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization must be attached to the Storm Water Pollution Prevention Plan prior to submittal of any reports, certifications, or information signed by the authorized representative.

10. Certification

Any person signing documents under Provision 9 shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

11. Reporting Requirements

a. Planned changes: The discharger shall give notice to the Regional Water Board and local storm water management agency as soon as possible of any planned physical alteration or additions to the general permitted facility. Notice is required under this provision only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged.

b. Anticipated noncompliance: The discharger will give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the permitted facility or activity which may result in noncompliance with general permit requirements.

c. Compliance schedules: Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this general permit shall be submitted no later than 14 days following each schedule date.

d. Noncompliance reporting: The discharger shall report any noncompliance at the time monitoring reports are submitted. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

12. Oil and Hazardous Substance Liability

Nothing in this general permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject under Section 311 of the CWA.

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13. Severability

The provisions of this general permit are severable, and if any provision of this general permit, or the application of any provision of this general permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this general permit shall not be affected thereby.

14. Reopener Clause [modified by Order No. 92-12-DWQ, September 1992]

This general permit may be modified, revoked, and reissued, or terminated for cause due to promulgation of amended regulations, receipt of USEPA guidance concerning regulated activities, judicial decision, or in accordance with 40 CFR 122.62, 122.63, 122.64, and 124.5.

15. Penalties for Violations of General Permit Conditions.

a. Section 309 of the CWA provides significant penalties for any person who violates a general permit condition implementing Sections 301, 302, 306, 307 308, 318, or 405 of the CWA, or any general permit condition or limitation implementing any such section in a general permit issued under Section 402. Any person who violates any general permit condition of this general permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, in some cases greater than those under the CWA.

16. Availability

A copy of this general permit shall be maintained at the discharge facility and be available at all times to operating personnel.

17. Transfers

This general permit is not transferable to any person. A new owner or operator of an existing facility must submit a NOI in accordance with the requirements of this general permit to be authorized to discharge under this general permit.

18. Continuation of Expired General Permit

This general permit continues in force and effect until a new general permit is issued or the State Water Board rescinds the general permit. Only those dischargers authorized to discharge under the expiring general permit are covered by the continued general permit.

19. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this general permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or by both.

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ATTACHMENT 1

FACILITIES COVERED BY THIS GENERAL PERMIT

Industrial facilities include Federal, State, municipally owned, and private facilities from the following categories:

1. FACILITIES SUBJECT TO STORM WATER EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS, OR TOXIC POLLUTANT EFFLUENT STANDARDS (40 CFR SUBCHAPTER N). Currently, categories of facilities subject to storm water effluent limitations guidelines are Cement Manufacturing (40 CFR Part 411), Feedlots (40 CFR Part 412), Fertilizer Manufacturing (40 CFR Part 418), Petroleum Refining (40 CFR Part 419), Phosphate Manufacturing (40 CFR Part 422), Steam Electric (40 CFR Part 423), Coal Mining (40 CFR Part 434), Mineral Mining and Processing (40 CFR Part 436), Ore Mining and Dressing (40 CFR Part 440), and Asphalt Emulsion (40 CFR Part 443). The fact sheet accompanying this general permit contains additional information pertaining to facilities subject to new source performance standards or toxic pollutant effluent standards.

2. MANUFACTURING FACILITIES: Standard Industrial Classifications (SICs) 24 (except 2411 and 2434), 26 (except 265 and 267), 28 (except 283 and 285) 29, 311, 32 (except 323), 33, 3441, and 373.

3. OIL AND GAS/MINING FACILITIES: SICs 10 through 14 including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l) because of performance bond issued to the facility by the appropriate Surface Mining Control and Reclamation Act (SMCRA) authority has been released, or except for area of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge stormwater contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products, or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined material, or sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim.

4. HAZARDOUS WASTE TREATMENT, STORAGE, OR DISPOSAL FACILITIES: Includes those operating under interim status or a general permit under Subtitle C of the federal Resource Conservation and Recovery Act (RCRA).

5. LANDFILLS, LAND APPLICATION SITES, AND OPEN DUMPS: Sites that receive or have received industrial waste from any of the facilities covered by this general permit, sites subject to regulation under Subtitle D of RCRA, and sites that have accepted wastes from construction activities (construction activities include any clearing, grading, or excavation that results in disturbance of five acres or more).

6. RECYCLING FACILITIES: SICs 5015 and 5093. These codes include metal scrapyards, battery reclaimers, salvage yards, motor vehicle dismantlers and wreckers, and recycling facilities that are engaged in assembling, breaking up, sorting, and wholesale distribution of scrap and waste material such as bottles, wastepaper, textile wastes, oil waste, etc.

7. STEAM ELECTRIC POWER GENERATING FACILITIES: Includes any facility that generates steam for electric power through the combustion of coal, oil, wood, etc.

8. TRANSPORTATION FACILITIES: SICs 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication) or other operations identified herein that are associated with industrial activity.

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9. SEWAGE OR WASTEWATER TREATMENT WORKS: Facilities used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day or more, or required to have an approved pretreatment program under 40 CFR Part 403. Not included are farm lands, domestic gardens, or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with Section 405 of the CWA.

11. MANUFACTURING FACILITIES WHERE MATERIALS ARE EXPOSED TO STORM WATER: SICs 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, and 4221-4225.

Note: Category 10, Construction activity, is covered by a separate general permit.

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ATTACHMENT 2

STATE WATER RESOURCES CONTROL BOARD

P. O. Box 100, Sacramento, CA 95812-0100

Legislative and Public Affairs: (916) 657-2390
Water Quality Information: (916) 657-0687

Clean Water Programs Information: (916) 739-4400
Water Rights Information: (916) 657-2170

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)

5550 Skylane Blvd. Suite A
Santa Rosa, CA 95403
(707) 576-2220

SAN FRANCISCO BAY REGION (2)

2101 Webster Street, Ste. 500
Oakland, CA 94612
(510) 286-1255

CENTRAL COAST REGION (3)

81 Higuera St., Suite 200
San Luis Obispo, CA 93401-5414
(805) 549-3147

LOS ANGELES REGION (4)

101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213) 266-7500

CENTRAL VALLEY REGION (5)

3443 Routier Road
Sacramento, CA 95827-3098
(916) 255-3000

Fresno Branch Office

3614 East Ashlan Ave.
Fresno, CA 93726
(209) 445-5116

Redding Branch Office

415 Knollcrest Drive
Redding, CA 96002
(916) 224-4845

LAHONTAN REGION (6)

2092 Lake Tahoe Boulevard, Suite 2
South Lake Tahoe, CA 96150
(916) 544-3481

Victorville Branch Office

Civic Plaza,
15428 Civic Drive, Suite 100
Victorville, CA 92392-2359
(619) 241-6583

COLORADO RIVER BASIN REGION (7)

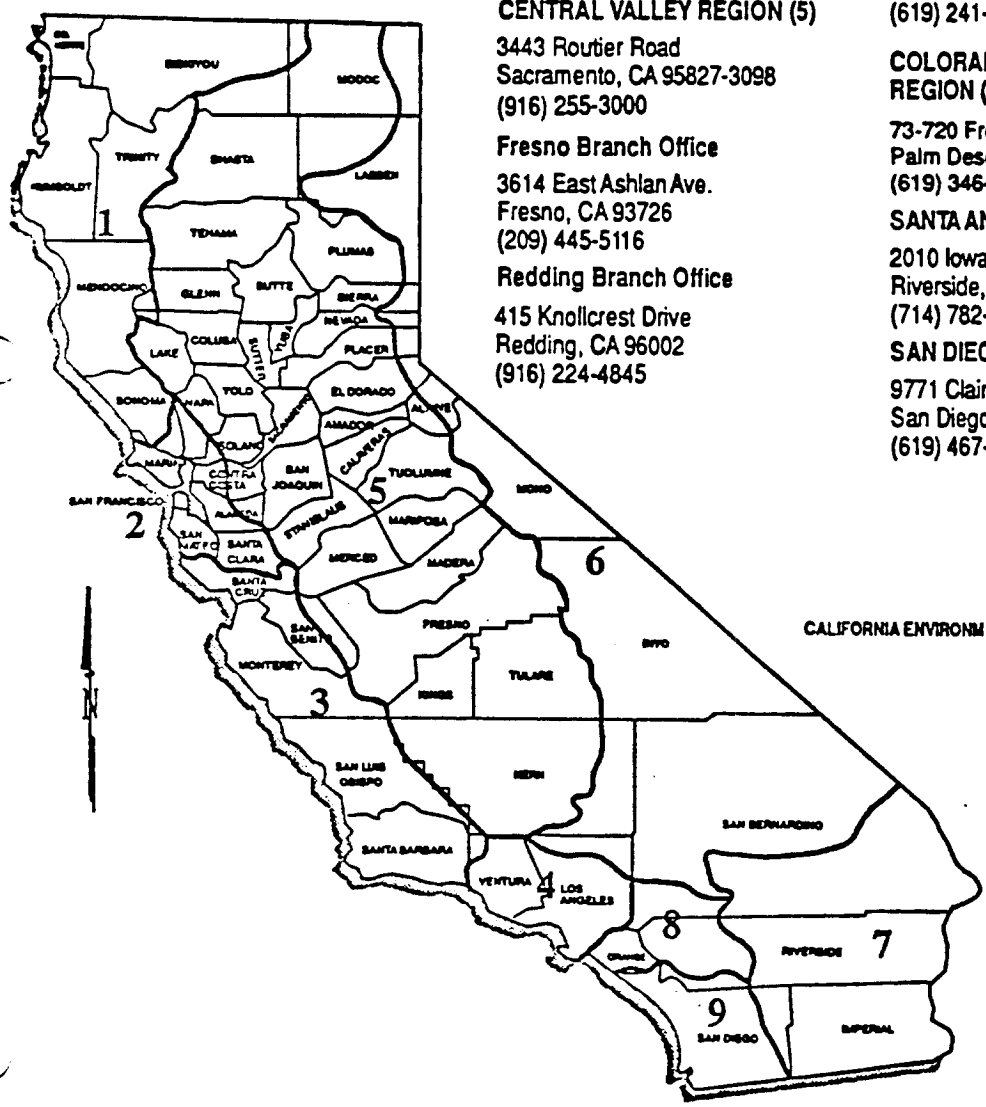
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
(619) 346-7491

SANTA ANA REGION (8)

2010 Iowa Avenue, Ste. 100
Riverside, CA 92507-2409
(714) 782-4130

SAN DIEGO REGION (9)

9771 Clairemont Mesa Blvd. Ste. B
San Diego, CA 92124
(619) 467-2952



STATE OF CALIFORNIA
Pete Wilson, Governor

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
James M. Strock, Secretary

10/16/92

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ATTACHMENT 3

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

NOTICE OF INTENT (NOI) TO COMPLY WITH THE TERMS
OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED
WITH INDUSTRIAL ACTIVITIES EXCLUDING
CONSTRUCTION ACTIVITIES

GENERAL INSTRUCTIONS

Updated October 15, 1992

Who Must Submit

Facilities which have been defined by the USEPA regulations as having "storm water discharges associated with industrial activity" must obtain coverage under an NPDES permit for their storm water discharges. Facilities requiring coverage are defined in 40 CFR Section 122.26(b)(14). All facilities in California except those listed below, may seek coverage under the State Water Board's NPDES general permit.

Facilities Not Covered By This General Permit

Storm water discharges from the following facilities may not obtain coverage by this general permit:

a. Facilities in Santa Clara County which drain to San Francisco Bay must seek coverage under a separate general permit issued by the San Francisco Bay Regional Water Board.

b. Facilities with an existing NPDES permit that specifically limits and regulates storm water discharges.

c. Construction activities greater than five acres must obtain coverage under the NPDES construction activity storm water general permit.

d. Facilities on Indian lands will be regulated by the USEPA.

e. Logging Activities.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
P.O. Box 1977
Sacramento, CA 95812-1977
Attn: Storm Water Permitting Unit

When to Apply

Owners/operators of existing facilities must file a NOI, along with the appropriate annual fee, prior to March 30, 1992. Owners/operators of new facilities (those beginning operations after March 30, 1992) must file a NOI at least 30 days prior to the beginning of operations. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late.

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Fees

The annual fee is $250.00 for each facility which discharges into a municipal separate storm sewer system regulated by an areawide urban storm water general permit and $500.00 for all other facilities.

Facilities that have either a NPDES permit or waste discharge requirements (WDRs) and already pay an annual fee are not subject to an additional fee for the storm water general permit. Feedlots subject to this general permit will pay a one-time only fee of $2,000. Feedlots that already have a NPDES general permit or WDRs and have paid the $2,000 fee do not have to pay an additional fee for the storm water general permit.

Completing the NOI

Completion and submittal of the attached NOI (Form NOI-1) is required to gain coverage under the general permit. It must be completely and accurately filled out. A facility will be considered to be covered by the general permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. Each discharger will be given a distinct identification number. Upon receipt of the NOI and fee, each discharger will be sent a letter containing the discharger's identification number.

Questions?

If you have any questions completing the NOI after reading the following line-by-line instructions, please call the appropriate Regional Water Board or the State Water Board at (916) 657-0919.

NOI—LINE-BY LINE INSTRUCTIONS

The NOI consists of two parts--a NOI Form (Form NOI-1) and a site map. Please type or letter when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for an existing facility, box 2 if the facility is new (has not started operations), and box 3 if the NOI is being submitted to report changes to a facility already covered by the general permit. An example of a change that warrants a resubmittal of the NOI would be a change of owner/operator of a facility. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID number must be included.

SECTION I—OWNER/OPERATOR

Enter the name of the person, company, firm, public organization, or any other entity which owns the facility (or operates the facility when the owner does not operate the facility) and check the box corresponding to the appropriate ownership status of the facility. The owner/operator information may or may not be the same as the facility information requested in Section II.

SECTION II—FACILITY/SITE INFORMATION

Enter the facility's official or legal name and provide the address, county, and contact person information for the facility. Facilities that do not have a street address must attach to the NOI a legal description of the facility site. The contact person should be the plant or site manager completely familiar with the facility and charged with compliance and oversight of the general permit.

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SECTION III—BILLING ADDRESS

To continue coverage under the general permit, the annual fee must be paid. Use this section to indicate whether the annual fee invoices should be sent to the owner/operator, facility, or other party (include address).

SECTION IV—RECEIVING WATER INFORMATION

In Part A of this section, the owner/operator is required to indicate whether the facility's storm water runoff discharges to a separate storm sewer system, directly to waters of the United States, or indirectly to waters of the United States.

Discharges to separate storm sewer systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the United States will typically have an outfall structure directly from the facility to a river, creek, lake, ocean, etc. Indirect discharges are those that may flow over adjacent properties or right-of-ways prior to discharging to waters of the United States.

Regardless of point of discharge, the applicant must determine the closest receiving water for its storm water discharge. If discharge is to a separate storm sewer system, the owner of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V—INDUSTRIAL INFORMATION

Part A of this section requests the owner/operator to provide the standard industrial classification (SIC) codes(s) which best describes the industrial activity taking place at your facility. Briefly describe the nature of business in Part B. In Part C, check the general industrial activities that take place at the facility.

SECTION VI—MATERIAL HANDLING/MANAGEMENT PRACTICES

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If other types of materials other than those listed are maintained on site, please check "other" and describe the type of material.

Part B of this section requests information on any existing management practices employed at the facility. Check the appropriate categories or list other control measures you use at your facility. If none are used, leave this part blank.

SECTION VII—FACILITY INFORMATION

List the size, in acres or square feet, of the facility and the percentage of the site that is impervious.

SECTION VIII—REGULATORY STATUS

Check the appropriate box(es) and indicate the identification number of any permits currently in effect at the facility.

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SECTION IX—CERTIFICATION

This section should be read by the owner/operator. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner/operator to certify that the provisions in the general permit will be complied with.

The NOI must be signed by:

For a Corporation: a responsible corporate officer (or authorized individual).
For a Partnership or Sole Proprietorship: a general partner or the proprietor, respectively.
For a Municipality, State, or other non-federal Public Agency: either a principal executive officer or ranking elected official.
For a Federal Agency: either the chief or senior executive officer of the agency.

SITE MAP

Provide a "to scale" drawing of the site and its immediate surroundings. Include as much detail about the site as possible. At a minimum, show buildings, material handling areas, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets. The attached form may be used, if convenient. Thomas Guide maps, local street maps, or USGS quadrangle maps may be used to indicate the location of the facility if appropriate (e.g., very large facilities). The source of map and map number, or other identifiers should be shown in the lower left hand corner of the site map.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH INDUSTRIAL ACTIVITY (WQ Order Nos. (91-13-DWQ & 92-12-DWQ)
(Excluding Construction Activities)

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MARK ONLY ONE ITEM	1. ☐ Existing Facility 2. ☐ New Facility	3. ☐ Change of Information WDID #

I. OWNER/OPERATOR

Name			A. Owner/Operator Type (Check one) 1. ☐ City 2. ☐ County 3. ☐ State 4. ☐ Federal 5. ☐ Special District 6. ☐ Gov. Combo 7. ☐ Private
Mailing Address			
City	State	Zip	Phone
Contact Person			B. 1. ☐ Owner 2. ☐ Operator 3. ☐ Owner/Operator

II. FACILITY/SITE INFORMATION

Facility Name			County
Street Address			Contact Person
City	State CA	Zip	Phone

III. BILLING ADDRESS

Send to: ☐ OWNER/OPERATOR ☐ FACILITY ☐ OTHER *(Enter information at right)*	Name		
	Mailing Address		
	City	State	Zip

IV. RECEIVING WATER INFORMATION

A. Does your construction site's storm water discharge to (Check one)

1. ☐ Storm drain system - Enter system owners name
2. ☐ Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water

STATE USE ONLY

WDID:	Regional Board Office:		Date Permit Issued:
NPDES Permit Number: CA	Order Number:	Fee Amount Received: $	Date NOI Received:

FOR008SH4

NOI-1 (10/15/92)

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V. INDUSTRIAL INFORMATION

A. SIC Code(s) 1. ____ . 2. ____ 3. ____ 4. ____

B. Type of Business

C. Industrial activities at facility (Check all that apply)

1. ☐ Manufacturing
2. ☐ Vehicle Maintenance
3. ☐ Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4. ☐ Material Storage
5. ☐ Vehicle Storage
6. ☐ Material Handling
7. ☐ Wastewater Treatment
8. ☐ Power Generation
9. ☐ Recycling
10. ☐ Landfill
99. ☐ Other: _____

VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors (Check all that apply)

1. ☐ Solvents
2. ☐ Scrap Metal
3. ☐ Petroleum Products
4. ☐ Plating Products
5. ☐ Pesticides
6. ☐ Hazardous Wastes
7. ☐ Paints
8. ☐ Wood Treating Products
99. ☐ Other (Please list)

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges (Check all that apply)

1. ☐ Oil/Water Separator
2. ☐ Containment
3. ☐ Berms
4. ☐ Leachate Collection
5. ☐ Overhead Coverage
6. ☐ Recycling
7. ☐ Retention Facilities
8. ☐ Chemical Treatment
99. ☐ Other (Please list)

VII. FACILITY INFORMATION

A. Total size of site (Check one) ____ ☐ Acres ☐ Sq. Ft.

B. Percent of site impervious (including rooftops) ____ %

VIII. REGULATORY STATUS (Check all that apply)

A. ☐ Regulated by Storm water Effluent Guidelines (40 CFR Subchapter N)

B. ☐ Waste Discharge Requirements (Order Number) ____

C. ☐ NPDES Permit CA ____

D. ☐ RCRA Permit Number ____

E. ☐ Regulated by California Code of Regulations Article 6, Chapter 15 (Feedlots).

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date: _____

Title: _____

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ATTACHMENT A

DEFINITIONS

1. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

2. Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500 as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; 33 USC. 1251 et seq.

3. "Facility" is a collection of industrial processes discharging storm water associated with industrial activity within the property boundary of operational unit.

4. "Non-Storm Water Discharge" means any discharge to storm sewer systems that is not composed entirely of storm water except discharges pursuant to a NPDES permit and discharges resulting from fire fighting activities. (See fact sheet, page 8, for clarification on non-storm water dischargers unrelated to industrial activity).

5. "Significant Materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERLCA); any chemical the facility is required to report pursuant to Section 313 of Title III of Superfund Amendments and Reauthorization Act (SARA); fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

6. "Significant Quantities" is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and cause or contribute to a violation of any applicable water quality standards for the receiving water.

7. "Storm water" means storm water runoff, snow melt runoff, and surface runoff and drainage. It excludes infiltration and runoff from agricultural land.

8. "Storm Water Associated with Industrial Activity" means "the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program. The term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR Part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The term also includes storm water discharges from all areas listed in the previous sentence (except access roads) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. Material handling activities include the: storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product, or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are federally, state, or municipally owned or operated that meet the description of the facilities listed in this paragraph) include those facilities designated under 40 CFR 122.26(a)(1)(v).

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APPENDIX B

APWA OVERVIEW OF THE NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES

APWA STORM WATER TASK FORCE

OVERVIEW OF THE NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES

The California NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES, EXCLUDING CONSTRUCTION ACTIVITIES (General Permit) was adopted by the State Water Resources Control Board (SWRCB) on November 19, 1991. Notices of Intent for coverage under the General Permit must be submitted to the SWRCB between the dates of January 15, 1992 and March 30, 1992. A California General Permit for Discharges of Storm Water Associated with Construction Activities is scheduled for adoption in Summer 1992.

The Federal storm water regulations identify the industry types, which are subject to storm water runoff, that require a permit. These industry types are described either by a specific description or by Standard Industrial Classifications (SIC) Code. The industry types identified include some facilities which may not typically be thought of as "industrial" and some facilities which are typically owned and operated by public agencies.

The General Permit covers storm water runoff from 10 of the following 11 categories listed in the Federal storm water regulations. The facilities included in each category are described in Attachment I and listed in the tables shown below in parentheses.

EPA Categories

i. Facilities subject to storm water effluent guidelines, new source performance standards or toxic pollutant effluent standards under 40CFR Subchapter N (Table 1)

ii. Certain manufacturing facilities (Table 2)

iii. Active and inactive oil and gas operations and mining facilities (Table 2)

iv. Hazardous waste treatment, storage, or disposal facilities (Table 4)

v. Landfills, land application sites, and open dumps that receive or have received any industrial wastes from facilities listed herein (Table 4)

vi. Recycling facilities, including metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards (Table 2)

vii. Steam electric power generating facilities (Table 4)

viii. Transportation facilities which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations (Table 2)

ix. Wastewater treatment plants with design flows greater than 1.0 mgd or plants required to have a pretreatment program (Table 4)

x. Construction (will be covered under the separate General Permit for Discharges of Storm Water Associated with Construction Activities)

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xi. Other manufacturing facilities where materials, machinery, or products are exposed to storm water (Table 3)

General Information

A. Permit Fee

1. $250 in areas with a municipal NPDES permit
2. $500 in all other areas

B. To obtain a permit application form (NOI), call Stefanie Gordon at 916/657-0752

C. You will receive a letter 2 to 3 weeks after submitting your application confirming that you are covered by the General Permit

D. If you fail to submit an NOI by the March 30, 1992 deadline, submit an NOI anyway with an explanation why you were delayed

E. Certain determinations about this permitting process by the U.S. Environmental Protection Agency (EPA) may not apply in California. Procedures and applicability of the General Permit will be determined by the State Water Resources Board

F. The two major requirements of the General Permit are development and implementation of a Storm Water Monitoring and Reporting Program and a Storm Water Pollution Prevention Plan

G. Submit your completed NOI and permit fee to:

State Water Resources Control Board
Division of Water Quality
P.O. Box 1977
Sacramento, CA 95812-1977

Attention: Storm Water Permitting Section

H. A Standard Industrial Classification (SIC) Manual can be found at most libraries. To order a manual call:

1-800-872-6386 or 1-800-562-0245
Specify Title Code #84161-9.

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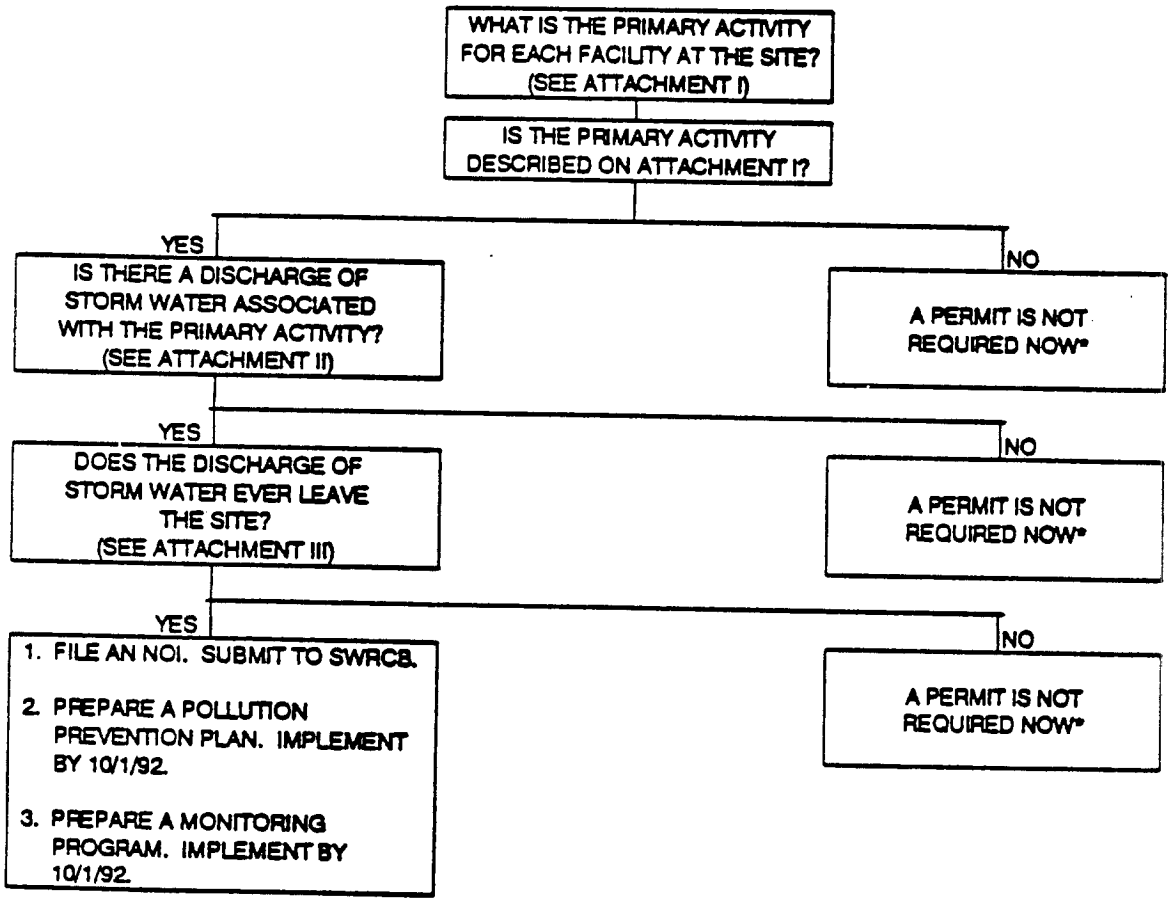
DECISION TREE

DOES THE GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES APPLY TO MY SITE?



* LOCAL AGENCIES MAY ADOPT OTHER PERMITS, CONDITIONS, RULES OR ORDINANCES THAT APPLY TO YOUR INDUSTRY.

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ATTACHMENT I

INTRODUCTION

The State NPDES General Permit for Discharges of Storm Water Associated with Industrial Activities (General Permit) covers 10 of the 11 categories of industrial facilities described in the federal storm water regulations. All 11 categories are described below. Industrial facilities owned or operated by governmental entities (including federal, state, and municipal facilities) and included in any of the 10 designated categories (Categories i through ix, and xi) are subject to General Permit requirements. Category x facilities will be covered by a separate General Permit for Discharges of Storm Water Associated with Construction Activities (scheduled for adoption in Summer 1992).

Category i through ix facilities must file a Notice of Intent to be covered by the General Permit if they discharge industrial storm water (see Attachment II) to waters of the United States (see Attachment III). Category xi facilities must file a Notice of Intent to be covered by the General Permit only if they have equipment or material (outdoor activities) exposed to storm water (see Attachments II and III).

Five categories of facilities (ii, iii, vi, viii, and xi) are defined by Standard Industrial Classification (SIC) codes. Application of SIC codes is described below. Affected SIC codes are listed in Tables 2 and 3.

The remaining six categories of facilities (i, iv, v, vii, ix, and x) are defined by industrial activity descriptions.

APPLICATION OF SIC CODES

Identify Each Facility Contained at the Site

A facility is defined as "something that is built, installed, or established to serve a particular purpose" (Webster's Ninth New College Dictionary, 1986). Therefore, identifying the "purpose" is critical in defining a facility, i.e., each facility will achieve a particular end which can be described with a SIC code.

If more than one activity is occurring, the site may involve two separate, but contiguous facilities. Factors to consider include physical barriers and separate management. For example, a hotel complex could include a marina facility managed by a separate party or separated by a physical barrier from the hotel complex. In this case, the marina would be considered a separate facility associated with industrial activity subject to the Permit requirements (Transportation SIC 4493).

Identify Primary Activity

Once all facilities are identified, determine the primary purpose for each facility. The primary purpose is determined by the principal product or groups of products produced or distributed, or services rendered. The principal product or service should be determined by its relative share of value added (gross production, sales, receipts, or revenues) at the facility. Once the primary purpose of facility is identified, you will be able to determine if the primary purpose is described by one of the listed SIC codes.

In issuing the General Permit, the SWRCB indicated that a facility must be permitted if the primary activity (purpose) at the facility is described by one of the listed SIC codes (whether or not the activity is primary or auxiliary to the owner or operator of the facility). Thus, the primary activity at the facility should be considered when applying the SIC codes rather than the primary business of the owner or operator.

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For example, a school bus maintenance facility is required to obtain a permit since establishments operating school buses (SIC 4151) are in one of the categories described in the storm water permit regulations, even though the facility is owned by an educational institution (e.g., a school district) which is not described by one of the listed SIC codes.

If a site contains two or more facilities each described by designated SIC codes, only one NPDES permit may be necessary if the owner of the site assumes responsibility for all facilities (see Attachment III - Who is Responsible for Obtaining the NPDES permit?). As an alternative, the operators for each facility could apply for separate permits.

GENERAL DESCRIPTION OF INDUSTRIAL FACILITY CATEGORIES

Category i

Facilities Listed Under 40 CFR Subchapter N

These consist of all facilities subject to promulgated: a) storm water effluent limitation guidelines, b) new source performance standards, or c) toxic pollutant effluent standards under 40 CFR Subchapter N. All affected industrial categories are identified in Table 1.

Industries listed with the new source performance standards group need only be permitted if they are a "new source"; meaning an industrial facility built after the performance standards were promulgated by EPA. Industries that believe that they may be included in Category i should review the Subchapter N guidelines and/or consult their local Regional Water Quality Control Board.

Excluded are facilities with toxic pollutant effluent standards which are exempted under Category xi (i.e. because materials, equipment, and products are not exposed to storm water).

Category ii

Manufacturing Facilities

These consist of facilities engaged in the mechanical or chemical transformation of materials or substances into new products, and are usually described as plants, factories, or mills and characteristically use power driven machines and materials handling equipment. Establishments engaged in assembling component parts of manufactured products or in the blending of materials such as lubricating oils, plastics, or liquors are included. Table 2 includes all four digit SIC codes within this category.

All facilities identified by this category are required to file to be covered by the General Permit, regardless of whether equipment and/or materials are exposed to storm water. These facilities should also note that the definition of "storm water discharge associated with industrial activity" (see Attachment II) includes, but is not limited to, discharges from the specified industrial activity areas. Included in the definition are manufacturing buildings and material and waste storage areas (whether totally enclosed or not) including tank farm areas. Activities of concern include emissions from stacks or air exhaust systems, use of unhoused manufacturing and heavy industrial equipment, and generation of dust or particulates.

Excluded are facilities engaged in services or wholesale or retail trade.

Category iii

Oil and Gas/Mining Facilities

These consist of active or inactive mining operations and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water

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contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products, or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Included are SIC Codes 10 (Metal Mining), 11 (Anthracite Mining), 12 (Coal Mining), 13 (Oil and Gas Extraction), and 14 (Mining and Quarrying of Nonmetallic Minerals, Except Fuels). Table 2 includes all four digit SIC codes within this category.

Excluded are inactive mining sites where mining claims are being maintained prior to disturbances associated with the extraction, benefaction, or processing of mined material, nor sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim. Also excluded are certain areas of coal mining meeting the definition of a reclamation area under 40 CFR 434.11(1) and certain areas of non-coal mining which have been released from state or federal reclamation requirements after December 17, 1990.

Category iv

Hazardous Waste Treatment, Storage, or Disposal Facilities

These consist of hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or permit under Subtitle C of the Resource Conservation and Recovery ACT (RCRA). These include only hazardous waste facilities under the federal definition of hazardous waste (RCRA hazardous waste as defined in Title 22, Section 66261.3, CA Health and Safety Code). The California definition of hazardous waste is broader and includes non-RCRA hazardous wastes. Only hazardous waste facilities based on the federal definition are required to obtain a NPDES storm water permit. However, non-RCRA hazardous waste facilities are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency. See Table 4 for further detail.

Category v

Landfills, Land Application Sites, and Open Dumps

These consist of landfills, land application sites, and dumps that received any industrial wastes, including active and inactive sites that receive or have received industrial waste from any of the types of facilities described as industrial facilities in the storm water regulations (i.e., these eleven categories), sites subject to regulation under Subtitle D of RCRA, and sites that have accepted wastes from construction activities (construction activities include any clearing, grading, or excavation that results in disturbance of five acres or more). It is probable that most active and inactive landfills have received industrial waste. See Table 4 for further detail.

Excluded are properly closed landfills that now function as a different land use (e.g., park, golf course, etc.) and which do not pose a threat of discharging storm water exposed to landfill waste.

Category vi

Recycling Facilities

These consist of facilities involved in the recycling of materials, including facilities engaged in assembling, breaking up, sorting, and wholesale distribution of motor vehicle motors and parts, scrap, and other waste materials, and include metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards. Included are facilities which store and recycle paper, glass, metals, oil, rubber, plastics, and other synthetics. These include SIC Code 5015-Used Motor Vehicle Parts and SIC Code 5093-Scrap and Waste Materials.

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Excluded are municipal waste collection sites where bottles, cans, and papers are collected for recycling purposes.

Category vii

Steam Electric Power Generating Facilities

These consist of steam electric power generating facilities, including coal handling sites. See Table 4 for further detail.

Excluded are onsite and offsite ancillary transformer facilities, as long as such facilities have regular inspections and management practices in place, including spill prevention, response, and clean up.

Category viii

Transportation Facilities

These consist of transportation facilities classified by the SIC indicated below which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or other operations identified under Categories i through vii or ix through xi must be permitted.

In determining whether a facility is covered by the transportation category, first determine whether the facility is involved in providing transportation to individual customers or for other companies or establishments, or provides long-distance trucking services to anyone. Maintenance facilities owned or operated by companies or public agencies which are involved in providing transportation services to the public or other businesses are covered, including the transportation of individuals (such as by buses, vans, or taxies) and goods (such as by trucks, rail, ships, or airplanes). All long-distance trucking facilities are covered.

Excluded are transportation facilities which only transport goods for the company or enterprise of which it is a part or only transport its own employees. Municipal corporation yards are excluded unless they perform the functions described in the SIC codes below, such as the service of an urban or suburban bus line (SIC 4111 - Local and Suburban Transit), or contain a warehousing and storage facility described by SIC codes 4225 or 4226. However, all municipal corporation yards are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a Permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

Also excluded are fuel stations, vehicle repair or service stations, and body shops which are not associated with the establishments described in the SIC codes below. However, these establishments are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

Major transportation groups covered by the Permit are described below:

SIC 40 - Railroad Transportation

This major group includes establishments furnishing transportation by line-haul railroad, and switching and terminal establishments. Railways serving a single municipality, contiguous municipalities, or a municipality and its suburban areas are classified in Major Group 41.

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SIC 41 - Local and Suburban Transit and Interurban Highway Passenger Transportation

This major group includes establishments primarily engaged in furnishing local and suburban passenger transportation, such as those providing passenger transportation within a single municipality, contiguous municipalities, or a municipality and its suburban areas by bus, rail, or subway, either separately or in combination, and establishments engaged in furnishing transportation to local scenic features. Also included are establishments primarily engaged in furnishing highway passenger transportation and establishments furnishing highway passenger terminal or maintenance facilities. Intercity bus lines are included in this major group, but interurban railways are classified in Major Group 40.

SIC 42 - Motor Freight Transportation and Warehousing (except SIC 4221-25 (Public Warehousing) which are included in Category xi)

This major group includes establishments furnishing local or long-distance trucking or transfer services or those engaged in the storage of special products (SIC 4226) such as automobiles (dead storage only), furs (for the trade), textiles, whiskey, and goods at foreign trade zones.

SIC 43 - United States Postal Service

SIC 44 - Water Transportation

This major group includes establishments engaged in freight and passenger transportation on the open seas or inland waters, and establishments furnishing such incidental service as lighterage, towing, and canal operation. This major group also includes excursion boats, sightseeing boats, and water taxis. Establishments engaged in the operation of charter or party fishing boats are not included.

SIC 45 - Transportation by Air

This major group includes establishments engaged in furnishing domestic and foreign transportation by air and also those operating airports and flying fields and furnishing terminal services. Establishments primarily engaged in performing services which may incidentally use airplanes (e.g. crop dusting and aerial photography) are not included.

SIC 5171 - Petroleum Bulk Stations and Terminals

These include establishments primarily engaged in the wholesale distribution of crude petroleum and petroleum products, including liquefied petroleum gas, from bulk liquid storage facilities.

Table 2 includes a complete list of all four digit SIC codes within this category. All facilities identified by this category are required to obtain NPDES permits for the discharge of industrial storm water regardless of material, equipment, or product exposure.

Category ix

Sewage or Wastewater Treatment Works

These consist of treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day (MGD) or more, or required to have an approved pretreatment program under 40 CFR Part 403. Industrial activity areas at these facilities include, but are not limited to, onsite sludge composting;

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storage of chemicals such as ferric chloride, alum polymers, and chlorine; and areas which experience spills and bubbleovers. See Table 4 for further detail.

Excluded are farm lands, domestic gardens, or lands used for sludge management or reclamation of municipal wastewater where the sludge or wastewater is beneficially reused and which are not physically located in the confines of the facility.

Category x

Construction Activities

These include, but are not limited to, clearing, grading, and excavation activities. The State intends to issue a separate General Permit for Discharges of Storm Water Associated with Construction Activities to cover storm water discharges from these activities. The General Permit for Construction Activities will further delineate the extent of affected construction activities.

Excluded from the General Permit for Construction Activities will be operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale. However, such operations are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by local permitted municipal storm water agencies.

Category xi

Manufacturing Facilities

These consist of manufacturing facilities identified by SIC code which have storm water discharges "associated with industrial activities" from areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. Discharges of storm water "associated with industrial activity" and "exposure" to storm water are addressed in Attachment II.

Areas of industrial activity include manufacturing buildings and storage areas. Areas of industrial activity do not include access roads and rail lines.

Table 3 is a complete list of four digit SIC codes included in this category.

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ATTACHMENT II

IS THERE A DISCHARGE OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY?

The term "discharges of storm water associated with industrial activity" means discharges of storm water from areas at a facility where storm water may contact pollutants or activities may release pollutants to storm water. Such discharges include, but are not limited to, discharges from the following:

a. Industrial plan yards;
b. Immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility (except for category xi);
c. Material handling sites;
d. Refuse sites;
e. Sites used for the application or disposal of process waste waters; 40 CFR 401
f. Sites used for the storage and maintenance of material handling equipment;
g. Sites used for residual treatment, storage, or disposal;
h. Shipping and receiving areas;
i. Storage areas (including tank farms) for raw materials, and intermediate and finished products;
j. Manufacturing buildings; and
k. Areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water.

Significant materials include, but are not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Access roads and rail lines include those used or traveled by carriers of raw materials, manufactured products, waste materials, or by-products used or created by the facility. Included are haul roads or rail lines dedicated to transportation of industrial products at facilities and roads and rail lines which are exclusively or primarily dedicated for use by the facility. They do not include public access roads or roads used to transport bulk samples of raw materials or products in small-scale prior to industrial production.

Note that the definition of industrial activity areas is not limited to the specified areas. Any area at a facility where storm water may contact pollutants or activities may release pollutants to storm water must be considered. Also note that the definition includes manufacturing buildings and material and waste storage areas (whether totally enclosed or not). Activities of concern in these areas include emissions from stacks or air exhaust systems, use of unhoused manufacturing and heavy industrial equipment, generation of dust or particulates, use of material handling equipment, and material handling activities.

Non-industrial Areas are areas located at facilities such as office buildings and accompanying parking lots are generally excluded, as long as the drainage from the excluded areas is discharged separately from storm water drained from areas with industrial activities. The intent of the regulations is to control industrial activity storm water discharges. Non-industrial areas are considered equivalent to residential or commercial land-use areas and should be managed as such. These areas may be subject to other requirements imposed by local agencies which have jurisdiction over or manage storm drain systems or waterways.

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For the manufacturing facilities identified by Category xi, storm water discharge associated with industrial activity includes only storm water discharges from the areas (except access roads and rail lines) that are listed above where material handling equipment or activities, raw materials, intermediate products, final products, waste material, by-products, or industrial machinery are exposed to storm water.

Exposure means either direct contact with storm water or the possibility of release (e.g., spills) of pollutants to storm water. For example, roof drainage from manufacturing buildings must be considered when determining exposure. Exposure in this circumstance would include direct or potential contact or release of pollutants (associated with raw materials, products, or waste) from roof stacks to storm water. Manufacturing facilities may also be sources of dust or particulates associated with material handling equipment or activities, raw materials, products, or waste, or industrial machinery. Enclosed storage areas are also defined as areas of industrial activity where there may be exposure during loading/unloading of materials or exposure due to spills.

Category xi facilities are expected to use reasonable and professional judgment when making the determination of exposure from the listed areas and activities. In order to demonstrate that these areas are not exposed to storm water, the following conditions must be met:

1. All illicit (un-permitted) connections to the storm drainage system must be eliminated;

2. All materials must be completely contained at all times so, if spilled, they will not directly or indirectly contact storm water, and

3. All emissions from stacks or air exhaust systems, unhoused manufacturing and heavy industrial equipment, and emissions of dust or particulates must not be exposed to storm water.

If a facility demonstrates that there is no exposure, documentation of the rationale for the determination should be retained on site. Written approval by a Regional Board and a NPDES industrial storm water discharge permit is not required for such facilities. However, such facilities are expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

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ATTACHMENT III

IS THERE A DISCHARGE OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY TO WATERS OF THE UNITED STATES?

The answer is yes, and a General Permit is required, if either of the following applies:

a. The discharge of industrial storm water is directly to waters of the United States through any conveyance. The conveyance does not have to be a pipe or ditch. It includes "sheet flow" discharges resulting from any manipulation of land surface (e.g., pavement).

b. The discharge of industrial storm water is to a storm drain system which ultimate discharges to waters of the United States. In this case all "sheet flow" discharges are included.

The answer is no, and General Permit is not required, if either of the following applies:

a. The discharge of industrial storm water is to a municipal sanitary sewer system or combined sewer system (combined sanitary and storm sewer system).

b. The discharge of industrial storm water is to evaporation ponds, percolation ponds, or dry wells (groundwater injection wells), and there is no discharge to surface waters under any circumstances.

Even though these types of discharges are not required to obtain a General Permit, the discharges may be subject to separate waste discharge requirements issued by a Regional Water Quality Control Board (Regional Board) if they pose a threat to groundwater. If there is a question, call the local Regional Board to obtain guidance.

IS A SEPARATE STORM WATER PERMIT REQUIRED IF THE FACILITY ALREADY HAS A NPDES PERMIT?

A separate General Permit is not required if an existing NPDES permit identifies and addresses all industrial storm water discharges from the facility.

An existing NPDES permit may be modified to address all industrial storm water. Normally, this modification will occur when the existing permit is reissued or amended by a Regional Board. In the interim, the facility should obtain coverage under the General Permit.

WHO IS RESPONSIBLE FOR OBTAINING THE GENERAL PERMIT?

Either the owner or operator of the facility may obtain the Permit. Generally, the operator will be responsible for obtaining the permit. The operator is usually responsible for the industrial activity, and therefore, more appropriately, the best entity to manage the activity in compliance with the permit. However, owners may obtain coverage for a facility with the understanding that they will be directly responsible for the storm water discharge and consequently, responsible for compliance with permit conditions.

For example, a tenant which operates an industrial facility at an airport complex may be responsible for submitting a NOI for coverage under the General Permit and would be responsible for implementing a Storm Water Pollution Prevention Plan (SWPP Plan) for its facility. Alternatively, the airport owner may choose to assume responsibility for its tenants, in addition to its own industrial activities. In this case, the airport owner would submit a NOI and would be responsible for implementing a SWPP Plan that addresses all noted activities at the airport complex.

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TABLE 1
SUBCHAPTER N - EFFLUENT GUIDELINES AND STANDARDS
(Category i)

Group 1	Group 2	Group 3	Part	Description
	X		405	Dairy products processing point source category
	X		406	Grain mills point source category
	X		407	Canned and preserved fruits and vegetables processing point source category
	X		408	Canned and preserved seafood processing point source category
	X		409	Sugar processing point source category
	X	X	410	Textile mills point source category
X	X		411	Cement manufacturing point source category
X	X		412	Feedlots point source category
	X	X	413	Electroplating point source category
	X	X	414	Organic chemicals, plastics, and synthetic fibers
	X	X	415	Inorganic chemicals manufacturing point source category
	X		417	Soap and detergent manufacturing point source category
X	X		418	Fertilizer manufacturing point source category
X	X	X	419	Petroleum refining point source category
	X	X	420	Iron and steel manufacturing point source category
	X	X	421	Nonferrous metals manufacturing point source category
X	X		422	Phosphate manufacturing point source category
X	X	X	423	Steam electric power generating point source category
	X	X	424	Ferroalloy manufacturing point source category
	X	X	425	Leather tanning and finishing point source category
	X	X	426	Glass manufacturing point source category
	X		427	Asbestos manufacturing point source category
	X	X	428	Rubber manufacturing point source category
	X	X	429	Timber products processing point source category
	X	X	430	Pulp, paper, and paperboard point source category
	X		431	The builders' paper and board mills point source category
	X		432	Meat products point source category
	X	X	433	Metal finishing point source category

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TABLE 1 (Continued)
SUBCHAPTER N - EFFLUENT GUIDELINES AND STANDARDS
(Category i)

Group 1	Group 2	Group 3	Part	Description
X	X		434	Coal mining point source category; BPT, BAT, BCT limitations and new source performance standards
			435	Oil and gas extraction point source category
X			436	Mineral mining and processing point source category
	X	X	439	Pharmaceutical manufacturing point source category
X	X	X	440	Ore mining and dressing point source category
X	X		443	Effluent limitations guidelines for existing sources and standards of performance and pretreatment standards for new sources for the paving and roofing materials (tars and asphalt) point source category
	X		446	Paint formulating point source category
	X		447	Ink formulating point source category
			454	Gum and wood chemicals manufacturing point source category
		X	455	Pesticide chemicals
			457	Explosives manufacturing point source category
	X		458	Carbon black manufacturing point source category
		X	459	Photographic point source category
			460	Hospital point source category
	X	X	461	Battery manufacturing point source category
	X		463	Plastics molding and forming point source category
	X	X	464	Metal molding and casting point source category
	X	X	465	Coil coating point source category
	X	X	466	Porcelain enameling point source category
	X	X	467	Aluminum forming point source category
	X	X	468	Copper forming point source category
	X	X	469	Electrical and electronic components point source category
	X	X	471	Nonferrous metals forming and metal powders point source category

Group 1: Storm water effluent limitations guidelines - Permit Mandatory
Group 2: New source performance standards - Permit Mandatory
Group 3: Toxic pollutant effluent standards - Permit conditional on exposure to storm water (Category xi)

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TABLE 2

MANDATORY INDUSTRIES (Categories ii,iii, vi, and viii)
Permit Required in Any Case

Metal Mining

1011	Iron Ores
1021	Copper Ores
1031	Lead & Zinc Ores
1041	Gold Ores
1044	Silver Ores
1061	Ferroalloy Ores, Except Vanadium
1081	Metal Mining Services
1094	Uranium-Radium-Vanadium Ores
1099	Miscellaneous Metal Ores, N.E.C.

Coal Mining

1221	Bituminous Coal and Lignite Surface Mining
1222	Bituminous Coal Underground Mining
1231	Anthracite Mining
1241	Coal Mining Services

Oil & Gas Extraction

1311	Crude Petroleum & Natural Gas
1321	Natural Gas Liquids
1381	Drilling Oil & Gas Wells
1382	Oil & Gas Field Exploration Services
1389	Oil & Gas Field Services, N.E.C.

Mining & Quarrying of Nonmetallic Minerals, Except Fuels

1411	Dimension Stone
1422	Crushed & Broken Limestone
1423	Crushed & Broken Granite
1429	Crushed & Broken Stone, N.E.C
1442	Construction Sand & Gravel
1446	Industrial Sand
1455	Kaoline & Ball Clay
1459	Clay & Related Minerals, N.E.C.
1474	Potash, Soda, & Borate Minerals
1475	Phosphate Rock
1479	Chemical & Fertilizer Mineral Mining, N.E.C.
1481	Nonmetallic Minerals Services, Except Fuels
1499	Miscellaneous Nonmetallic Minerals, Except Fuels, N.E.C.

Lumber & Wood Products, Except Furniture

2421	Sawmills & Planing Mills, General
2426	Hardwood Dimension & Flooring Mills
2429	Special Product Sawmills, N.E.C.
2431	Millwork
2435	Hardwood Veneer & Plywood
2436	Softwood Veneer & Plywood
2439	Structural Wood Members, N.E.C.
2441	Nailed and Lock Corner Wood Boxes & Shook
2448	Wood Pallets & Skids
2449	Wood Containers, N.E.C.
2451	Mobile Homes

Lumber & Wood Products, Except Furniture (Cont.)

2452	Prefabricated Wood Buildings
2491	Wood Preserving
2493	Reconstituted Wood Products
2499	Wood Products, N.E.C.

Paper & Allied Products

2611	Pulp Mills
2621	Paper Mills
2631	Paperboard Mills

Chemicals & Allied Products

2812	Alkalies & Chlorine
2813	Industrial Gases
2816	Inorganic Pigments
2819	Industrial Inorganic Chemicals, N.E.C.
2821	Plastics Materials, Synthetic Resins, & Nonvolcanizable Elastomers
2822	Synthetic Rubber
2823	Cellulosic Manmade Fibers
2824	Manmade Organic Fibers, Except Cellulosic
2841	Soap & Other Detergents, Except Specialty Cleaners
2842	Specialty Cleaning, Polishing, & Sanitation Preparations
2843	Surface Active Agents, Finishing Agents, Sulforated Oils, and Assistants
2844	Perfumes, Cosmetics, & Other Toilet Preparations
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
2861	Gum & Wood Chemicals
2865	Cyclic Organic Crudes & Intermediates, & Organic Dyes & Pigments
2869	Industrial Organic Chemicals, N.E.C.
2873	Nitrogenous Fertilizers
2874	Phosphatic Fertilizers
2875	Fertilizers, Mixing Only
2879	Pesticides & Agricultural Chemicals, N.E.C.
2891	Adhesives & Sealants
2892	Explosives
2893	Printing Ink
2895	Carbon Black
2899	Chemicals & Chemical Preparations, N.E.C.

Petroleum Refining & Related Industries

2911	Petroleum Refining
2951	Asphalt Paving Mixtures & Blocks
2952	Asphalt Felts & Coatings
2992	Lubricating Oils & Greases
2999	Products of Petroleum & Coal, N.E.C.

Leather Tanning & Finishing

3111	Leather Tanning & Finishing

Note: N.E.C. means Not Elsewhere Classified.

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Stone, Clay, Glass, & Concrete Products

3211 Flat Glass
3221 Glass Containers
3229 Pressed & Blown Glass & Glassware, N.E.C.
3241 Cement, Hydraulic
3251 Brick & Structural Clay Tile
3253 Ceramic Wall & Floor Tile
3255 Clay Refractories
3259 Structural Clay Products, N.E.C.
3261 Vitreous China Plumbing Fixtures & China & Earthenware Fittings & Bathroom Accessories
3262 Vitreous China Table and Kitchen Articles
3263 Fine Earthenware (Whiteware) Table and Kitchen Articles
3264 Porcelain Electrical Supplies
3269 Pottery Products, N.E.C.
3271 Concrete Block & Brick
3272 Concrete Products, Except Block & Brick, N.E.C.
3273 Ready-Mixed Concrete
3274 Lime
3275 Gypsum Products
3281 Cut Stone & Stone Products
3291 Abrasive Products
3292 Asbestos Products
3295 Minerals & Earths, Ground or Otherwise Treated
3296 Mineral Wool
3297 Nonclay Refractories
3299 Nonmetallic Mineral Products, N.E.C.

Primary Metal Industries

3312 Steel Works, Blast Furnaces (Including Coke Ovens), & Rolling Mills
3313 Electrometallurgical Products, Except Steel
3315 Steel Wiredrawing & Steel Nails & Spikes
3316 Cold-Rolled Steel Sheet, Strip, & Bars
3317 Steel Pipe & Tubes
3321 Gray & Ductile Iron Foundries
3322 Malleable Iron Foundries
3324 Steel Investment Foundries
3325 Steel Foundries, N.E.C.
3331 Primary Smelting & Refining of Copper
3334 Primary Production of Aluminum
3339 Primary Smelting & Refining of Nonferrous Metals, Except Copper & Aluminum
3341 Secondary Smelting & Refining of Nonferrous Metals
3351 Rolling, Drawing, & Extruding of Copper
3353 Aluminum Sheet, Plate, & Foil
3354 Aluminum Extruded Products
3355 Aluminum Rolling & Drawing, N.E.C.
3356 Rolling & Drawing of Nonferrous Metals, Except Copper & Aluminum
3357 Drawing & Insulating of Nonferrous Wire
3363 Aluminum Die-Castings
3364 Nonferrous Die-Castings, Except Aluminum
3365 Aluminum Foundries
3366 Copper Foundries

Primary Metal Industries (Cont.)

3369 Nonferrous Foundries, Except Aluminum & Copper
3398 Metal Heat Treating
3399 Primary Metal Products, N.E.C.

Fabricated Structural Metal Products

3441 Fabricated Structural Metal

Electronic & Other Electrical Equipment & Components, Except Computer Equipment

3648 Lighting Equipment, N.E.C.
3652 Phonograph Records & Prerecorded Audio Tapes & Disks
3679 Electronic Components, N.E.C.

Ship & Boat Building & Repairing

3731 Ship Building & Repairing
3732 Boat Building & Repairing

Railroads

4011 Railroads, Line-Haul Operating
4013 Railroad Switching & Terminal Establishments

Local & Suburban Transit & Interurban Highway Passenger Transportation

4111 Local & Suburban Transit
4119 Local Passenger Transportation, N.E.C.
4121 Taxicabs
4131 Intercity & Rural Bus Transportation
4141 Local Bus Charter Service
4142 Bus Charter Service, Except Local
4151 School Buses
4173 Terminal & Service Facilities for Motor Vehicle Passenger Transportation

Motor Freight Transportation & Warehousing

4212 Trucking, Local Without Storage
4213 Trucking, Except Local
4214 Local Trucking & Storage
4215 Courier Services, Except By Air
4226 Special Warehousing & Storage, N.E.C.
4231 Terminal Facilities & Joint Terminal Maintenance Facilities for Motor Freight Transportation

United States Postal Service

4311 United States Postal Service

Water Transportation

4412 Deep Sea Foreign Transportation of Freight
4424 Deep Sea Domestic Transportation of Freight
4432 Freight Transportation on the Great Lakes - St. Lawrence Seaway
4449 Water Transportation of Freight, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Water Transportation (Cont.)

4481	Deep Sea Transportation of Passengers, Except by Ferry
4482	Ferries
4489	Water Transportation of Passengers, N.E.C.
4491	Marine Cargo Handling
4492	Towing & Tugboat Services
4493	Marinas
4499	Water Transportation Services, N.E.C.

Transportation By Air

4512	Air Transportation, Scheduled
4513	Air Courier Services
4522	Air Transportation, Nonscheduled
4581	Airports, Flying Fields, & Airport Terminal Services

Wholesale Trade - Durable Goods

5015	Motor Vehicle Parts, Used
5093	Scrap & Waste Materials

Petroleum & Petroleum Products

5171	Petroleum & Petroleum Product Wholesalers, Except Bulk Stations & Terminals

Note: N.E.C. means Not Elsewhere Classified.

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TABLE 3

CONDITIONAL INDUSTRIES (Category xi)
Permit required only if materials, machinery, or products are exposed to stormwater

Food & Kindred Products

2011	Meat Packing Plants
2013	Sausages & Other Prepared Meat Products
2015	Poultry Slaughtering & Processing
2021	Creamery Butter
2022	Natural, Processed, & Imitation Cheese
2023	Dry, Condensed, & Evaporated Dairy Products
2024	Ice Cream & Frozen Desserts
2026	Fluid Milk
2032	Canned Specialities
2033	Canned Fruits, Vegetables, Preserves, Jams, & Jellies
2034	Dried & Dehydrated Fruits, Vegetables, & Soups Mixes
2035	Pickled Fruits & Vegetables, Vegetable Sauces & Seasonings, & Salad Dessings
2037	Frozen Fruits, Fruit Juices, & Vegetables
2038	Frozen Specialities, N.E.C.
2041	Flour & Other Grain Mill Products
2043	Cereal Breakfast Foods
2044	Rice Milling
2045	Prepared Flour Mixes & Doughs
2046	Wet Corn Milling
2047	Dog & Cat Food
2048	Prepared Feeds & Feed Ingredients for Animals & Fowls, Except Dogs & Cats
2051	Bread & Other Bakery Products, Except Cookies & Crackers
2052	Cookies & Crackers
2053	Frozen Bakery Products, Except Bread
2061	Cane Sugar, Except Refining
2062	Sugar Cane Refining
2063	Beet Sugar
2064	Candy & Other Confectionery Products
2066	Chocolate & Cocoa Products
2067	Chewing Gum
2068	Salted & Roasted Nuts & Seeds
2074	Cottonseed Oil Mills
2075	Soybean Oil Mills
2076	Vegetable Oil Mills, Except Corn, Cottonseed, & Soybean
2077	Animal & Marine Fats & Oils
2079	Shortening, Table Oils, Margerine, & Other Edible Fats & Oils, N.E.C.
2082	Malt Beverages
2083	Malt
2084	Wines, Brandy, & Brandy Spirits
2085	Distilled & Blended Liquors
2086	Bottled & Canned Soft Drinks & Carbonated Waters
2087	Flavoring Extracts & Syrups, N.E.C.
2091	Canned & Cured Fish & Seafoods
2092	Prepared Fresh or Frozen Fish & Seafoods
2095	Roasted Coffee
2096	Potatoe Chips, Corn Chips, & Similar Snacks
2097	Manufactured Ice
2098	Macaroni, Spaghetti, Vermicelli, & Noodles

Food & Kindred Products (Cont.)

2099	Food Preparations, N.E.C.

Tobacco Products

2111	Cigarettes
2121	Cigars
2131	Chewing & Smoking Tobacco & Snuff
2141	Tobacco Stemming & Redrying

Textile Mill Products

2211	Broadwoven Fabric Mills, Cotton
2221	Broadwoven Fabric Mills, Manmade Fiber & Silk
2231	Broadwoven Fabric Mills, Wool (Including Dyeing & Finishing)
2241	Narrow Fabric & Other Smallwares Mills: Cotton, Wool, Silk, & Manmade Fiber
2251	Women's Full-Length & Knee-Length Hosiery, Except Socks
2252	Hosiery, N.E.C.
2253	Knit Outerwear Mills
2254	Knit Underwear & Nightwear Mills
2257	Weft Knit Fabric Mills
2258	Lace & Warp Knit Fabric Mills
2259	Knitting Mills, N.E.C.
2261	Finishers of Broadwoven Fabrics of Cotton
2262	Finishers of Broadwoven Fabrics of Manmade Fiber & Silk
2269	Finishers of Textiles, N.E.C.
2273	Carpets & Rugs
2281	Yarn Spinning Mills
2282	Yarn Texturizing, Throwing, Twisting, & Winding Mills
2284	Thread Mills
2295	Coated Fabrics, Not Rubberized
2296	Tire Cord & Fabrics
2297	Nonwoven Fabrics
2298	Cordage & Twine
2299	Textile Goods, N.E.C.

Apparel & Other Finished Products Made From Fabrics & Similar Materials

2311	Men's & Boy's Suits, Coats, & Overcoats
2321	Men's & Boy's Shirts, Except Work Shirts
2322	Men's & Boy's Underwear & Nightwear
2325	Men's & Boy's Separate Trousers & Slacks
2326	Men's & Boy's Work Clothing
2329	Men's & Boy's Clothing, N.E.C.
2331	Women's, Misses' & Juniors' Blouses & Shirts
2335	Women's, Misses' & Juniors' Dresses
2337	Women's, Misses' & Juniors' Suits, Skirts, & Coats
2339	Women's, Misses'& Juniors' Outerwear, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Apparel & Other Finished Products Made From Fabrics & Similar Materials (Cont.)

2341	Women's, Misses, Children's, & Infants' Underwear & Nightwear
2342	Brassieres, Girdles, & Allied Garments
2353	Hats, Caps, & Millinery
2361	Girls' Children's & Infants' Dresses, Blouses, & Shirts
2369	Girls', Childrens', & Infants' Outerwear, N.E.C.
2371	Fur Goods
2381	Dress & Work Gloves, Except Knit & All-Leather
2384	Robes & Dressing Gowns
2385	Waterproof Outerwear
2386	Leather & Sheep-Lined Clothing
2387	Apparel Belts
2389	Apparel & Accessories, N.E.C.
2391	Curtains & Draperies
2392	Housefurnishings, Except Curtains & Draperies
2393	Textile Bags
2394	Canvas & Related Products
2395	Pleating, Decorative & Novelty Stitching, & Tucking for the Trade
2396	Automotive Trimmings, Apparel Findings, & Related Products
2397	Schiffli Machine Embroideries
2399	Fabricated Textile Products, N.E.C.

Millwork, Veneer, Plywood, & Structural Wood Members

2434	Wood Kitchen Cabinets

Furniture & Fixtures

2511	Wood Household Furniture, Except Upholstered
2512	Wood Household Furniture, Upholstered
2514	Metal Household Furniture
2515	Mattresses, Foundations, & Convertible Beds
2517	Wood Television, Radio, Phonograph, & Sewing Machine Cabinets
2519	Household Furniture, N.E.C.
2521	Wood Office Furniture
2522	Office Furniture, Except Wood
2531	Public Building and Related Furniture
2541	Wood Office & Store Fixtures, Partitions, Shelving, & Lockers
2542	Office & Store Fixtures, Partitions, Shelving, & Lockers, Except Wood
2591	Drapery Hardware & Window Blinds & Shades
2599	Furniture & Fixtures, N.E.C.

Paper & Allied Products

2652	Setup Paperboard Boxes
2653	Corrugated & Solid Fiber Boxes
2655	Fiber Cans, Tubes, Drums & Similar Products
2656	Sanitary Food Containers, Except Folding

Paper & Allied Products (Cont.)

2657	Folding Paperboard Boxes, Including Sanitary
2671	Packaging Paper & Plastics Film, Coated & Laminated
2672	Coated & Laminated Paper, N.E.C.
2673	Plastics, Foil & Coated Paper Bags
2674	Uncoated Paper & Multiwall Bags
2675	Die-Cut Paper, Paperboard, & Cardboard
2676	Sanitary Paper Products
2677	Envelopes
2678	Stationery Tablets & Related Products
2679	Converted Paper & Paperboard Products, N.E.C.

Printing, Publishing, & Allied Industries

2711	Newspapers: Publishing, or Publishing & Printing
2721	Periodicals: Publishing, or Publishing & Printing
2731	Books: Publishing, or Publishing & Printing
2732	Book Printing
2741	Miscellaneous Publishing
2752	Commercial Printing, Lithographic
2754	Commercial Printing, Gravure
2759	Commercial Printing, N.E.C.
2761	Manifold Business Forms
2771	Greeting Cards
2782	Blankbooks, Looseleaf Binders & Devices
2789	Bookbinding & Related Work
2791	Typesetting
2796	Platemaking & Related Services

Drugs

2833	Medicinal Chemicals & Botanical Products
2834	Pharmaceutical Preparations
2835	In Vitro & In Vivo Diagnostic Substances
2836	Biological Products, Except Diagnostic Substances

Paints, Varnishes, Lacquers, Enamels, & Allied Products

2851	Paints, Varnishes, Lacquers, Enamels, & Allied Products

Rubber & Miscellaneous Plastics Products

3011	Tires & Inner Tubes
3021	Rubber & Plastics Footwear
3052	Rubber & Plastics Hose & Belting
3053	Gaskets, Packing & Sealing Devices
3061	Molded, Extruded, & Lathe-Cut Rubber Mechanical Goods
3069	Fabricated Rubber Products, N.E.C.
3081	Unsupported Plastics Film & Sheet
3082	Unsupported Plastics Profile Shapes
3083	Laminated Plastics Plate, Sheet, & Profile Shapes
3084	Plastics Pipe
3085	Plastics Bottles

Note: N.E.C. means Not Elsewhere Classified.

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Rubber & Miscellaneous Plastics Products

3086 Plastics Foam Products
3087 Custom Compounding of Purchased Plastics Resins
3088 Plastics Plumbing Fixtures
3089 Plastics Products, N.E.C.

Leather & Leather Products

3131 Boot & Shoe Cut Stock & Findings
3142 House Slippers
3143 Men's Footwear, Except Athletic
3144 Women's Footwear, Except Athletic
3149 Footwear, Except Rubber, N.E.C.
3151 Leather Gloves & Mittens
3161 Luggage
3171 Women's Handbags & Purses
3172 Personal Leather Goods, Except Women's Handbags & Purses
3199 Leather Goods, N.E.C.

Glass Products, Made Of Purchased Glass

3231 Glass Products Made of Purchased Glass

Fabricated Metal Products, Except Machinery & Transportation Equipment

3411 Metal Cans
3412 Metal Shipping Barrels, Drums, Kegs, & Pails
3421 Cutlery
3423 Hand & Edge Tools, Except Machine Tools & Handsaws
3425 Saw Blades & Handsaws
3429 Hardware, N.E.C.
3431 Enameled Iron & Metal Sanitary Ware
3432 Plumbing Fixture Fittings & Trim
3433 Heating Equipment, Except Electric & Warm Air Furnaces
3442 Metal Doors, Sash, Frames, Molding, & Trim
3443 Fabricated Plate Work (Boiler Shops)
3444 Sheet Metal Work
3446 Architectural & Ornamental Metal Work
3448 Prefabricated Metal Buildings & Components
3449 Miscellaneous Structural Metal Work
3451 Screw Machine Products
3452 Bolts, Nuts, Screws, Rivets, & Washers
3462 Iron & Steel Forgings
3463 Nonferrous Forgings
3465 Automotive Stampings
3466 Crowns & Closures
3469 Metal Stampings, N.E.C.
3471 Electroplating, Plating, Polishing, Anodizing, & Coloring
3479 Coating, Engraving, & Allied Services, N.E.C.
3482 Small Arms Ammunition
3483 Ammunition, Except for Small Arms
3484 Small Arms
3489 Ordinance & Accessories, N.E.C.
3491 Industrial Valves
3492 Fluid Power Valves & Hose Fittings

Fabricated Metal Products, Except Machinery & Transportation Equipment (Cont.)

3493 Springs, Steel, Except Wire
3494 Valves & Pipe Fittings, N.E.C.
3495 Wire Springs
3496 Miscellaneous Fabricated Wire Products
3497 Metal Foil & Leaf
3498 Fabricated Pipe & Pipe Fittings
3499 Fabricated Metal Products, N.E.C.

Industrial & Commercial Machinery & Computer Equipment

3511 Steam, Gas, & Hydraulic Turbines, & Turbine Generator Set Units
3519 Internal Combustion Engines, N.E.C.
3523 Farm Machinery & Equipment
3524 Lawn & Garden Tractors & Home Lawn & Garden Equipment
3531 Construction Machinery & Equipment
3532 Mining Machinery & Equipment, Except Oil & Gas Field Machinery & Equipment
3533 Oil & Gas Field Machinery & Equipment
3534 Elevators & Moving Stairways
3535 Conveyors & Conveying Equipment
3536 Overhead Traveling Cranes, Hoists, & Monorail Systems
3537 Industrial Trucks, Tractors, Trailers, & Stackers
3541 Machine Tools, Metal Cutting Types
3542 Machine Tools, Metal Forming Types
3543 Industrial Patterns
3544 Special Dies & Tools, Die Sets, Jigs, & Fixtures, & Industrial Molds
3545 Cutting Tools, Machine Tool Accessories, & Machinists' Precision Measuring Devices
3546 Power Driven Handtools
3547 Rolling Mill Machinery & Equipment
3548 Electric & Gas Welding & Soldering Equipment
3549 Metalworking Machinery, N.E.C.
3552 Textile Machinery
3553 Woodworking Machinery
3554 Paper Industries Machinery
3555 Printing Trades Machinery & Equipment
3556 Food Products Machinery
3559 Special Industry Machinery, N.E.C.
3561 Pumps & Pumping Equipment
3562 Ball & Roller Bearings
3563 Air & Gas Compressors
3564 Industrial & Commercial Fans & Blowers, & Air Purification Equipment
3565 Packaging Machinery
3566 Speed Changers, Industrial High-Speed Drives, & Gears
3567 Industrial Process Furnaces & Ovens
3568 Mechanical Power Transmission Equipment, N.E.C.
3569 General Industrial Machinery & Equipment, N.E.C.
3571 Electronic Computers
3572 Computer Storage Devices
3575 Computer Terminals
3577 Computer Peripheral Equipment, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Industrial & Commercial Machinery & Computer Equipment

3578	Calculating & Accounting Machines, Except Electronic Computers
3579	Office Machines, N.E.C.
3581	Automatic Vending Machines
3582	Commercial Laundry, Drycleaning, & Pressing Machines
3585	Air Conditioning & Warm Air Heating Equipment & Commercial & Industrial Refrigeration Equipment
3586	Measuring & Dispensing Pumps
3589	Service Industry Machinery, N.E.C.
3592	Carburetors, Pistons, Piston Rings, & Valves
3593	Fluid Power Cylinders & Actuators
3594	Fluid Power Pumps & Motors
3596	Scales & Balances, Except Laboratory
3599	Industrial & Commercial Machinery & Equipment, N.E.C.

Electronic & Other Electrical Equipment & Components, Except Computer Equipment

3612	Power, Distribution, & Specialty Transformers
3613	Switchgear & Switchboard Apparatus
3621	Motors & Generators
3624	Carbon & Graphite Products
3625	Relays & Industrial Controls
3629	Electrical Industrial Apparatus, N.E.C.
3631	Household Cooking Equipment
3632	Household Refrigerators, & Home & Farm Freezers
3633	Household Laundry Equipment
3634	Electrical Housewares & Fans
3635	Household Vacuum Cleaners
3639	Household Appliances, N.E.C.
3641	Electric Lamps Bulbs & Tubes
3643	Current-Carrying Wiring Devices
3644	Noncurrent-Carrying Wiring Devices
3645	Residential Electric Lighting Fixtures
3646	Commercial, Industrial, & Institutional Electric Lighting Fixtures
3647	Vehicular Lighting Equipment
3648	Lighting Equipment, N.E.C.
3651	Household Audio & Video Equipment
3652	Phonograph Records & Prerecorded Audio Tapes & Disks
3661	Telephone & Telegraph Apparatus
3663	Radio & Television Broadcasting & Communications Equipment
3669	Communications Equipment, N.E.C.
3671	Electron Tubes
3672	Printed Circuit Boards
3674	Semiconductors & Related Devices
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils, Transformers, & Other Inductors
3678	Electronic Connectors
3679	Electronic Components, N.E.C.
3691	Storage Batteries
3692	Primary Batteries, Dry & Wet

Electronic & Other Electrical Equipment & Components, Except Computer Equipment (Cont.)

3694	Electrical Equipment for Internal Combustion Engines
3695	Magnetic & Optical Recording Media
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3713	Truck & Bus Bodies
3714	Motor Vehicle Parts & Accessories
3715	Truck Trailers
3716	Motor Homes
3721	Aircraft
3724	Aircraft Engines & Engine Parts
3728	Aircraft Parts & Auxiliary Equipment, N.E.C.
3743	Railroad Equipment
3751	Motorcycles, Bicycles, & Parts
3761	Guided Missiles & Space Vehicles
3764	Guided Missile & Space Vehicle Propulsion Units & Propulsion Unit Parts
3769	Guided Missile & Space Vehicle Parts & Auxiliary Equipment, N.E.C.
3792	Travel Trailers & Campers
3795	Tanks & Tank Components
3799	Transportation Equipment, N.E.C.

Measuring, Analyzing & Controlling Instruments; Photographic, Medical, & Optical Goods; Watches & Clocks

3812	Search, Detection, Navigation, Guidance, Aeronautical, & Nautical Systems & Instruments
3821	Laboratory Apparatus & Furniture
3822	Automatic Controls for Regulating Residential & Commercial Environments & Appliances
3823	Industrial Instruments for Measurement, Display, & Control of Process Variables, & Related Products
3824	Totalizing Fluid Meters & Counting Devices
3825	Instruments for Measuring & Testing of Electricity & Electrical Signals
3826	Laboratory Analytical Instruments
3827	Optical Instruments & Lenses
3829	Measuring & Controlling Devices, N.E.C.
3841	Surgical & Medical Instruments & Apparatus
3842	Orthopedic, Prosthetic, & Surgical Appliances & Supplies
3843	Dental Equipment & Supplies
3844	X-Ray Apparatus & Tubes & Related Irradiation Apparatus
3845	Electromedical & Electrotherapeutic Apparatus
3851	Ophthalmic Goods
3861	Photographic Equipment & Supplies
3873	Watches, Clocks, Clockwork Operated Devices, & Parts

Note: N.E.C. means Not Elsewhere Classified.

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3915	Jewelers' Findings & Materials, & Lapidary Work
3931	Musical Instruments
3942	Dolls & Stuffed Toys
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Note: N.E.C. means Not Elsewhere Classified.

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TABLE 4
MANDATORY INDUSTRIES (Categories iv, v, vii, and ix)
Permit Required in Any Case
April 1992

TYPE OF FACILITY	FACILITIES INCLUDED	FACILITIES EXCLUDED	COMMENTS
Hazardous Waste Treatment Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) use any method, technique, or process, to change the physical, chemical, or biological character or composition of RCRA hazardous wastes for the purpose of neutralization; energy or material resource recovery; rendering such waste nonhazardous, less hazardous, or safer to transport, store, or dispose; reducing waste volume; or making such waste more amenable for recovery or storage.		RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Hazardous Waste Storage Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) hold RCRA hazardous wastes from onsite or offsite locations for a temporary period until the waste is treated, disposed of, or stored elsewhere.	Temporary hazardous wastes storage facilities operated for less than 90 days are not covered by RCRA.	RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Hazardous Waste Disposal Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) discharge, deposit, inject, or place RCRA hazardous wastes on or into any land or water.		RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Landfills	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.		A Landfill is defined as an area of land or excavation in which wastes are placed for permanent disposal, excluding land application sites, surface impoundments, injection wells, and waste piles (40 CFR Part 257.2).

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TABLE 4
MANDATORY INDUSTRIES (Categories iv, v, vii, and ix)
Permit Required in Any Case
April 1992

TYPE OF FACILITY	FACILITIES INCLUDED	FACILITIES EXCLUDED	COMMENTS
Land Application Sites	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.	Manure spreading operations.	A Land Application Site is defined as an area where wastes are applied onto or incorporated into the soil surface for agricultural purposes or for treatment and disposal (40 CFR Part 257.2).
Open Dumps	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.		An Open Dump is a municipal landfill failing to satisfy the Criteria for Municipal Solid Waste Landfills specified in 40 CFR Part 258. Open dumps are prohibited under Section 4005 of RCRA.
Steam Electric Power Generating Facilities	Facilities that generate electricity utilizing fossil type fuel (coal, oil, or gas) ~~or nuclear fuel and thermal cycle~~ using a steam water system, and raw material storage areas, including coal handling sites.	Facilities with NPDES permits which regulate stormwater discharges.	
Wastewater Treatment, Storage, Recycling, or Reclamation Facilities	Facilities that treat, store, recycle, or reclaim municipal wastewater, including adjoining land dedicated to sewage sludge disposal.	1. Facilities with NPDES permits which regulate stormwater discharges. 2. Facilities with design capacities of less than 1 MGD which are not required to have a pretreatment program under 40 CFR Part 403. 3. Farm lands and domestic gardens where sludge is beneficially reused, or sludge management facilities which are not located on land adjoining the treatment, storage, recycling, or reclamation facilities site. 4. Facilities that are in compliance with Section 405 of the Clean Water Act (federal regulations governing sewage sludge disposal). 5. Facilities that collect all stormwater runoff and discharge the runoff back to the headworks of the treatment facility.	

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APPENDIX C

SAMPLE SWPPP

APPENDIX C

EXAMPLE SWPPP

Presented in the following pages is an example of a Storm Water Pollution Prevention Plan (SWPPP). The example was prepared following the procedures and worksheets presented in Chapter 2. The industrial facility is a cargo container business located in a marine port. The contents of this example follow the requirements of the State of California General Permit (Appendix A). However, your Regional Water Quality Control Board may request additional items as specified in your permit.

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STORM WATER POLLUTION PREVENTION PLAN

LOADUM STEVEDORE COMPANY

Sknits Bay Facility

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CHAPTER 1 INTRODUCTION

Federal regulations, administered by the Ahctog Water Quality Board (AWQB), requires the Loadum Company facility at Sknits Bay to have a General Industrial Storm Water Permit (hereafter referred to as the "Permit"). The purpose of the regulations is to protect water quality by reducing the amount of pollutants in the storm water. These pollutants come from our outdoor activities, as well as atmospheric deposition over which we have no control. The permit covers the entire Facility except for the Administration Building and the adjoining employee parking lot. These activities are not included in the permit because they drain to their own drainage system. A copy of the Permit is at the back of this Storm Water Pollution Prevention Plan. The original is kept at Headquarters.

1.1 Purpose of the SWPPP

The regulations require us to prepare a Storm Water Pollution Prevention Plan (SWPPP). It describes the measures that we will take through November 19, 1996, as specified in our permit. This plan is to be kept on the premises at the office of the Environmental Coordinator.

1.2 BMP Implementation Committee

The Permit requires that the SWPPP identify personnel to oversee the implementation of any measures to reduce pollution (called Best Management Practices), to modify the SWPPP as necessary over time. We have formed a standing committee which participated in the preparation of this plan and will oversee its implementation. The committee will be lead by the Facility Environmental Coordinator plus the following: M&R Repair Manager, Container Yard Manager, Marine Manager, Safety Director (also the Spill Response Team Leader), Facilities Management, and a Union representative.

1.3 Implementation Schedule

All of what are called "management BMPs" (those that do not involve any major construction) are to be implemented by the end of FY 1993. The oil/water separator for the vehicle wash area is being installed as soon as approval is received from the city sewer department. This rapid installation is required by the Permit. Other connections to the separator as identified in the SWPPP will not occur until FY95. The new fueling station will be installed in FY95.

1.4 Protocol on Public Access to the SWPPP

Although this is a Company plan, meant for the use by our employees, it is a public document. Representatives of the AWQB who visit the Facility on occasion are allowed direct access to the plan when on site. Any request for a copy of the plan by the AWQB, or other government agency is to be forwarded to the Director of Environmental Affairs at the Headquarters Office.

1.5 Updating the SWPPP

The AWQB can require changes to the plan. We are not required to forward this plan automatically to the AWQB but only upon request. We are required to change the plan whenever a change in our activities occurs that may affect significantly the discharge of pollutants. We may also change the plan if we determine that there are more economical BMPs to reduce pollutants than the one's currently identified in the SWPPP. The Facility Environmental Coordinator is responsible for determining if the SWPPP is to be changed, and when done, by the involvement of the Committee.

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CHAPTER 2 SITE LOCATION AND GENERAL ENVIRONS

Although this is our plan to carryout the needed actions to reduce storm water pollution, this plan contains general background information that is of value to the public and the AWQB should they request a copy, and for Headquarters, given the large number of Company facilities.

2.1 General Nature of Facility Activities

The Facility's primary objective is the loading and unloading of cargo containers on seagoing ships. Some break bulk packing occurs. The loading equipment (container cranes, top pickers, tractors, container trailers and forklifts) and miscellaneous vehicles are maintained on site. This includes engine maintenance, lubrication, frame welding, miscellaneous painting, and washing. Highway tractors (trucks) are not maintained on site as they are not owned by the Company.

2.2 Map of General Environs

Map 1 shows the Facility and the immediately surrounding area. The site covers a total of 125 acres and is completely covered with pavement or buildings. All storm water discharges to Ignatia Bay either directly or via storm drains. There are no active or inactive wells on site. There are no streams or wetlands on the site.

2.3 Maps of Facility Layout

The location of buildings and major activity areas are shown on Map 1. There are four (4) buildings (A, B, C and the Crane Maintenance Shop) and several activities in the open as described below.

Building A is the Company administrative office and employee parking lot (not included in the permit).

Building B is for break bulk containerization; where various types of dry goods are packed in containers such as lumber, wire, and paper. However, this is a minor part of the operation. In excess of 99% of all cargo passing through the Facility comes to the site in containers. This area is not considered a "significant source" of pollutants (as defined in the Permit) and therefore is not discussed further in the SWPPP.

Building C is for maintenance and repair (M&R). Outside the building in the general M&R area are: the wash rack where containers and equipment are stream cleaned; the reefer area where reefer (refrigerated) containers are temporarily stored; the fueling station; and outside storage of various parts and fluids.

Container Trailer Storage Yard: Trailers are temporarily stored in this area and repaired.

Container yard: Containers awaiting loading are stacked or temporarily stored on trailers.

Dock apron: Loading/unloading of ships occurs in this area. The container cranes are located on tracks. Containers are loaded on to trailers that are pulled either by a dock tractor or a highway truck tractor.

Crane maintenance shop: Located next to the dock apron, where materials are kept that are needed to repair the container cranes.

2.4 Description of Storm Drainage System and Outfalls

The drainage pipes, outfalls, and the boundaries of the areas that drain to each outfall are shown on Map 2 (enclosed in the back cover pocket). Included in the drainage system are a large number of catch basins. These basins do provide a moderate level of treatment. The sumps are of sufficient depth to collect settleable pollutants. Each catch basin has a "turned down" elbow in the discharge line. This traps much of the floating debris and some petroleum products. We point this out because to be effective the catch basins need to be cleaned more frequently if they are to work.

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CHAPTER 3 DESCRIPTION OF POTENTIAL SOURCES OF POLLUTION

The locations of various activities that could be sources of pollution are shown on Map 3. Enclosed at the back of this report are various completed worksheets, including a summary of materials that could become contaminants such as used oil.

3.1 Maintenance and Repair (M&R) Area

With the exception of the container cranes located on the dock apron, maintenance of vehicles and equipment occurs in M & R Area. Because of height limitations maintenance of top picks occurs outside the building. The chiller units on reefer containers are serviced in the designated area. Servicing is done from a motorized platform that can elevate to the height of the reefer unit. Servicing involves replacement of coolant and lubricants. The platform is enclosed on three sides.

Worksheet 2, in the Appendix, lists the types and quantities of both fresh and used fluids located in M&R area. These materials are potential pollutants if not handling properly. They include motor oil, hydraulic/lube oil, degreasers (mineral spirits), cleaning solvent, spray paint cans, rust removers, antifreeze, cleaning detergents, and batteries.

On the west side of the shop is a space for gensets, where portable generators sets are stored and serviced including fueling with #2 diesel. The internal drains of the shop drain to an oil/water separator which in turn drains to the sanitary sewer.

Hydraulic/lube oil is purchased in 55 gallon drums and stored in the designated walkin containment box (on the south side of M&R shop). This container is watertight, has a containment floor, and is approved by the city fire department. Bulk motor oil is stored inside the shop as is fresh solvent. Solvent, used to clean parts and to clean the surfaces of equipment, is supplied by Safety-Kleen who also removes used solvent which is stored in containers provided by Safety-Kleen.

The used solvent container, as well as containers for other used fluids (except engine oil), are stored in a walk-in containment box (#2 on the south side of the shop). It has a containment floor and is approved by the fire department. Used engine oil is stored in a 500 gallon underground tank. The used oil is removed by a private contractor.

Used antifreeze is recycled after it is cleaned of contaminates. This is done inside the shop. Minor touchup painting occurs using spray cans.

Containers and equipment are steam cleaned at the location shown in Map 4. The water drains to a storm catch basin. The area is swept clean each day of surface debris.

The fueling station situated on the south side of the M&R shop is not enclosed. Service vehicles and small trucks use the fueling station. Top pickers and bulls are fueled throughout the site by a fueling truck (see below). There are two underground 5,000 gallon tanks: one for #2 diesel and one for unleaded gasoline. These tanks are to be replaced in FY 93 with new tanks that meet the current underground tank regulations.

Potential sources of pollution are:

- spills from the fueling of vehicles and equipment;
- spills when fuel is delivered;
- spills when fueling generator sets
- spills from servicing reefers
- spills when taking used fluids to the used fluids storage shed.
- materials discharged from steam cleaning area

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3.2 Container Trailer Storage Yard

Container trailers are repaired and serviced outside, south of Building B. Repairs involve minor welding and spot painting (with spray cans). Servicing involves greasing and axle oil replacement. The only potential source of pollution is the changing of axle oil.

3.3 Container Yard

The container handling equipment (top picks, tractors, and forklifts) have hydraulic oil lines that can break, spilling oil. The maximum capacity is 75 gallons.

Hazardous Materials passing through the Facility are temporarily stored in designated areas as required by the fire department. Spills from a container can reach storm drains.

Fueling of top picks and forklifts occurs in the container yard. Spills could occur.

Yard transformers contain mineral oil, not PCBs, for insulation. Mineral oil could leak if the transformers are damaged.

3.4 Dock Apron

Container cranes are serviced at dock side. The cranes are electric. Therefore maintenance is limited to various lubricants and oils. The maximum capacity of oil tank is 30 gallons. No fueling occurs. Solvent stored at the Crane Maintenance shop is used to clean the metal surfaces of the crane. Spills of these materials during handling and transfer to the crane could occur.

Ship fueling occurs at dockside by truck. Spills could occur. Painting of the ship hull occurs infrequently and is limited to the deck. Hull painting does not occur. Consequently, loss to the bay is unlikely.

3.5 Crane Maintenance Shop

Small parts, grease, and tools are kept in this small shop located immediately adjacent to the dock apron. Fresh and used hydraulic oil and filters are kept at the M&R shop and not at the crane maintenance shop. Parts are not cleaned here except if it can done by a cloth. Solvent is used to clean (with a cloth) the surfaces of the cranes. Cleaning of parts by dunking is done at the M&R shop. As the cranes are electric there is no fueling.

3.6 Maintenance, Repair, Remodeling of Facility Buildings

This is discussed separately as it is the responsibility of Facilities Management. Any major repairs or additions to buildings are performed by off-site contractors who are responsible for their activities. Potential sources of pollution include spilled or dumped paint, and washing of materials down the drain.

3.7 Improper Connections to the Storm Drain

The line from the wash rack area is connected to the storm drain. Wash water is considered a process or waste water, not storm water, and needs to be discharged to the sanitary sewer.

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CHAPTER 4 POTENTIAL POLLUTANTS

4.1 Significant Materials that May Come in Contact with Storm Water

Worksheet 2 (Appendix) lists materials that may come in contact with storm water. Essentially all of these materials are related to the maintenance, repair, and fueling of vehicles and materials handling equipment.

4.2 Types of Pollutants by Potential Source

Table 1 is a table listing the types of pollutants that may be present in storm water from the Facility.

4.3 Existing Data on Quality of Storm Water from Site

There are no data on the quality of the storm water from the Facility site.

4.4 Estimate of Pollutant Loadings to Sknits Bay

Because of the episodic nature of many activities (such as painting) and the lack of storm water data we are unable to calculate with sufficient accuracy the probable loadings of the various pollutants in Table 1.

4.5 Spills of Significant Materials After November 19, 1988

It is required by the regulations that we list spills since the date indicated. There have been no such spills.

TABLE 1. LIST OF POLLUTANTS WITH A REASONABLE POTENTIAL TO BE PRESENT IN STORM WATER IN SIGNIFICANT QUANTITIES

Oil/grease
PAH (polynuclear aromatic hydrocarbons)
Petroleum hydrocarbons
Zinc
Lead
Copper
Cadmium
Chromium
Total suspended solids
Small floatable debris (wood pieces)
Phenol
Benzene
Napthalene
Phosphorus
Nitrogen

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CHAPTER 5 STEPS TO REDUCE POLLUTION - BOTH OLD AND NEW

Table 2 summarizes existing and new BMPs, denoting which of the Permit categories (listed below) applies. Also indicated is the schedule of implementation and the department that is responsible for carrying out the BMP. Worksheet #5 "grades" the area for general housekeeping quality, indicating that in general we are doing a good job already.

5.1 What are Best Management Practices (BMPs)

The storm regulations state that we are to put in place Best Management Practices (BMPs) to reduce the contamination or potential for contamination of storm water. BMPs can be simple and low cost, such as sweeping the container yard, or expensive such as installing an oil/water separator. Many of the BMPs we are already doing: these are included in the SWPPP with new BMPs that need to be implemented.

We are required by the permit to identify BMPs in the following general areas:

1. Good housekeeping: - Refers to those things we do to keep the work areas clean.

2. Preventive maintenance: - Maintenance of our equipment in a way that anticipates problems that could occur,resulting in pollution. An example is routine replacement of hydraulic lines on the top picks.

3. Spill prevention and response: - Particular attention is to be devoted to minimizing spills, which is already covered by our Business Plan.

4. Storm water management practices: This refers to BMPs that involve construction such as installation of an oil/water separator, or containment sump.

5. Employee training: Our training program needs to include training as necessary for the various BMPs.

6. Inspections: We must at least annually inspect the facility to be certain that all of the BMPs are being implemented, decide if they are effective, and make changes as necessary. A record of these exceptions is to be kept.

7. Monitoring: During the wet season (October-April), we will collect and analyze runoff samples from two storms.

What follows is a description of BMPs that we already do and new ones that we need to do. The following discussion is organized by area of the Facility, with a few exceptions.

5.2 Assignments to Implement the BMPs

The department responsible for the various BMPs are shown in Table 2.

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TABLE 2. BMP LIST

BMPs	BMP STATUS		IMPLEMENTATION SCHEDULE	DEPARTMENT ASSIGNED
	CURRENT	NEW		
M&R AREA				
Proper Storage of Hazardous Materials/Wastes	X		NA	M&R
New Fueling Station		X	FY95	FM
Clean-up of Spills absorbent materials staging	X		NA	M&R
Sweep Wash Rack Area	X		NA	M&R
Install Oil/Water Separator		X	FY94	FM
Use Drip Pans		X	FY93	M&R
Oily Rags/Filter Container		X	FY93	M&R
Secondary Containment Pallets		X	FY93	M&R
Signing Shop	X	X	FY93	M&R
Sweep Yard	X			FM
Clean Catch Basins		X	FY93	FM
Signing Catch Basins		X	FY93	FM
TRAILER STORAGE YARD				
Spill Clean-up Materials	X			M&R
CONTAINER YARD				
Sweep Yard		X	FY93	FM
Clean Catch Basins		X	FY93	FM
DOCK APRON				
Sweep Yard		X	FY93	FM
Proper Fueling Procedures	X			MM
Spill Procedures on Ship Fueling	X			SC
Temporary Drain Plugs		X	FY93	MM
BUILDING M&R				
Drop Cloths		X	FY93	FM
Contract Language		X	FY93	FM
TRAINING	X	X	FY93	FEC
INSPECTIONS/MONITORING		X	FY93	FEC

CODES:

FM Facilities Management
FEC Facilities Environmental Coordinator
FY93 Means to implement by the end of our 1993 (or 1994 or 1995) fiscal year
M&R Maintenance and Repair Shop Manager
MM Marine Manager
NA Non Applicable
SC Spill Control Team Leader

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5.3 Maintenance and Repair (M&R) Area

Current BMPs: Minor spills are cleaned up promptly by M&R shop personnel. Spill absorbent materials of various types are stored in the brightly marked container at the northeast corner of the M&R shop. The used fluids and filters are placed in marked containers, properly stored as previously described, and are inventoried and removed by XYZ Environmental. The fresh and used materials storage areas are checked weekly by the M&R Manager. The shop floor is cleaned weekly using liquid detergent. These wash waters drain to a sanitary sewer. The wash rack area is swept clean of debris each day that washing occurs. When serviced, all vehicles and equipment are checked for faulty parts and hydraulic hose wear; these are replaced as potential problems are discovered. A solvent sink is used to clean parts.

New BMPs: The following will be implemented.

- When the two storage tanks are removed (FY 93) they will be replaced by one above ground tank for #2 diesel. Pickup trucks which are the only vehicles that use gasoline will be fueled off-site at a gas station.
- The above ground tank will be placed on a concrete pad sloped inward towards a drain that will connect to a oil/water separator which will discharge to the sanitary sewer. A valve will keep the line closed under fueling operations so that major spills can be contained within the pad. When fueling is not occurring the valve will be open to allow storm water to drain from the pad via the oil/water separator to the sanitary line.
- The wash rack area will also drain to this oil/water separator.
- The floor drains from the shop will be plumbed to the oil/water separator as required by a recent order of the city sewer department.
- Oil contaminated materials such as rags, pads, filters and adsorbent materials are currently placed in covered dumpsters. Containment drums will be obtained and marked for these materials.
- When using a forklift to transport drums with fluid, the drums will be placed in a secondary containment device.
- The catch basins within the immediate vicinity of the M&R shop will be stenciled "dump no waste" so that we all remember that wastes are not be dumped.
- Whenever vehicles and equipment are in the shop for servicing all hydraulic lines are to be checked for wear. Whenever there are indications of wear of a nature as to possible cause failure, the lines are to be replaced.
- When servicing top picks, drip pans will be used to the maximum extent practical.
- Signs within the shop area will be examined and modified as appropriate.

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5.4 Container Trailer Storage Yard

Current BMPs: The only relevant BMP is spill cleanup if axle lubricant oil is spilled. A brightly marked barrel of absorbent materials is located in the yard area. Used absorbent material is removed promptly so as to not be washed down to the storm drain.

New BMPs: None are needed.

5.5 Container yard

Current BMPs: The yard is swept by a contract sweeper once per month. Hand sweepers are used as needed in areas that cannot be reached by the mechanical sweeper. Spills are immediately cleaned with appropriate absorbent materials. These materials are located in the bright yellow bins placed at four locations around the yard. Major spills are handled by XYZ Environmental, under contract to the Company (as per the Company's Spill Prevention and Control Plan). When fueling top picks and forklifts the fuel truck operator is always present throughout the fueling operation. Spraying of stripes occurs during dry weather only. Spills of hazardous materials on site for transhipment (that is, not the Company's materials or wastes) and major spills during fueling operations are cleaned up by XYZ Environmental, as per the Company's Spill Prevention and Control Plan. The Facility has already implemented all practical measures to reduce hazardous wastes as per our Business Plan.

New BMPs: Currently the catch basins are not cleaned. Hence forth they are to be checked twice per year and cleaned whenever sediment reaches within 2 feet of the outlet pipe. This will not always be easy to do since containers and trailers are typically parked over many of the catch basins. However, to the maximum extent practical these catch basins will be checked and cleaned when accessible. XYZ Environmental's contract will be modified to include this work.

5.6 Dock Apron

Current BMPs: Vessel fueling is done as per Coast Guard requirements. This includes personnel at both ends of the operation in radio contact with each other, monitoring of tank levels, and closing of ship scuppers during fueling. As per our Spill Prevention and Cleanup Plan, XYZ Environmental responds to marine spills upon Company request. Agencies to notify in the event of spills is contained in the Company's Spill Prevention and Control Plan.

New BMPs: A container marked for oily rags, filters, etc will be obtained so that this material is no longer placed in the dumpster. It will be disposed in accordance with our hazardous waste plan. When fueling or hydraulic fluid is being added to the crane, the drain holes in the apron will be temporarily plugged with a removal plug to contain any significant spill that might occur.

5.7 Maintenance, Repair, Remodeling of Facility Buildings

Current BMPs: None specified

New BMPs: When Company employees are doing minor painting, drop cloths will be used. Contracts with outside contractors who do major work will contain suitable clauses regarding practices to diminish the risk of storm water contamination such as keeping the work area clean, use of drop cloths, and proper disposal of residual materials.

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5.8 Employee Training

Current BMPs: Employees already receive training on spill cleanup and control, and safety measures which for the M&R staff includes proper handling of hazardous materials. Safety training also supports actions that will minimize the risk of storm water contamination.

New BMPs: Current training procedures will be modified to include awareness about storm water pollution, and the relationship between our activities and potential pollutants. This will occur once per year. All new employees will be provided this information during their normal orientation training.

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CHAPTER 6 MONITORING AND RECORD KEEPING

6.1 Checking on New BMP Implementation

An annual inspection is required which must be documented (see below and the Permit). This inspection will be carried out by the Facility Environmental Coordinator with the respective Managers assisting in their areas. Upon completion of the annual inspection the BMP Implementation Committee will meet to consider: how well the BMPs are working, progress with the more substantial BMPs, and changes to both the BMPs and the SWPPP.

The M&R Manager will conduct (as is done now) weekly inspections of the M&R area, and will use a checklist of BMPs to denote if they are in place, if there are problems, and if so, the solution. These checklists will be kept at the M&R office, with a copy forwarded to the Facility Environmental Coordinator.

6.2 Monitoring of Storm Water

During the wet season, the Facility Environmental Coordinator will assign and train field personnel to collect runoff samples from two storms. Grab samples will be collected from the last catch basin in the container yard prior to the bay discharge. AB Analytical Services will provide appropriate sampling equipment to provide for the analyzes of pH, total suspended solids, specific conductance, and total organic carbon samples will be iced after collection and transported immediately to AB Analytical Services. Analytical results will be submitted to the Facility Environmental Coordinator and kept on file.

6.3 Record Keeping

The results of the annual inspection will be documented by the Facility Environmental Coordinator and kept on file as required by the Permit. Records will be kept on cleaning of catch basins by Facilities Management.

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CHAPTER 7 CERTIFICATIONS AND SIGNATURES

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

BY: _____

_____

TITLE

_____

DATE

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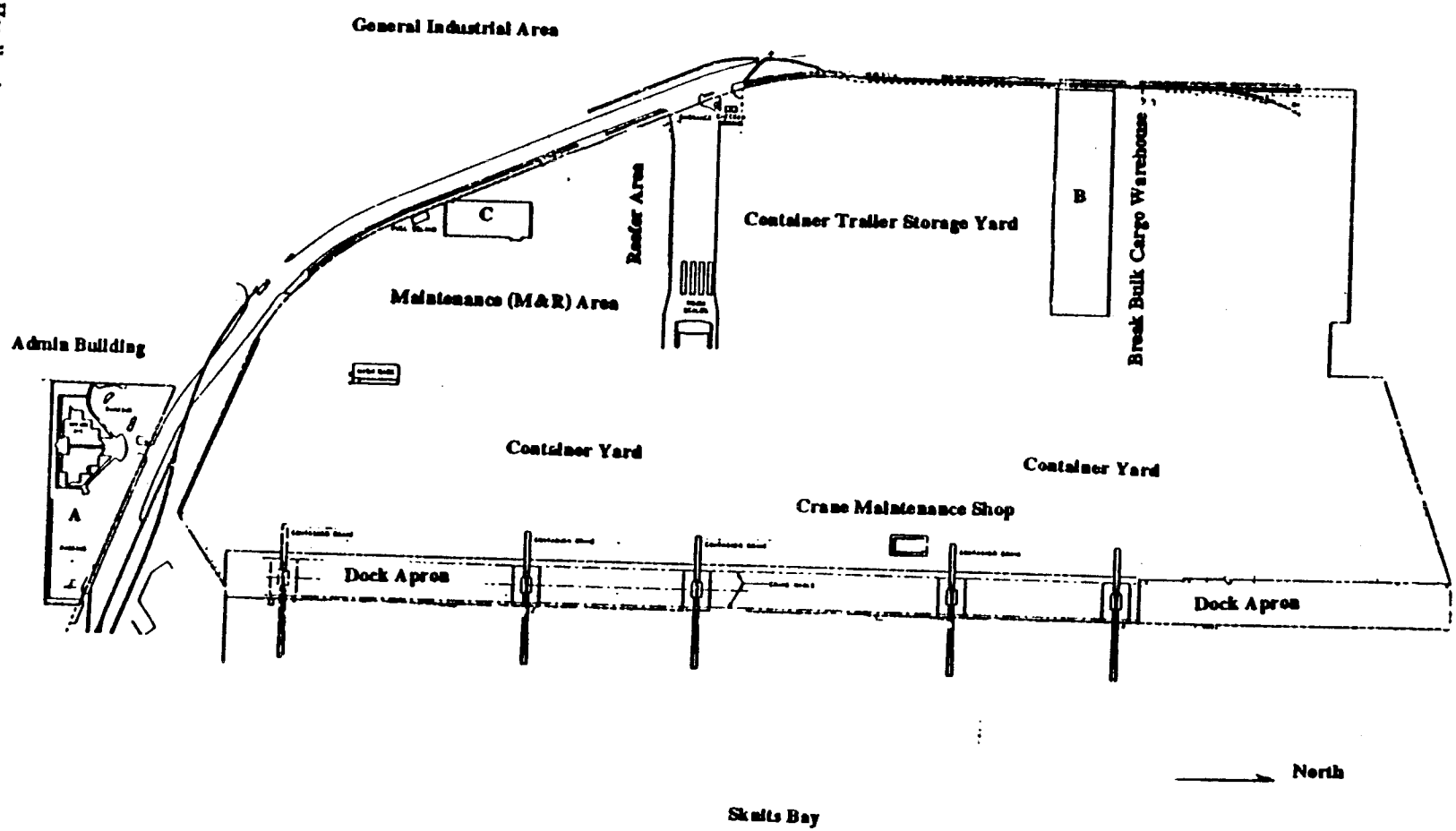

Map 1 F[illegible]ity and General Activities

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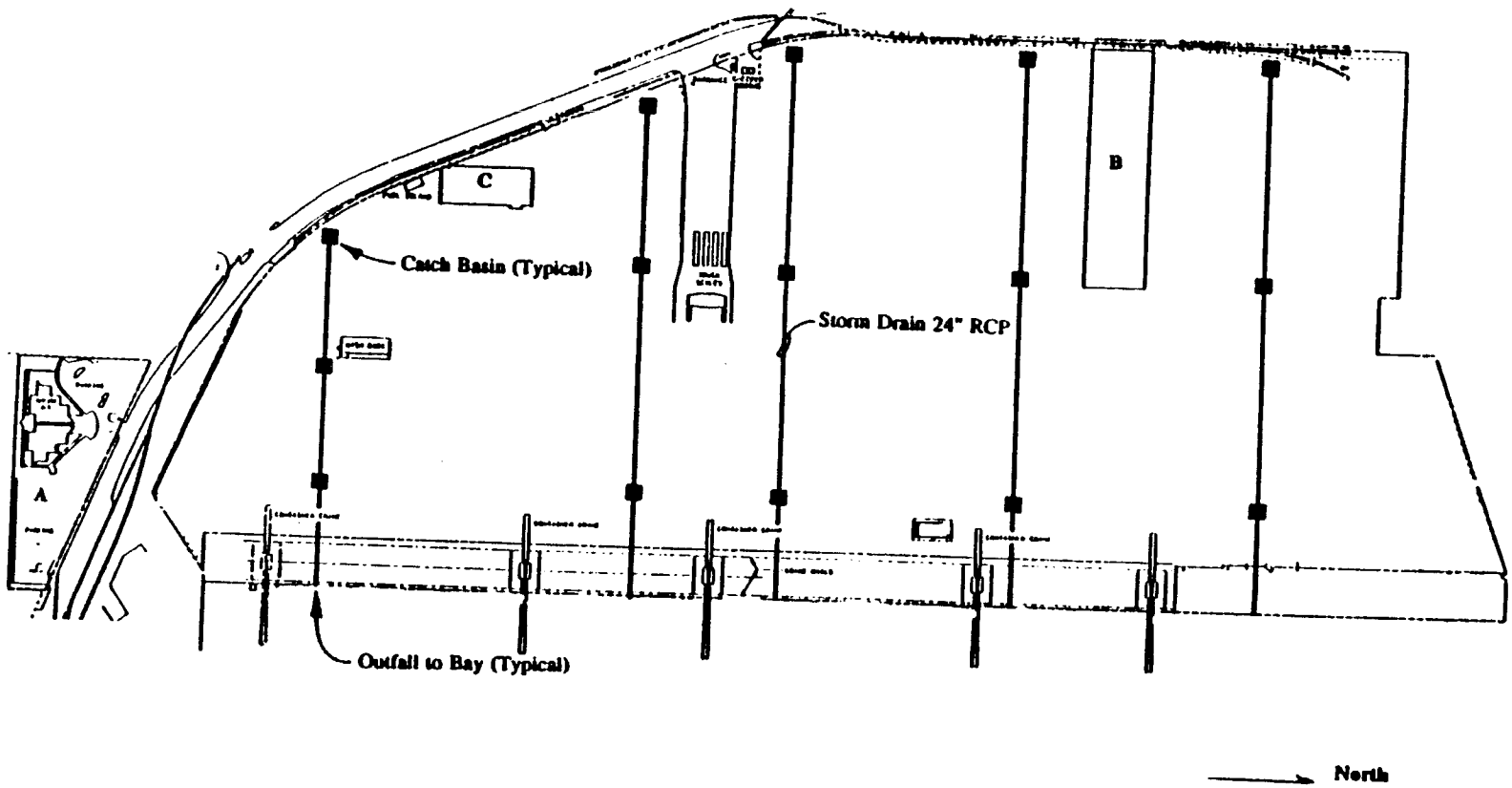

Map 2 Storm Drain System and Outfalls

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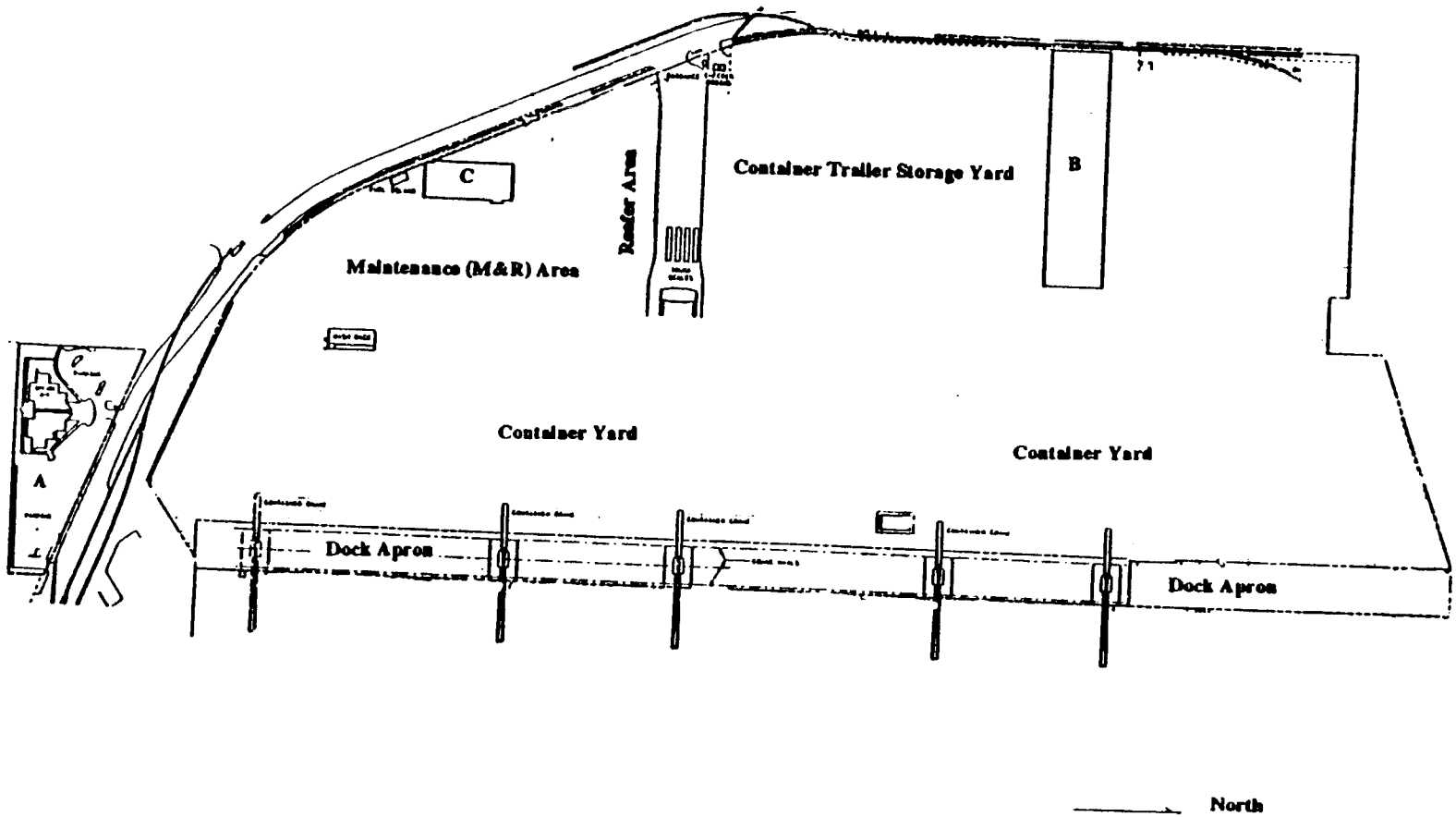

Map 3 Possible Sources of Pollution

R0034831

MATERIAL INVENTORY

(Adopt from EPA, 1992)

Worksheet No. 1
Completed By: L. Smoltz
Title: Environmental Coordinator
Date: 10/15/92

Instructions: List all materials used, stored, or produced onsite. Assess and evaluate these materials for their potential to contribute pollutants to storm water runoff. Also complete Worksheet 3 if the material has been exposed during the last three years.

Material	Purpose/Location	Quantity (units)		Quantity Exposed in Last 3 Years*	Likelihood of contact with storm water.	Past Significant Spill or Leak**	
		Used	Produced			Yes	No
DIESEL #2	Fuel line - Building C, Yard	30,000 Gal.	0	Incidental Drippings	High		X
HYDRAULIC OIL	Engines/Building C	1,000 Gal.	0	0	None		X
ANTI-FREEZE	Engines/Building C	400 Gal.	0	0	None		X
SOLVENTS	Engines/Building C	Recycled	0	o	None		X
BUNKER OIL	Ship/Dockside	Unknown	0	50,000 Gal.	Low	X	
AXLE OIL	Chasses/Building C	400 Gal.	0	0	None		X
BATTERIES	Engines/Building C	12	0	0	None		X
USED ENGINE FLUIDS (ABOVE)	Engines/Building C	1,500 Gal.		0			X
USED ENGINE PARTS/BATTERIES	Engines/Building C	Varies		0	None		

NOTE: All cargo is in containers or packaged inside Building B.

* Explain on separate sheet if quantity was more than the "minimum?"
** Explain items checked yes on a separate sheet.

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MATERIAL INVENTORY

Worksheet No. 2
Completed By: L. Smoltz
Title: Environmental Coordinator
Date: 10/15/92

Instructions: Based on your material inventory, describe the significant materials that were exposed to storm water during the past three years and/or are currently exposed. For the definition of "significant materials" see Appendix B of the manual.

Description of Exposed Significant Material	Period of Exposure	Quantity Exposed (units)	Location (as indicated on the site map)	Method of Storage or Disposal (e.g., pile, drum, tank)	Description of Material Management Practices (e.g., pile covered, drum sealed)
DIESEL #2	WHEN FUELING	SMALL	BUILDING C, YARD	TRUCK	SPILL CLEAN MATERIALS
USED OIL*	WHEN TRANSFERRING	SMALL	BUILDING C	DRUM UNDER COVER	ENCLOSED STORAGE
USED ANTIFREEZE*	WHEN TRANSFERRING	SMALL	BUILDING C	DRUM UNDER COVER	ENCLOSED STORAGE
USED SOLVENT*	WHEN TRANSFERRING	SMALL	BUILDING C	DRUM UNDER COVER	ENCLOSED STORAGE
HYDRAULIC OIL*	WHEN TRANSFERRING	SMALL	BUILDING C	DRUM UNDER COVER	ENCLOSED STORAGE
BUNKER OIL	WHEN FUELING	SUBSTANTIAL	DOCK APRON	N/A	SPCC
AXLE OIL	SERVICING	SMALL	TRAILER YARD	DRUMS UNDER COVER	SPILL CLEAN-UP MATERIALS
WASH DEBRIS	WHEN WASHING	SIGNIFICANT	WASH RACK	DUMPSTER	SWEEP AREA

* Material stored under cover and only exposed to storm water during transferring operations.

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SPILLS INVENTORY

(Adopt from EPA, 1992)

Worksheet No. 3
Completed By: *L. Smoltz*
Title: *Environmental Coordinator*
Date: *10/15/92*

Instructions: Record below all significant spills and significant leaks of toxic or hazardous pollutants that have occurred at the facility in the three years prior to the effective date of the permit.

Definitions: Significant spills include, but are not limited to, releases of oil or hazardous substances in excess of reportable quantities.

1st Year Prior *SPCC Implemented to control spill of bunker oil*

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		

2nd Year Prior

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		
10/12/92	*X*		*Dock Apron*	*Bunker Oil*	*20 gal.*	*Oil Tank*	*Ruptered Tank*	*Absorbents, Clean-up*	*Develop SPCC*

3rd Year Prior *None Recorded*

Date (month/day/year)	Check Box		Location (as indicated on site map)	Description				Response Procedure	Preventive Measures Taken
	Spill	Leak		Type of Material	Quantity	Source, If Known	Reason		

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WORKSHEET #4
ACTIVITIES ASSESSMENT CHECKLIST

Name of Reviewer: L. SMOLTZ

Date: 10/12/92

ACTIVITIES - Check each activity present at site	EFFECTIVENESS		
	HIGH	MOD.	LOW
☐ Non-storm water discharges to drains. Describe BMPs in place: WASH WATER FROM WASH RACK CONNECTED TO STORM DRAIN			✓
☒ Vehicle and equipment fueling. Describe BMPs in place: SPILL CLEAN UP MATERIALS AVAILABLE		✓	
☒ Vehicle and equipment washing and steam cleaning. Describe BMPs in place: SWEEP AREA EACH DAY			✓
☒ Vehicle and equipment maintenance and repair. Describe BMPs in place: PROPER HAZARDOUS WASTE STORAGE, SOLVENT RECYCLED, PROPER STORAGE OR FRESH FLUIDS	✓		
☒ Outdoors loading/unloading of liquid materials. Describe BMPs in place: LIQUIDS ARE STORED IN CONTAINERS	✓		
☒ Outdoor container storage of liquids. Describe BMPs in place: LIQUIDS ARE STORED IN CONTAINERS	✓		
☐ Outdoor process equipment operations and maintenance. Describe BMPs in place:			
☐ Outdoor storage of raw materials, products and byproducts. Describe BMPs in place:			
☒ Waste handling and disposal. Describe BMPs in place: M&R SHOP, SEE ABOVE			
☐ Contaminated or erodible surface areas. Describe BMPs in place:			
☒ Building and grounds maintenance. Describe BMPs in place: NONE IN PLACE			
☒ Building repair, remodeling, and construction. Describe BMPs in place: NONE IN PLACE			
☐ Over-water activities. Describe BMPs in place: SPCC PLAN	✓		

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WORKSHEET #5
CHECKLIST FOR CONSIDERATION OF MINIMUM BMPs

Check which of the following describe your facility.

Name of Reviewer: L. SMOLTZ AND COMMITTEE | Date: 10/15/92

Yes	No	N/A	
☒	☐	☐	Are outside areas kept neat and clean?
☒	☐	☐	Is the facility orderly and neat?
☒	☐	☐	Is process debris removed regularly?
☒	☐	☐	Is the area clear of excessive dust from industrial operations?
☐	☒	☐	Is there no evidence of leaks and drips from equipment and machinery? MINOR SPILLS NOTICED IN YARD, ABSORBENT MATERIAL USED.
☒	☐	☐	Are employees regularly informed of the importance of good housekeeping?
☐	☒	☐	Are catch basins, storm conveyance pipes, and storm water treatment facilities cleaned at the appropriate intervals (see Chapter 5)?
☐	☒	☐	Are good housekeeping procedures and reminders posted in appropriate locations?
☒	☐	☐	Are vehicle maintenance activities kept indoors and do not tend to "creep" out the front door of the maintenance shop? LARGE EQUIPMENT AND REEFERS SERVED OUTDOORS.
☒	☐	☐	Are containers for chemical substances and for temporary storage of wastes labeled?
☐	☒	☐	Is vehicle and equipment washing done in a designated area so that the wash water can be discharged to the sanitary or process wastewater sewer? YES, BUT NOT CONNECTED.
☒	☐	☐	Are regular housekeeping practices carried out?
☒	☐	☐	Is there a spill prevention and response team?
☒	☐	☐	Are appropriate spill containment and cleanup materials kept on-site and in convenient locations?
☒	☐	☐	Are cleanup procedures for spills followed regularly and correctly?
☒	☐	☐	Are used absorbent materials removed and disposed in a timely manner?
☒	☐	☐	Are personnel regularly trained in the use of spill control materials?
☐	☐	☒	Is exposed piping and process equipment regularly inspected and/or tested to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters?
☐	☐	☒	Are drainage ditches or the areas around the outfall(s) free of erosion?
☐	☐	☒	Are unpaved outdoor areas protected from water or wind erosion?

Any items checked "No" require consideration in the selection of BMPs.
N/A = Not Applicable.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH INDUSTRIAL ACTIVITY (WQ Order Nos. (91-13-DWQ & 92-12-DWQ)
(Excluding Construction Activities)

EXAMPLE

MARK ONLY ONE ITEM: 1. ☒ Existing Facility 2. ☐ New Facility 3. ☐ Change of Information
WDID # ☐☐☐☐☐☐☐☐☐☐☐

I. OWNER/OPERATOR

Name: Leadam Stevedore Co.
Mailing Address: 222 Howard Avenue
City: Oakland State: CA Zip: 99999-0000 Phone: 510-946-2273
Contact Person: L. Bass

A. Owner/Operator Type (Check one): 1. ☐ City 2. ☐ County 3. ☐ State 4. ☐ Federal 5. ☐ Special District 6. ☐ Gov. Combo 7. ☒ Private

B. 1. ☐ Owner 2. ☒ Operator 3. ☐ Owner/Operator

II. FACILITY/SITE INFORMATION

Facility Name: Skuits Bay Facility
Street Address: 101 Next-to-the-Bay
City: Oakland State: CA Zip: 99999-0000 Phone: 510-931-2273
County: Alameda
Contact Person: L. Smoltz

III. BILLING ADDRESS

Send to:
☐ OWNER/OPERATOR
☒ FACILITY
☐ OTHER (Enter information at right)

Name: Skuits Bay Facility
Mailing Address: 101 Next-to-the Bay
City: Oakland State: CA Zip: 99999-0000

IV. RECEIVING WATER INFORMATION

A. Does your construction site's storm water discharge to (Check one)
1. ☐ Storm drain system - Enter system owners name
2. ☒ Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water: Skuits Bay

STATE USE ONLY

WDID | Regional Board Office | Date Permit Issued
NPDES Permit Number | Order Number | Fee Amount Received $ | Date NOI Received

NOI-1 (10/15/92)

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V. INDUSTRIAL INFORMATION

A. SIC Code(s) 1. 4419 2. 3. 4.

B. Type of Business: Cargo Loading & Unloading

C. Industrial activities at facility (Check all that apply)

1. ☐ Manufacturing
2. ☒ Vehicle Maintenance
3. ☐ Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4. ☒ Material Storage
5. ☐ Vehicle Storage
6. ☒ Material Handling
7. ☐ Wastewater Treatment
8. ☐ Power Generation
9. ☐ Recycling
10. ☐ Landfill
99. ☐ Other: _____

VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors (Check all that apply)

1. ☒ Solvents
2. ☐ Scrap Metal
3. ☒ Petroleum Products
4. ☐ Plating Products
5. ☐ Pesticides
6. ☐ Hazardous Wastes
7. ☒ Paints
8. ☐ Wood Treating Products
99. ☐ Other (Please list)

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges (Check all that apply)

1. ☒ Oil/Water Separator
2. ☒ Containment
3. ☐ Berms
4. ☐ Leachate Collection
5. ☒ Overhead Coverage
6. ☒ Recycling
7. ☐ Retention Facilities
8. ☐ Chemical Treatment
99. ☐ Other (Please list)

VII. FACILITY INFORMATION

A. Total size of site (Check one): 1.25 ☒ Acres ☐ Sq. Ft.

B. Percent of site impervious (including rooftops): 100 %

VIII. REGULATORY STATUS (Check all that apply)

A. ☐ Regulated by Storm water Effluent Guidelines (40 CFR Subchapter N)

B. ☐ Waste Discharge Requirements (Order Number)

C. ☐ NPDES Permit CA

D. ☐ RCRA Permit Number

E. ☐ Regulated by California Code of Regulations Article 6, Chapter 15 (Feedlots).

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: Lee Smoltz

Signature: Lee Smoltz

Title: Environmental Coordinator

Date: 11/1/92

FOR0065R4

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APPENDIX D

UNIT CONTROL VOLUMES

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APPENDIX D

Appendix D is used for sizing infiltration facilities (TC 1) and extended detention basins (TC 5). The sizing criteria was determined using the Storage, Treatment, Overflow, Runoff Model (STORM) as developed by the U.S. Corp of Engineers. STORM was applied to long-term, hourly rainfall data at fifteen (15) rain gauges across the State. Based on this analysis nine gauges were selected as being representative for sizing detention storage facilities (see Figure D.1). Zones were drawn to reflect these nine gauges taking into consideration rainfall data and topography. The sizing curves should apply to most areas within each zone. However, the zone boundaries are approximate and certain areas within each zone will be strongly influenced by topographic features.

Each sizing curve was developed using the following parameters:

- A drawdown time from the entire storage volume of 40 hours. This drawdown time allows quiescent conditions to establish in the basin, resulting in at least 80% sediment removal for most soils in California.
- Initial abstraction/depression storage on impervious surface of 0.06 inch.
- Runoff coefficient of 0.9 for impervious surfaces and 0.15 for pervious surfaces.

Appendix D may be used in the following manner:

1. Identify the appropriate zone for your location from Figure D.1 and Table D.I and then select the appropriate detention storage figure for your zone.
2. Determine for the drainage area the percentage of impervious area directly connected to the storm drain system. Directly connected impervious area (DCIA) is defined as the area covered by pavement, building, and other impervious surfaces which drain directly into the storm drain without first flowing across pervious areas (e.g. lawns).
3. Choose a capture goal, and read the required unit volume required for the basin. In selecting the capture goal consider the requirements of the local municipality or a point at the "knee of the curve". Once the capture goal has been established draw a horizontal line from the capture goal to the appropriate DCIA curve, then a vertical line to the unit storage volume.
4. Multiply the unit volume times the total acreage of the drainage area and convert to acre-feet or cubic feet.

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GENERAL ZONES WITHIN CALIFORNIA FOR SELECTING DETENTION/INFILTRATION SIZING CURVES

ZONE	AREA	GAGE
1	Inland Empire: Western San Diego, Riverside, San Bernardino Counties	Riverside City Experimental Station (#7473)
2	Mojave Desert: Eastern San Diego, Riverside, San Bernardino, Los Angeles, Kern Counties	Thermal Airport - Federal Aviation Administration (#8892) and Fire Station 39 (#8893)
3	Southern Coastal: Los Angeles, Orange, Ventura Counties	Los Angeles International Airport - Weather Service Office (#5114)
4	Central and Northern Coastal: Santa Barbara, San Luis Obispo, Monterey, Santa Cruz, Santa Clara, San Mateo, San Francisco, Alameda, Contra Costa, Western Solano, Napa, Marin, Sonoma, Mendocino, Trinity and Humboldt Counties	Oakland Airport - Weather Service Office (#6335)
5	Southern Central Valley: Kern County	Bakersfield Airport - Weather Service Office (#442)
6	Mid-Central Valley: Kings, Western Fresno, Western Tulare, Western Madera, Merced, and Mariposa Counties	Fresno Airport - Weather Service Office (#3257)
7	North Central Valley: Stanislaus, San Joaquin, Sacramento, Eastern Solano, Yolo, Colusa, Lake, Glenn, Tehama, Butte, Western Nevada, and Yuba Counties	Sacramento - Weather Service Office (#7633)
8	Owens Valley: Mono and Inyo Counties	Bishop Airport - Weather Service Office (#822)
9	Sierra: Del Norte, Siskiyou, Modoc, Shasta, Lassen, Plumas, Sierra, Eastern Nevada, Placer, El Dorado, Amador, Calaveras, Tuolume, Mariposa, Eastern Madera, Eastern Fresno, and Eastern Tulare Counties	Truckee (#9043)

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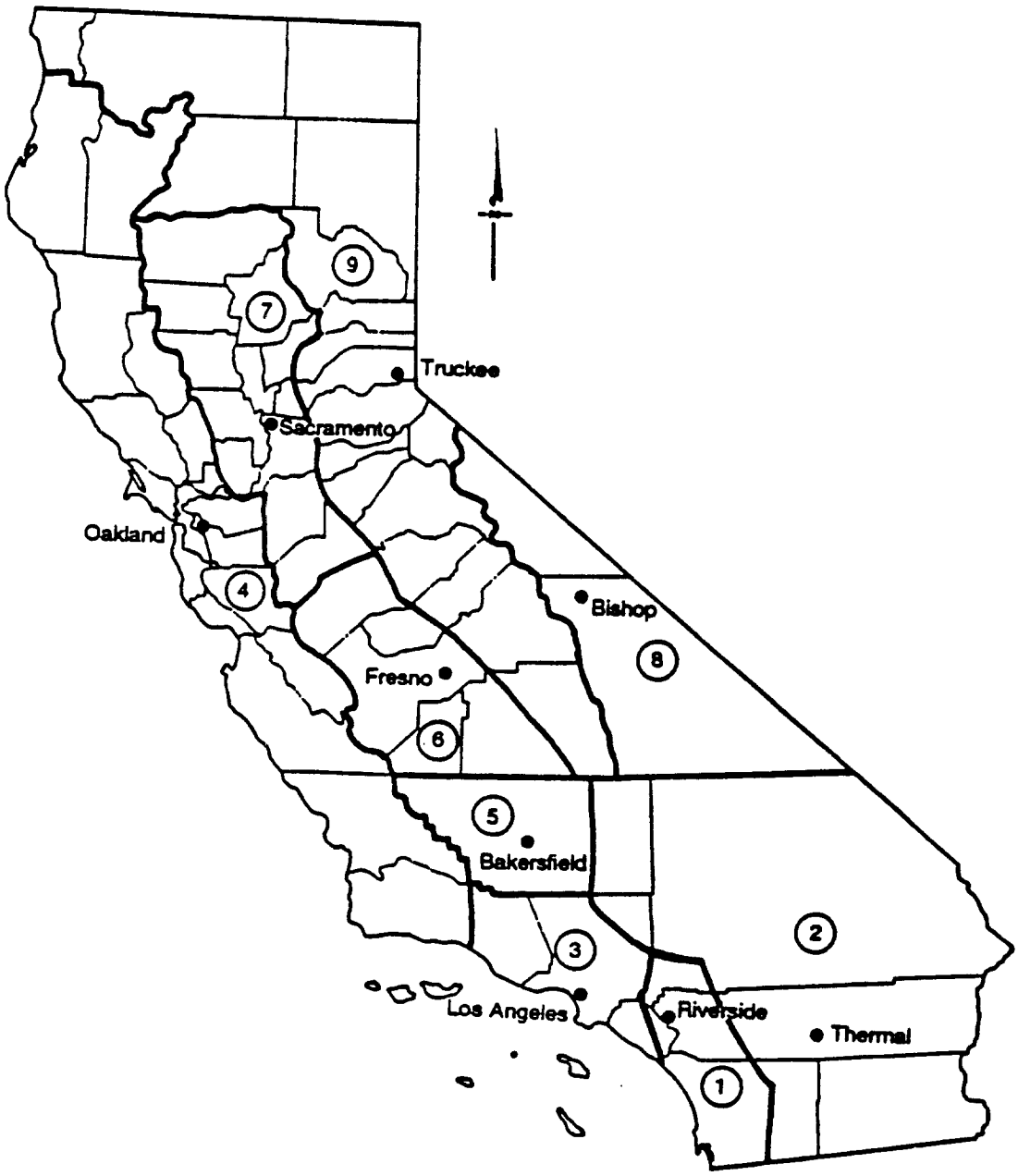

FIGURE D1. LOCATIONS OF RAIN GAGES USED FOR SIZING DETENTION/ INFILTRATION BASINS

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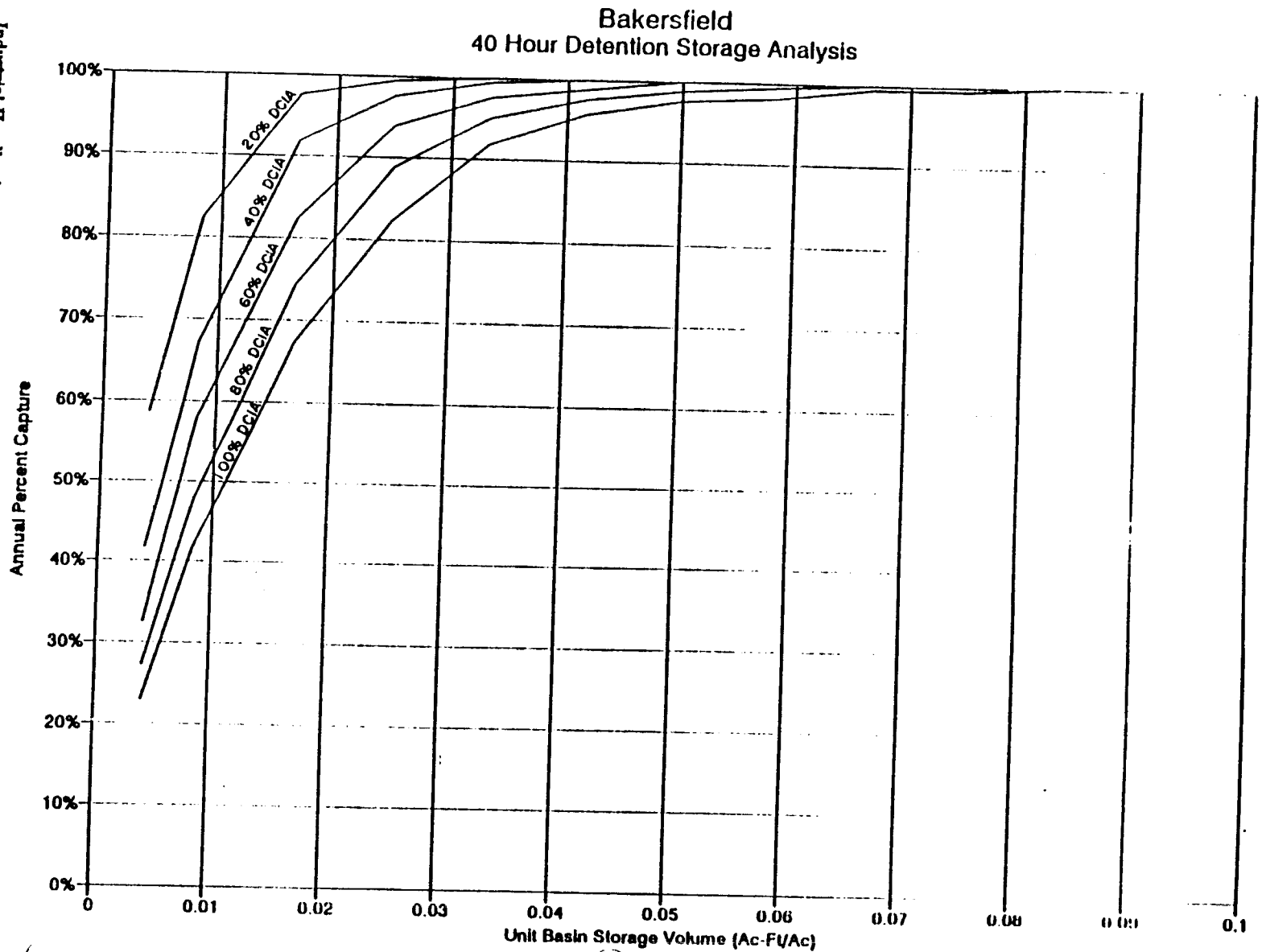
Bakersfield
40 Hour Detention Storage Analysis
Annual Percent Capture
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20% DCIA
40% DCIA
60% DCIA
80% DCIA
100% DCIA
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Unit Basin Storage Volume (Ac-Ft/Ac)

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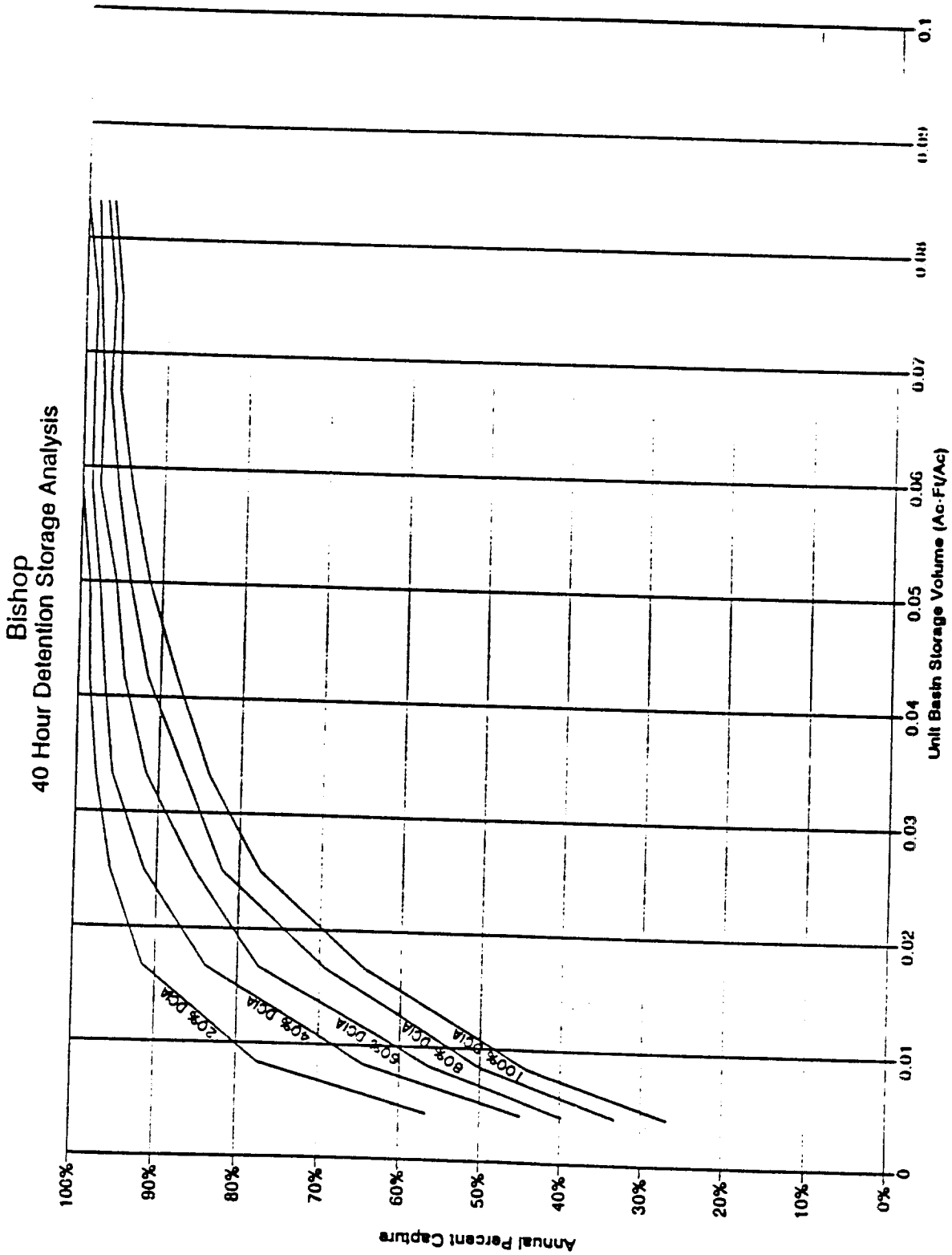

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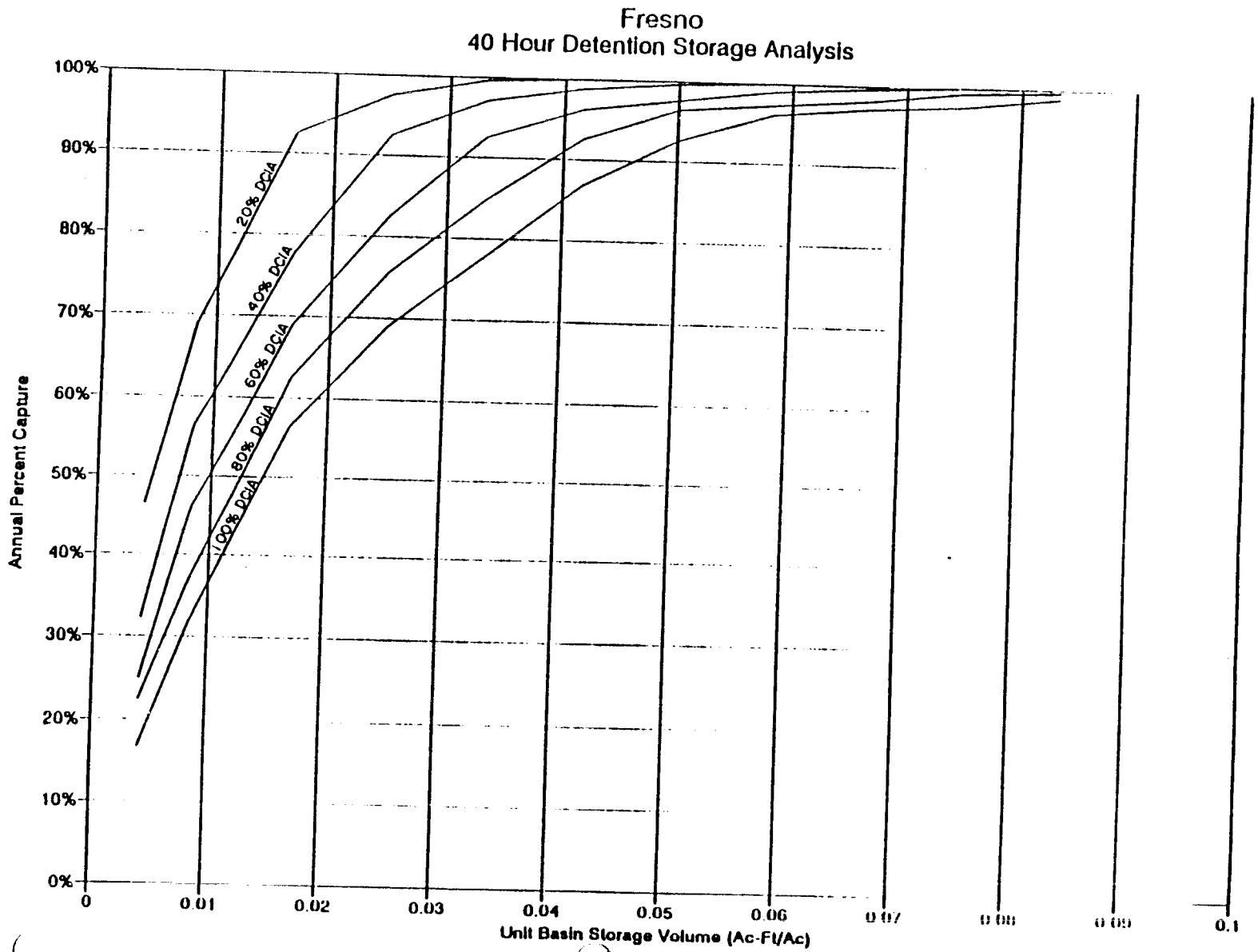
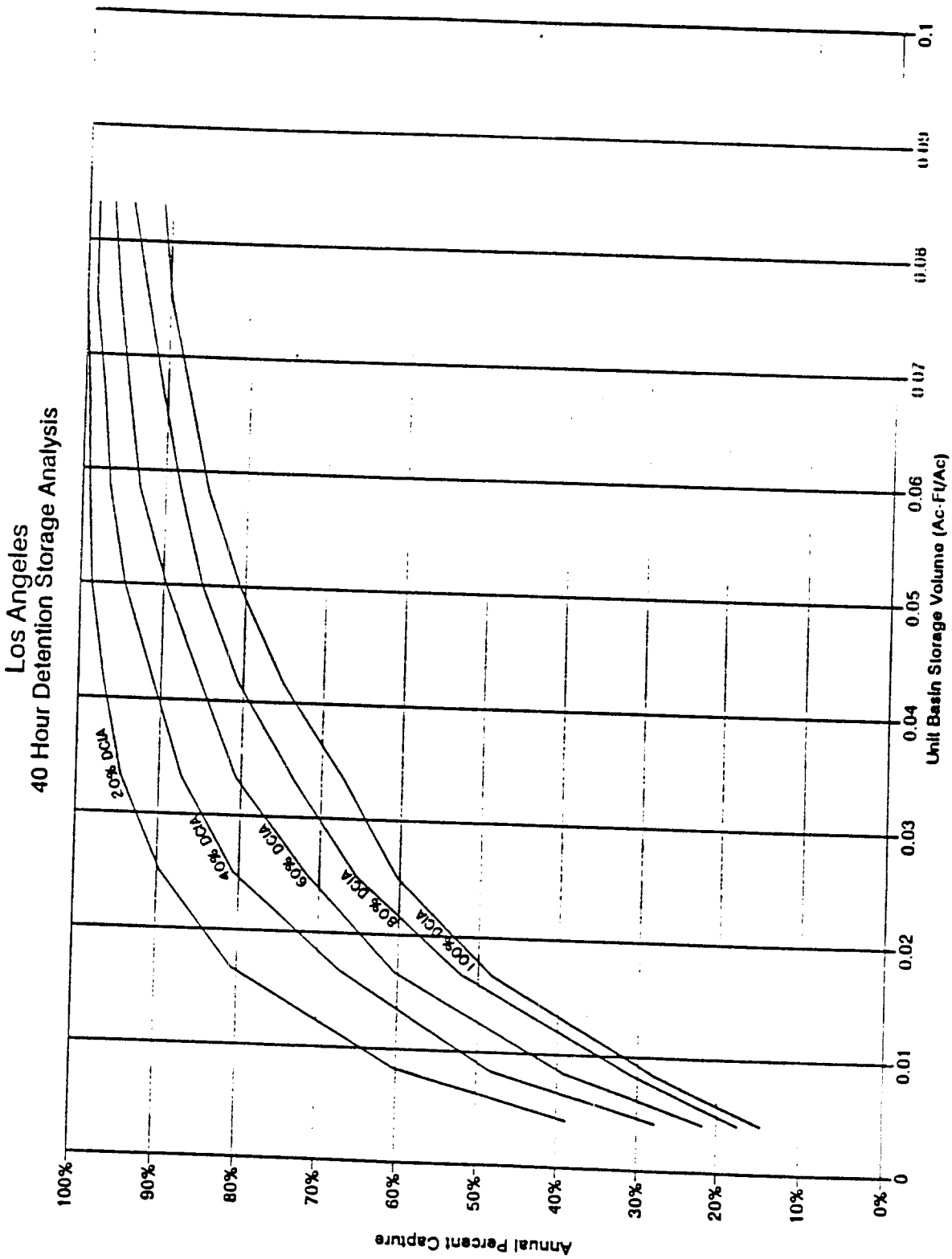

Fresno
40 Hour Detention Storage Analysis
Annual Percent Capture
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20% DCIA
40% DCIA
60% DCIA
80% DCIA
100% DCIA
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Unit Basin Storage Volume (Ac-Ft/Ac)



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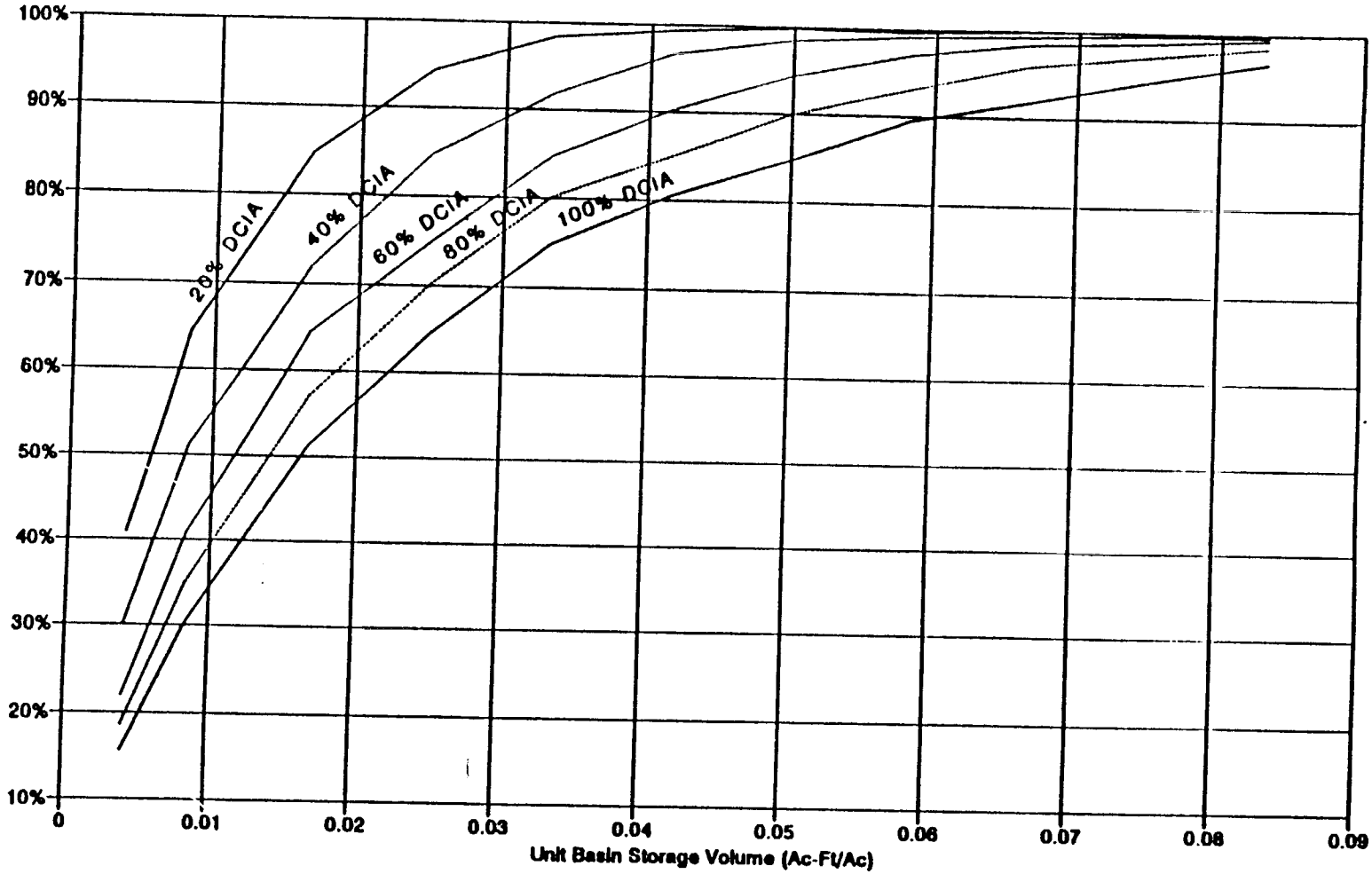
Oakland WSO Airport
40 Hour Detention Storage Analysis



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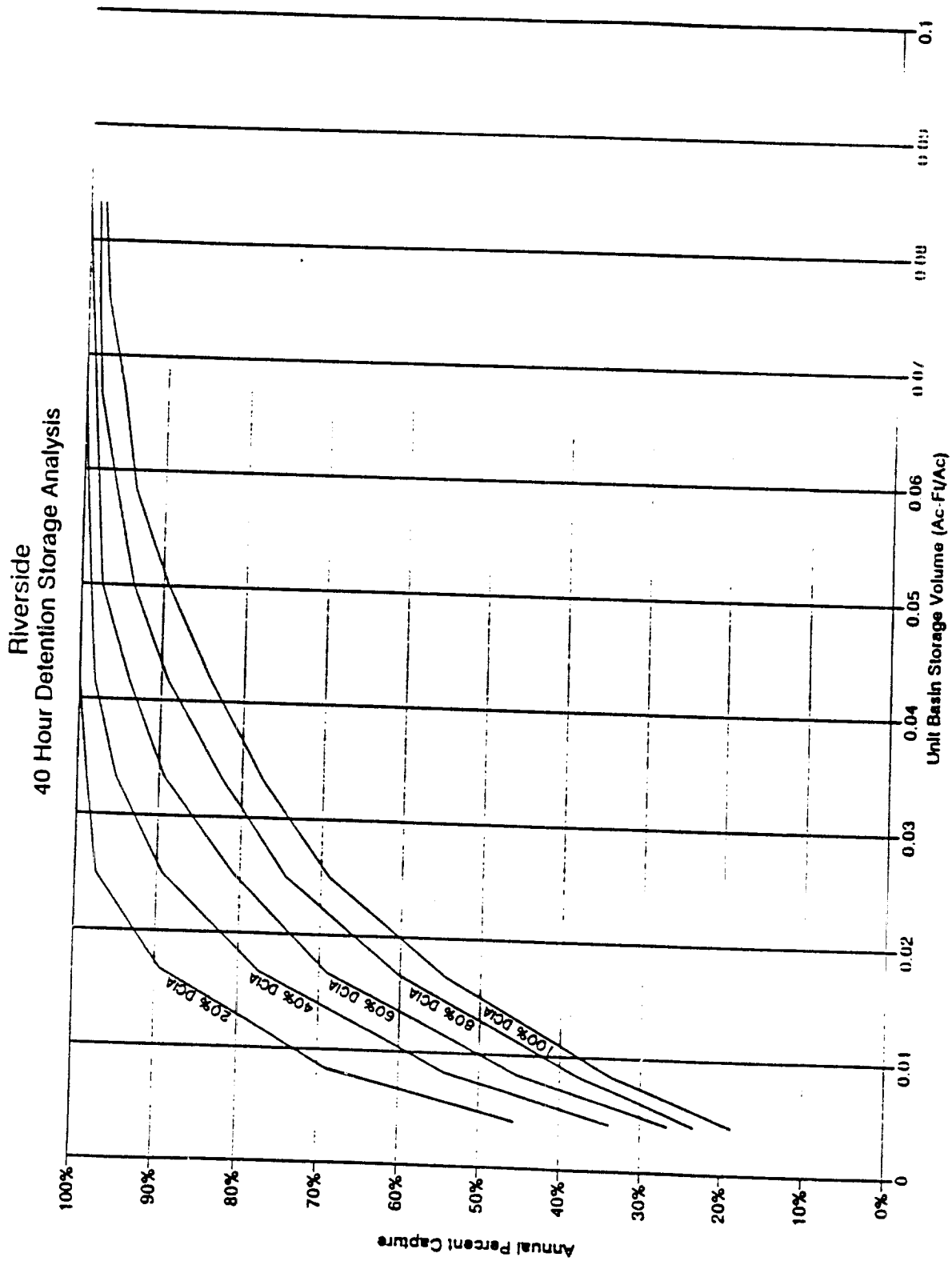

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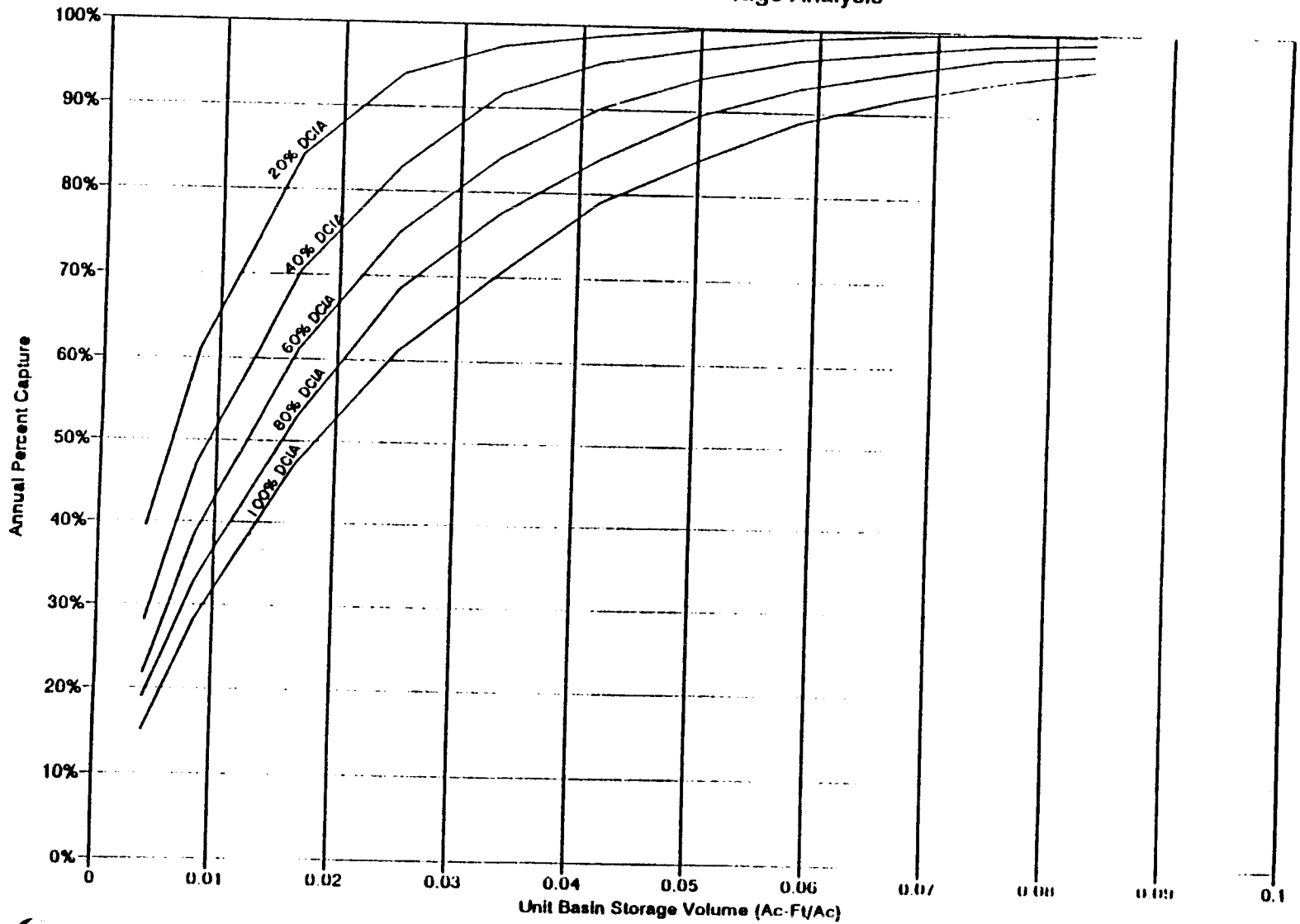
Sacramento
40 Hour Detention Storage Analysis



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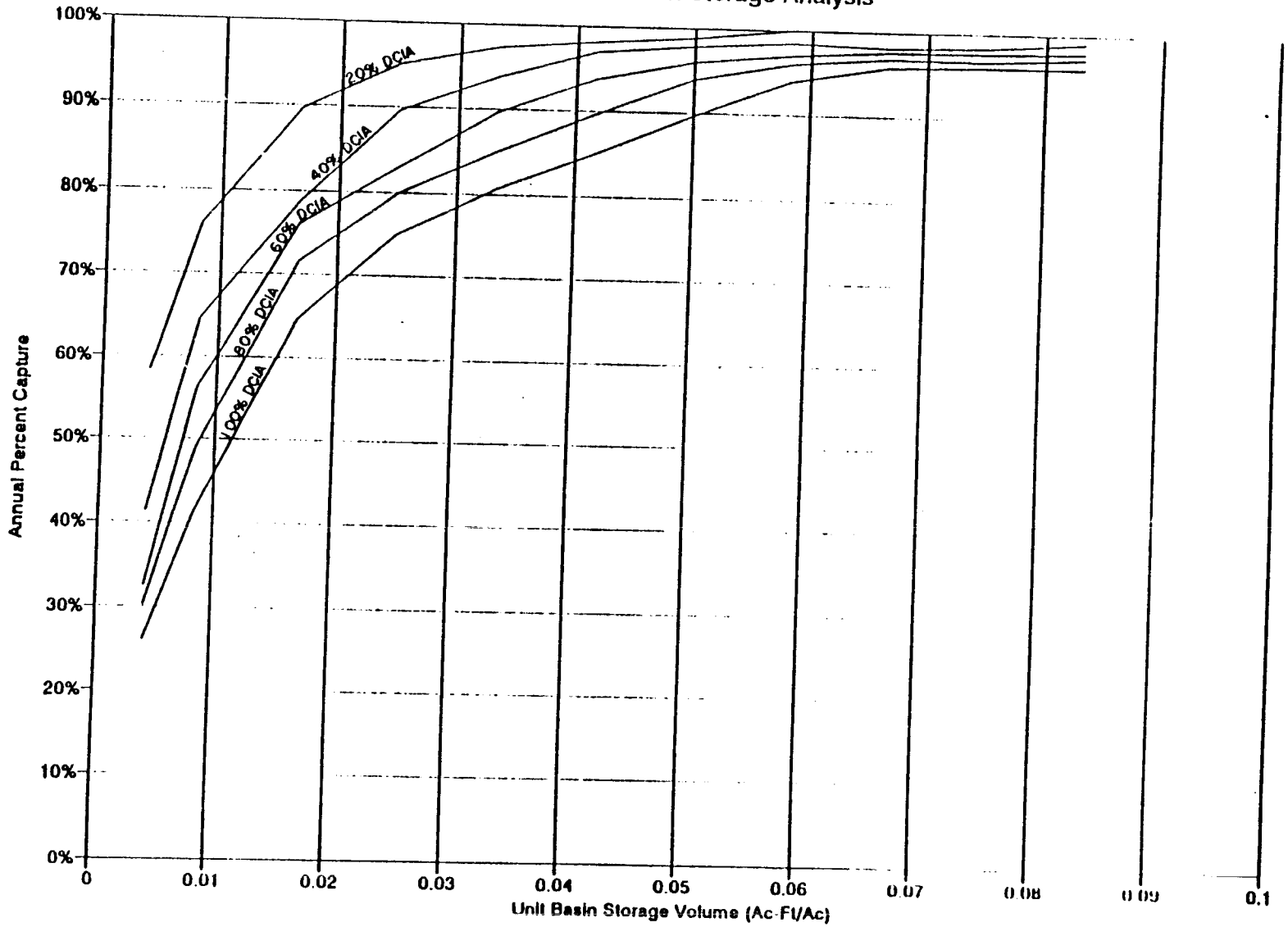

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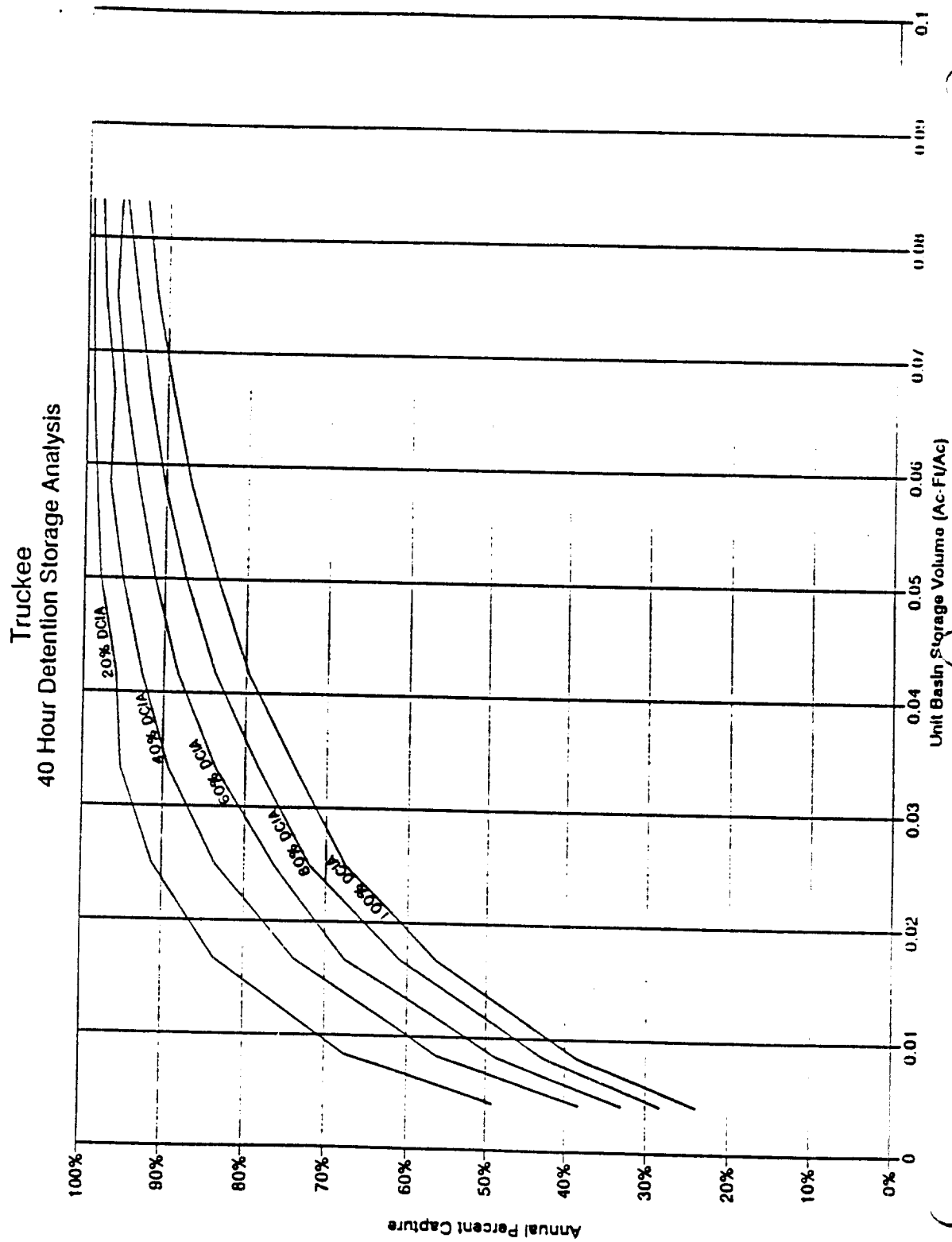

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APPENDIX E

GLOSSARY

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APPENDIX E

GLOSSARY

Best Management Practices (BMPs): Includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Catch Basin: Box-like underground concrete structure with openings in curbs and gutters designed to collect runoff from streets and pavement.

Conduit: Any channel or pipe for directing the flow of water.

Culvert: A covered channel or a large-diameter pipe that directs water flow below the ground level.

Discharge: A release or flow of storm water or other substance from a conveyance system or storage container.

Effluent Limits (numeric effluent limits): Limitations on amounts of pollutants that may be contained in effluents. Can be expressed in a number of ways including as a concentration, as a concentration over a time period (e.g., 30-day average must be less than 20 mg/l) or as a total mass per time unit.

Facility: Is a collection of industrial processes discharging storm water associated with industrial activity within the property boundary or operational unit.

Industrial General Permit: A National Pollutant Discharge Elimination System (NPDES) permit issued by the State Water Resources Control Board for the discharge of storm water associated with industrial activity.

Inlet: An entrance into a ditch, storm sewer, or other waterway.

Illegal Discharges: Any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges authorized by an NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire-fighting activities.

Land Application: Refers to the application of wastewater, or storm water to agricultural land.

Non-Storm Water Discharge: Any discharge to municipal separate storm sewer that is not composed entirely of storm water. Discharges containing process wastewater, non-contact cooling water, or sanitary wastewater are non-storm water discharges.

Nonpoint Source Pollution: Pollution that does not come from a point source. Nonpoint

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source pollution originates from aerial diffuse sources that are mostly related to land use.

Outfall: The end point where storm drains discharge water into a waterway.

Point Source: Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Generally any substance introduced into the environment that adversely affects the usefulness of a resource.

Precipitation: Any form of rain or snow.

Pretreatment: Treatment of wastewater before it is discharged to a wastewater collection system.

Process Wastewater: Wastewater that has been used in one or more industrial processes.

Reclaim (water reclamation): Planned use of treated effluent that would otherwise be discharged without being put to direct use.

Reuse (water reuse): (see Reclaim)

Runoff: Water originating from rainfall and other precipitations (e.g., sprinkler irrigation) that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, wetlands, and shallow groundwater.

Runon: Storm water surface flow or other surface flow which enters property other than that where it originated.

Significant Materials: Includes, but not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designed under Section 101(14) of CERLCA; any chemical the facility is required to report pursuant to Section 313 of Title III or SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Significant Quantities: Is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance, that adversely impact human health or the environment, and cause or contribute to a violation of any applicable water quality standards for the receiving water.

Source Control BMPs: Operational practices that prevent pollution by reducing potential pollutants at the source.

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Source Reduction (also source control): The technique of stopping and/or reducing pollutants at their point of generation so that they do not come into contact with storm water.

Storm Drains: Above and below ground structures for transporting storm water to streams or outfalls for flood control purposes.

Storm Water: Storm water runoff, snow melt runoff, surface runoff, and drainage. It excludes infiltration.

Storm Water Discharge Associated with Industrial Activity: Discharge from any conveyance which is used for collecting and conveying storm water which is directly related to manufacturing processing or raw materials storage areas at an industrial plant [see 40 CFR 122.26(b)(14)].

Treatment Control BMPs: Treatment methods to remove pollutants from storm water.

Toxicity: Poisonous.

Turbidity: Describes the ability of light to pass through water. The cloudy appearance of water caused by suspended and colloidal matter (particles).

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APPENDIX F

LIST OF ACRONYMS

APPENDIX F

LIST OF ACRONYMS

AIMP	Impervious Area
AINF	Infiltration Area
APWA	American Public Works Association
BAT	Best Available Technology (economically available)
BCT	Best Conventional Technology (pollution control)
BMPs	Best Management Practices
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Register
CPI	Coalescing Plate Interceptor
CWA	Clean Water Act (Federal Water Pollution Control Act of 1972 as amended in 1987)
DCIA	Directly Connected Impervious Area
DTSC	California Department of Toxic Substances Control
FHWA	Federal Highways Authority
Hazmat	Hazardous Material
O&M	Operations and Maintenance
MSDS	Material Safety Data Sheet
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAHs	Polyaromatic Hydrocarbons
POTW	Publicly Owned Treatment Works
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SIC	Standard Industrial Classification
SPCC	Spill Prevention Control and Countermeasure
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TSS	Total Suspended Solids
UFC	Uniform Fire Code
USEPA	United States Environmental Protection Agency

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APPENDIX G

DISTRIBUTION LIST, POLLUTION PREVENTION INFORMATION CLEARINGHOUSE

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Pollution Prevention Information Clearinghouse

Distribution List, February 1993

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Environmental Protection Agency
401 M. St., SW, PM-211A
Washington, D.C. 20460

PPIC Hotline
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PPIC Fax Line
202-260-0178

This list is a compilation of documents distributed by the PPIC. The Clearinghouse is a distribution point for EPA documents and fact sheets dealing with source reduction and recycling. It provides a referral service for pollution prevention questions. Information on waste minimization and the treatment of hazardous waste is available from the RCRA/ Superfund Hotline (800-424-9346).

Order documents by checking them on the list below. You can mail this form to the PPIC, call the hotline, or fax requests to the numbers shown above. The following EPA documents or fact sheets are provided at no cost, but **PLEASE LIMIT YOUR REQUEST TO A TOTAL OF 10 ITEMS.** Allow 4 weeks for delivery.

DOCUMENTS OF INTEREST

___ Environmental Protection Agency, Environmental Leadership Program; Proposed Establishment, January 15, 1993 58 FR 4802

___ Pollution Information Exchange System (PIES) Users Guide, Version 2.1

___ Total Cost Assessment: Accelerating Industrial Pollution Prevention Through Innovative Project Financial Analysis, with applications to the pulp and paper industries EPA/741/R-92/002

EPA DOCUMENTS

___ Assessing the Environmental Consumer Market
EPA 21P-1003

___ Case Studies from the Minnesota Technical Assistance Program and the Hazardous Waste Reduction Program of Oregon: Metal Finishing

___ Case Studies from the Pollution Prevention Clearinghouse: Electroplating

___ Case Studies from the Pollution Prevention Clearinghouse: Solvent Recovery

___ Directory of State and Local Pollution Prevention Programs: National Roundtable of State Pollution Prevention Programs

___ The Environmental Challenge of the 1990's: Proceedings
EPA/600/9-90/039

___ Federal Environmental Statutes Possibly Affecting the Commercial Printing Industry

___ Guidelines for Waste Reduction and Recycling: Metal Finishing, Electroplating, Printed Circuit Board Manufacturing

___ Guidelines for Waste Reduction and Recycling: Solvents

___ The Next Environmental Policy: Pollution Prevention

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___ Pollution Prevention Benefits Manual: Vol. I Phase II, The Manual

___ Pollution Prevention Case Studies Compendium
EPA/600/R-92/046

___ Pollution Prevention Guidance Manual for the Dye Manufacturing Industry
EPA/741/B-92/001

___ Pollution Prevention in Metal Manufacturing: Saving Money through Pollution Prevention (October 1989)
EPA/530/SW-89/056

___ Pollution Prevention Options in Metal Fabricated Products Industries: A Bibliographic Report

___ Pollution Prevention Options in Wood Furniture Manufacturing: A Bibliographic Report

___ Pollution Prevention Plan - Report to Congress
EPA/600/9-90/015

___ Pollution Prevention Quarterly Progress Report

___ Pollution Prevention Research Branch; Current Projects (January, 1991)

___ Pollution Prevention Research Plan (March 1990)
EPA/600-90/015

___ Pollution Prevention Resources and Training Opportunities in 1992
EPA/560/8-92/002

___ Pollution Prevention Through Compliance and Enforcement: A Review of OPTS Accomplishments
22T-1002

___ Profiting from Waste Reduction in Your Small Business

___ Promoting Source Reduction and Recyclability in the Marketplace
EPA/530/SW-89/066

___ Report on the US Environmental Protection Agency Pollution Prevention Program

___ Senior Policy Council: Pollution Prevention 1992 Annual Report

___ Waste Minimization in Metal Parts Cleaning
EPA/530/SW-89/049

___ Waste Minimization Opportunity Assessment Manual
EPA/625/7-88/003

EPA FACT SHEETS

___ ACE: Agriculture in Concert with the Environment - 2/91

___ Design for the Environment: Chemical Design Project

___ Design for the Environment: Cleaner Technology for a Safer Future

___ Design for the Environment: Dry Cleaning Project

___ Design for the Environment: Printing Project

___ EPA's 33/50 Program - 8/91

___ EPA's 33/50 Program: Forging and Alliance for Pollution Prevention - 8/91

___ EPA's Pollution Prevention Enforcement Settlement Strategy - 8/91

___ EPA's Pollution Prevention Incentives for States - Summer '90

___ EPA's Pollution Prevention Strategy - 3/91

___ Guides to Pollution Prevention - 3/91

___ Local Governments and Pollution Prevention - 3/91

___ National Pollution Prevention Center for Higher Education - 10/91

___ National Pollution Prevention Environmental Education Project - 10/91

___ New Form R Reporting Requirements - 8/91

___ Pollution Prevention Act of 1990 - 3/91

___ Pollution Prevention Grant Programs - 8/91

___ Pollution Prevention Information Clearinghouse - 3/91

___ Prevention Pollution Through Efficient Water Use - 7/90

___ Pollution Prevention Training and Education - 3/91

___ Recent Publications - Summer 1990

___ Setting up a Pollution Prevention Program - 3/90

___ Source Reduction Review Project - 3/92

___ You Can Make a Difference - 1/90

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FACT SHEETS

The following are a series of fact sheets written by state and regional organizations concerning relevant industries within their area of expertise. They have not been reviewed or approved by the Agency. Each category listed below contains numerous fact sheets.

___ GENERAL POLLUTION PREVENTION INFORMATION

___ AUTOMOTIVE REPAIR, MAINTENANCE, SALVAGE YARDS, PAINTING, RADIATORS

FACILITY AUDIT CHECKLISTS
- ___ Chemical Manufacturing
- ___ Cleaning
- ___ Coating/Painting
- ___ Dry Cleaning
- ___ Formulators
- ___ Machining
- ___ Metal Industry
- ___ Operating Procedures
- ___ Petroleum Industry
- ___ Photoprocessing
- ___ Printed Circuit Board
- ___ Radiator Repair

___ CHEMICALS

___ CIRCUIT BOARDS

___ COAL MINING

___ COOLING TOWERS

___ DRY CLEANING

___ ELECTROPLATING, MACHINE TOOLERS, METAL RECOVERY AND WIRE MILLING

___ FOOD AND KINDRED PRODUCTS - POULTRY, DAIRY, AND SHRIMP

___ FINANCIAL

___ LOCAL GOVERNMENT - POLICIES OF AND GUIDES FOR

___ LUMBER, WOOD PRODUCTS AND FURNITURE

___ PAINT

___ PAPER

___ PESTICIDES

___ PETROLEUM REFINING, ELECTRIC POWER GENERATION AND OIL CLEANUP

___ PLASTICS AND FIBERGLASS

___ PRIMARY METAL INDUSTRIES - METAL FINISHING, MANUFACTURING; STEEL; FOUNDRY

___ PRINTING, PUBLISHING, AND PHOTOPROCESSING

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___ TEXTILES - MILLS, MANUFACTURING

___ WASTE WATER TREATMENT

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Center for Environmental Research Information
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513-569-7562 513-569-7566 (Fax)

• Facility Pollution Prevention Guide		EPA/600/R-92/088
• Waste Minimization Opportunity Assessment Manual		EPA/625/7-88/003
• Life-Cycle Assessment: Inventory Guidelines and Principles		EPA/600/R-92/036
• Guides to Pollution Prevention:	Automotive Refinishing Industry	EPA/625/7-91/016
• Guides to Pollution Prevention:	Auto Repair Industry	EPA/625/7-91/013
• Guides to Pollution Prevention:	The Commercial Printing Industry	EPA/625/7-90/008
• Guides to Pollution Prevention:	The Fabricated Metal Industry	EPA/625/7-90/006
• Guides to Pollution Prevention:	Fiberglass Reinforced and Composite Plastics	EPA/625/7-91/014
• Guides to Pollution Prevention:	Marine Maintenance and Repair	EPA/625/7-91/015
• Guides to Pollution Prevention:	Mechanical Equipment Repair Industry	EPA/625/R-92/008
• Guides to Pollution Prevention:	Metal Casting and Heat Treating Industry	EPA/625/R-92/009
• Guides to Pollution Prevention:	Metal Finishing Industry	EPA/625/R-92/011
• Guides to Pollution Prevention:	The Paint Manufacturing Industry	EPA/625/7-90/005
• Guides to Pollution Prevention:	The Pesticide Formulating Industry	EPA/625/7-90/004
• Guides to Pollution Prevention:	Pharmaceutical Preparation	EPA/625/7-91/017
• Guides to Pollution Prevention:	Photoprocessing Industry	EPA/625/7-91/012
• Guides to Pollution Prevention:	The Printed Circuit Board Manufacturing Industry	EPA/625/7-90/007
• Guides to Pollution Prevention:	Research and Educational Institutions	EPA/625/7-90/010
• Guides to Pollution Prevention:	Selected Hospital Waste Streams	EPA/625/7-90-009

*Note: additional guidance manual on Thermal Metal Working scheduled for release in 1993

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• Waste Minimization Opportunity Assessment Manual		EPA/625/7-88/003
• Life-Cycle Assessment: Inventory Guidelines and Principles		EPA/600/R-92/036
• Guides to Pollution Prevention:	Automotive Refinishing Industry	EPA/625/7-91/016
• Guides to Pollution Prevention:	Auto Repair Industry	EPA/625/7-91/013
• Guides to Pollution Prevention:	The Commercial Printing Industry	EPA/625/7-90/008
• Guides to Pollution Prevention:	The Fabricated Metal Industry	EPA/625/7-90/006
• Guides to Pollution Prevention:	Fiberglass Reinforced and Composite Plastics	EPA/625/7-91/014
• Guides to Pollution Prevention:	Marine Maintenance and Repair	EPA/625/7-91/015
• Guides to Pollution Prevention:	Mechanical Equipment Repair Industry	EPA/625/R-92/008
• Guides to Pollution Prevention:	Metal Casting and Heat Treating Industry	EPA/625/R-92/009
• Guides to Pollution Prevention:	Metal Finishing Industry	EPA/625/R-92/011
• Guides to Pollution Prevention:	The Paint Manufacturing Industry	EPA/625/7-90/005
• Guides to Pollution Prevention:	The Pesticide Formulating Industry	EPA/625/7-90/004
• Guides to Pollution Prevention:	Pharmaceutical Preparation	EPA/625/7-91/017
• Guides to Pollution Prevention:	Photoprocessing Industry	EPA/625/7-91/012
• Guides to Pollution Prevention:	The Printed Circuit Board Manufacturing Industry	EPA/625/7-90/007
• Guides to Pollution Prevention:	Research and Educational Institutions	EPA/625/7-90/010
• Guides to Pollution Prevention:	Selected Hospital Waste Streams	EPA/625/7-90-009

*Note: additional guidance manual on Thermal Metal Working scheduled for release in 1993

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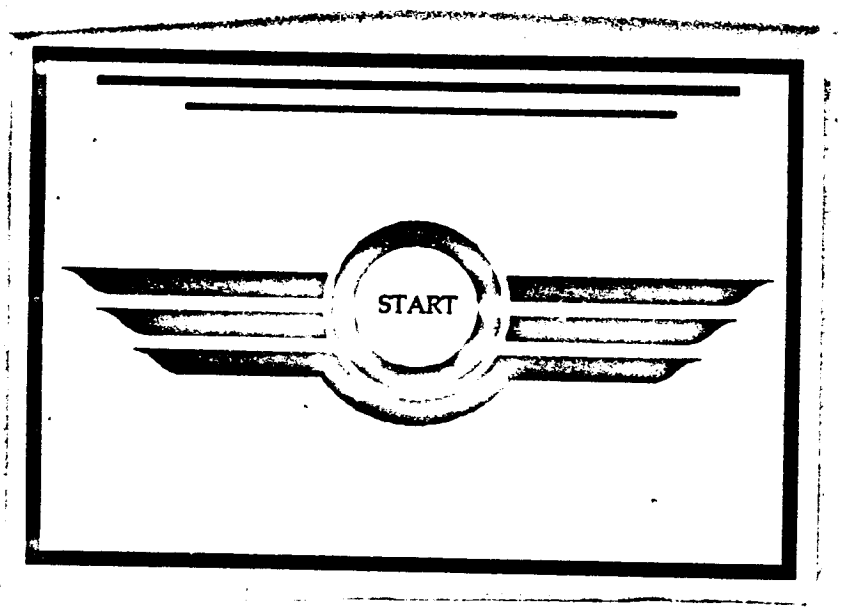

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Dear Interested Colleague:

A group of ten U.S. Environmental Protection Agency officials and ten State officials have been working since January to design a new approach to strengthening State nonpoint source management programs, reducing Federally-imposed administrative requirements and increasing the environmental protection afforded by the $100 million per year national nonpoint source grant program.

This group has now agreed on a series of important changes to the national guidance EPA uses to manage State nonpoint source management programs under section 319 of the Clean Water Act, as well as the Federal grants States use to implement those programs. We are pleased to provide you with a draft copy of this new national guidance so that we can benefit from your thoughts and suggestions. This draft guidance is also available through the Internet at http://www.epa.gov/OWOW.

State nonpoint source management programs have matured considerably since the passage of the 1987 Federal Clean Water Act; experience in many States extends much further back in history. All States now have approved nonpoint source programs under section 319 of the statute and EPA has provided about $370 million in grants to States to implement these programs. We are beginning to see environmental progress, but without question, Federal and State processes need to be reexamined to find ways to increase the effectiveness of State nonpoint source management programs and to speed progress towards solving our nonpoint source pollution problems.

Our long-term vision is that all States implement dynamic, effective nonpoint source programs designed to achieve and maintain beneficial uses of water.

To achieve this vision, we charged the State/EPA workgroup to take stock of current EPA and State nonpoint source programs and to recommend specific improvements to EPA's national guidance for State section 319 nonpoint source programs and for administering the Federal section 319 grants program. The group set the tone for the effort by adopting these themes for leadership:

- Search for opportunities - look for innovative ways to improve the program.
- Inspire a shared vision - enlist people in the effort.

- Foster collaboration - enable individuals and organizations to act by sharing information and providing choice.
- Model the way - achieve wins, unravel bureaucracy, put up signposts and create opportunities for victory.
- Celebrate accomplishments - recognize contributions that individuals make.
- Emphasize local, watershed-based approaches tailored to needs.

Our discussions have already led to several modifications to the nonpoint source grants program. For example, most States exceed ground-water targets established in prior nonpoint source grants guidance, so beginning in FY 1996, EPA dropped these targets. Similarly, targets were dropped for watershed resource restoration projects and national monitoring projects. While EPA and States recognize the continuing importance of these activities, States will be provided maximum flexibility in determining whether and to what extent to apply section 319 funds for these purposes. In addition, each State now has the discretion to use a small portion of its grant to conduct specific nonpoint source-related assessments and to revise and strengthen its nonpoint source management program.

Based on the recommendations of the workgroup, EPA has now moved beyond these initial steps to draft new national guidance for the nonpoint source program. This is the basic approach:

1. Upgrade State Programs. Beginning in Fiscal Year 1996, each State will review its nonpoint source program and revise it as needed to assure that the program achieves nine key program elements. These nine key elements are described briefly in the Executive Summary of the draft guidance and explained in more detail in Section III-A. A program evaluation guide based on these nine key elements is presented in Appendix A.

2. Eliminate Competitive Grants. EPA will no longer use a competitive grants approach, beginning in FY 1997. Using the current allocation formula based upon the magnitude of nonpoint sources and problems in each State, EPA will provide a predictable amount of funds to each State contingent upon Congressionally appropriated funding levels.

3. Streamline Grant Award and Reporting Processes. States will have greater flexibility for directing section 319 grant funds, consistent with the State's upgraded nonpoint source management programs and with Federal law. EPA will also reduce State reporting responsibilities and grant schedules are speeded up.

4. Reform State Oversight by Recognizing "Tier I Nonpoint Source States." Grant award and reporting procedures will be even further reduced and streamlined for States that have adopted all nine key program elements and which have a proven track record of effective implementation.

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Special recognition for Tier I Nonpoint Source States will be extended by EPA's Assistant Administrator for Water and Regional Administrators, and a number of added administrative incentives will be offered. Our goal is that all or most States will become Tier I Nonpoint Source States in a few years.

EPA and the States plan to follow this effort with a second, long-term effort to improve and strengthen State nonpoint source management programs even further. We expect to use a consensus-based approach to engage a wide variety of Federal, State, Tribal, local and private-sector partners to agree upon specific ways to help States to implement their new nonpoint source management programs, especially technical tools, assistance, monitoring, and supportive action.

We are enthusiastic about entering into a new era of EPA-State partnership with the implementation of an effective national nonpoint source program. We would appreciate receiving your comments and suggestions on our approach and on the enclosed draft guidance by no later than January 19, 1996, at the addresses below.

Sincerely,

Geoffrey H. Grubbs, Director
Assessment and Watershed Protection Division
USEPA (4503-F)
Washington, D.C. 20460
Fax (202) 260-7024

Robert Zimmerman, President
Association of State and Interstate Water Pollution Control Administrators
750 First Street, N.E.
Suite 910
Washington, D.C. 20002
Fax (202) 898-0929

Enclosure

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DRAFT--DECEMBER 13, 1995

VOL 12

NONPOINT SOURCE PROGRAM AND GRANTS GUIDANCE FOR FISCAL YEAR 1997 AND FUTURE YEARS

[DATE]

U.S. Environmental Protection Agency

Office of Water

Washington, D.C.

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EXECUTIVE SUMMARY

This guidance promotes a new generation of strong partnerships between the U.S. Environmental Protection Agency (EPA) and State lead nonpoint source agencies. Our long-term vision is:

ALL STATES ARE IMPLEMENTING DYNAMIC AND EFFECTIVE NONPOINT SOURCE PROGRAMS DESIGNED TO ACHIEVE AND MAINTAIN BENEFICIAL USES OF WATER.

To achieve this vision, EPA and State nonpoint source lead agencies have agreed upon a new, streamlined framework for the implementation of State nonpoint source programs under section 319 of the Clean Water Act. States and EPA will work together to review, revise and implement enhanced State nonpoint source management programs that apply nine key elements of State programs that have been developed jointly. States will have flexibility to implement their programs in a manner that maximizes their ability to achieve our long-term vision.

Beginning in late Fiscal Year 1996, States will review and, as appropriate, revise nonpoint source management programs to reflect the following nine key elements:

1. Explicit short- and long-term goals, objectives and strategies to protect surface and ground water.

2. A balanced approach that emphasizes both State-wide nonpoint source programs and on-the ground management of individual watersheds where waters are impaired and threatened.

3. The State program (a) abates water quality impairments from existing sources and (b) prevents significant threats to water quality from present and future activities.

4. An identification of waters and watersheds impaired or threatened by nonpoint source pollution and a process to progressively address these waters.

5. The State reviews, upgrades and implements all program components required by section 319 of the Clean Water Act, and establishes flexible, targeted, iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable.

6. Efficient and effective management and implementation of the State's nonpoint source program, including necessary financial management.

7. Strong working partnerships with appropriate State, Tribal, regional, and local entities, private sector groups, citizens groups, and Federal agencies.

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8. Identification of Federal lands and objectives which are not managed consistently with State program objectives.

9. A feedback loop whereby the State reviews, evaluates, and revises its nonpoint source assessment and its management program at least every five years.

These key elements of upgraded State nonpoint source management programs are discussed in Section III-A of this guidance and a program evaluation guide based on those nine key elements is presented in Appendix A.

Consistent with States' implementation of stronger programs, EPA will no longer use a competitive approach to award a portion of section 319 funds. Rather, EPA will use the allocation formula presented in Appendix G to determine the amount to be awarded to each State. EPA will also be paring grants application procedures and reporting requirements to the minimum necessary to assure that grant funds are used legally and effectively.

A State which incorporates all nine key elements in its revised nonpoint source management program and which has proven a track record of effective implementation of its nonpoint source programs will be formally recognized by the Regional Administrator and the Assistant Administrator for Water as a Tier I Nonpoint Source State. Tier I States will be afforded substantially less oversight and more flexibility than Tier II States which are still improving their programs to a Tier I level. Thus, while EPA has greatly streamlined the section 319 grants program for all States, EPA is providing further flexibility to the Tier I Nonpoint Source States with complete programs and proven track records. This additional flexibility is discussed in Section III-B.

It is our goal that within a few years, all or most States will have improved their programs to the extent that they are recognized as Tier I Nonpoint Source States.

EPA's role will increasingly be focused on helping States to develop complete and well-designed nonpoint source management programs. Further, EPA will focus increasingly on providing appropriate technical assistance and support to States to help them implement their approved nonpoint source management program. Within its resource constraints, EPA will provide more sophisticated assistance such as advanced modeling and monitoring tools and design of high-quality watershed projects. Where necessary and appropriate, EPA will also provide special assistance on matters involving Federal agencies and Federal lands.

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I. OUR VISION

This guidance promotes a new generation of strong partnerships between the U.S. Environmental Protection Agency (EPA) and State lead nonpoint source agencies. Our long-term vision is:

ALL STATES IMPLEMENT DYNAMIC AND EFFECTIVE NONPOINT SOURCE PROGRAMS DESIGNED TO ACHIEVE AND MAINTAIN BENEFICIAL USES OF WATER.

To achieve this vision, this guidance establishes a new, streamlined framework for the implementation of State nonpoint source management programs under section 319 of the Clean Water Act. States and EPA will work together to revise, approve, and implement enhanced State nonpoint source management programs that apply nine key elements. States will have the freedom to implement their programs in a flexible manner that maximizes their ability to achieve our long-term vision, supported by a predictable flow of nonpoint source grants from EPA.

II. INTRODUCTION

A. Background

Congress enacted section 319 of the Clean Water Act in 1987, establishing a national program to control nonpoint sources of water pollution. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground and carrying natural and human-made pollutants into lakes, rivers, streams, wetlands, estuaries, other coastal waters, and ground water. Atmospheric deposition and hydrologic modification are also sources of nonpoint pollution.

Under section 319, States address nonpoint pollution by developing nonpoint source assessment reports that identify nonpoint source pollution problems and the nonpoint sources responsible for the water quality problems. States also adopt management programs to control nonpoint source pollution and then implement the management programs. Section 319(h) provides for EPA's award of grants to States to help them to implement those management programs. Both the assessment report and management program must be approved by EPA in order for a State to be eligible for section 319(h) funds. All States now have EPA-approved assessment reports and management programs.

Congress appropriated the first section 319 grant funds in Fiscal Year (FY) 1990. On December 1 and 15, 1989, EPA issued interim guidance for awarding FY 1990 grant funds to the States, including an interim planning target formula based on nonpoint source control needs.

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After soliciting and obtaining public comment, EPA issued final grant guidance on February 15, 1991.

The 1991 guidance served as the main national guidance for the award of section 319(h) grants in FY 1991 - 1993. On June 24, 1993, EPA published a revised nonpoint source grants guidance to include an expedited schedule for awarding section 319(h) grants, improvements to the process for awarding such grants, and clarifications on reporting and other requirements. This revised guidance served as the basis for nonpoint source grants from FY 1994 to FY 1996.

States, Territories, and Tribes have made progress in tackling high priority nonpoint source water quality problems. Projects that have received funding from section 319 grants have ranged from information and educational programs to the demonstration of innovative technologies and watershed-based approaches to solving water quality problems. With the help of section 319 grants, States have been able to address site- and watershed-specific water quality problems as well as to initiate and maintain State-wide nonpoint source programs.

In recognition of this progress, representatives of EPA and State lead nonpoint source agencies held a series of meetings in 1995 to consider fundamental changes to the nonpoint source program. These meetings reflected the twin premises that given the increasing maturity of State programs, it is timely for the States to review, revise, and implement enhanced nonpoint source management programs, and it is correspondingly appropriate for EPA to provide States with increased flexibility to manage and implement these programs, supported by a streamlined and more efficient grants process.

These meetings led to initial grants policy changes that were announced in a memorandum dated April 7, 1995, which became effective at the beginning of FY 1996. Those changes, which continue to be reflected in this guidance, provide States greater flexibility to use a portion of their grant funds to improve their nonpoint source assessments and upgrade their nonpoint source management programs.

This guidance also continues the policy announced in the April 17, 1995 memorandum that States will now have greater flexibility to set their own priorities. Specifically, several set-asides or separate funding elements that applied in the past are now removed for ground-water protection, watershed resource restoration, and national nonpoint source monitoring projects. The original purposes of these set asides have been fulfilled or exceeded, so they are no longer necessary.

In subsequent meetings, EPA and State lead nonpoint source agencies considered more fundamental changes to the national nonpoint source program. The results of these efforts are reflected in this guidance.

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B. Scope of This Guidance

This guidance is primarily directed towards nonpoint source management programs and grants administered by State lead nonpoint source agencies under section 319 of the Clean Water Act. Territories of the United States are included by the Clean Water Act in the term "States" and are included as States in this guidance. Properly qualified Native American Tribes may also administer nonpoint source management programs under section 319 of the Clean Water Act. This guidance is not specifically directed to Tribal nonpoint source management programs, however, but may be used for administering section 319 programs and grants with the agreement of EPA and the eligible Tribe. Alternatively, A Tribal Guide to the State Section 319 Nonpoint Source Management Program (USEPA, Office of Water, September 1994) may be used.

This guidance contains two components. First, it establishes a framework for reviewing, revising, and approving enhanced State nonpoint source management programs. Second, it establishes a new framework for the national nonpoint source grants program. This guidance will serve as the basis for State nonpoint source management programs and for the national nonpoint source grants program, beginning in FY 1997.

This national guidance is intended to serve as the basis for a nationally consistent approach for State nonpoint source management programs and grants. Therefore, beginning in FY 1997, Regions will not issue separate, supplemental guidance specifically for State nonpoint source programs or grants. If particular Regional circumstances require additional clarifications on a particular issue, the Region will consult with the affected States and with EPA Headquarters on the appropriate next steps.

As in the past, EPA's policy will be to award all section 319 grants under section 319(h), in lieu of awarding separate grants under section 319(I). Thus this guidance applies to all section 319 grants. This approach will encourage integration of ground-water activities with overall State nonpoint source control programs, while maximizing State flexibility to consider and prioritize all causes and effects of nonpoint sources of water pollution.

C. Relationship to Other Environmental Protection Programs

The goal of national and State nonpoint source programs is to achieve and maintain beneficial uses of water. EPA and the States recognize that, to achieve this goal, EPA's and States' nonpoint source programs must be well integrated with other environmental and natural resource management programs. These programs include point source programs, particularly with respect to common and overlapping areas such as urban runoff, construction, inactive and abandoned mines, animal waste facilities, and marinas; comprehensive State ground-water protection programs; clean lakes programs; wetlands protection programs; estuary programs; watershed planning and total maximum daily loads; and ambient monitoring programs. Moreover, nonpoint source management programs should be consistent with the broad overarching principles

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of environmental management, including watershed protection and pollution prevention. Accordingly, State nonpoint source programs need to be broadly inclusive so as to best meet States' water quality needs.

Beneficial uses of water are established by States, participating Tribes and other jurisdictions as a part of State water quality standards adopted and approved under section 303 of the Clean Water Act. State water quality standards are dynamic in nature and are periodically revised to reflect changes in science and law, which may in turn result in changes to the specific objectives and requirements in State section 319 nonpoint source management programs. Since our vision for national and State nonpoint source programs is tied to the attainment and maintenance of beneficial uses of water, State nonpoint source programs must be closely coordinated with State water quality standards programs and be periodically revised to reflect changes in beneficial uses.

This guidance has also been drafted to be consistent with the broad principles of EPA's emerging grants policy. This policy is reflected in an Agency-wide development of Performance Partnership Grants and the related National Environmental Performance Partnership System. This approach, which is beginning to be implemented in certain States in FY 1996, is designed to provide greater flexibility to States to address their pollution problems holistically as measured by environmental goals and indicators and to move away from a focus on specific narrowly-defined outputs. In addition, it is also designed to provide for differential EPA oversight based on the level of State performance. Both of those principles are emphasized in this guidance.

III. NONPOINT SOURCE MANAGEMENT PROGRAMS

EPA and the State lead nonpoint source agencies agree that the national nonpoint source program should be redesigned to create incentives and support for States to develop enhanced nonpoint source management programs that successfully address all of the nine key elements of an effective State program as listed and discussed below. EPA's approach will be to work closely with the States and give them programmatic and technical support as they move into a more advanced and independent level of program implementation.

A key feature of the new approach is to recognize and reward States that adopt nine key program elements and which have a proven track record of effectively implementing nonpoint source programs. EPA intends that the States will be formally recognized as Tier I Nonpoint Source States by EPA's Regional Administrators and the Assistant Administrator for Water and be provided benefits commensurate with their advanced level of program accomplishment. These benefits are described in Section III-B and include priority for multi-year grant work plans, streamlined review of grants applications, increased technical assistance, reduced reporting requirements, and reduced EPA oversight.

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It is EPA's goal that within the next few years, all or most States will have improved their programs to the extent that they are recognized as Tier I Nonpoint Source States. EPA will focus its available resources on helping States achieve this advanced level of program development and implementation.

A. Nine Key Elements of an Effective State Program

EPA and the State lead nonpoint source agencies agree that the following nine key elements characterize an effective and dynamic State nonpoint source program. Each key element appears in bold type and is then followed by explanatory text that elaborates on the key element. The explanatory text provides information on means by which the States may choose to implement the key element.

All States will review and, as appropriate, revise their nonpoint source management programs in a manner that reflects these nine key elements. States will then submit their upgraded programs to EPA for approval. As discussed below in Sections III-B and V of this guidance, States that successfully incorporate these nine key elements into their programs and have a proven track record of effective implementation will be recognized Tier I Nonpoint Source States and be provided maximum flexibility in implementing their programs and other benefits.

1. The State program contains explicit short- and long-term goals, objectives and strategies to protect surface and ground water.

The State's long-term goals are consistent with the national program vision that all States implement dynamic and effective nonpoint source programs designed to achieve and maintain beneficial uses of water. The shorter-term objectives consist of activities, with milestones, that are designed to demonstrate reasonable further progress that leads to accomplishment of the long-term goals as expeditiously as possible. The State program includes objectives that address nonpoint sources of ground-water pollution. The objectives list both implementation steps and the results to be achieved (e.g., water quality improvements or load reductions).

The State program includes long-term goals; shorter-term (e.g., 3- to 5-year) objectives that are periodically updated based on progress; strategies to achieve progress towards achieving the goals, objectives; indicators to measure progress; and annual work plans to implement the strategies.

2. The State uses a balanced approach that emphasizes both State-wide nonpoint source programs and on-the-ground management of individual watersheds where waters are impaired and threatened.

The State nonpoint source management program emphasizes a watershed management approach and is well integrated with other important programs to protect and restore water

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quality. These include point source, ground water, drinking water, clean lakes, wetlands protection, and national estuary programs; coastal zone programs; conservation, and pesticide management programs; forestry programs; and other natural resource and environmental management programs.

Each State has the flexibility to design its nonpoint source management program in a manner that is best suited to attain and maintain beneficial uses of water. On-the-ground implementation of practices and programs is the best means of reducing and preventing pollution from nonpoint sources, but States may achieve this on-the-ground implementation by a combination of watershed approaches and State-wide programs. Similarly, as described more fully in key element 5 below, the State may use any combination of water-quality or technology-based approaches it deems appropriate to make progress towards attaining and maintaining beneficial uses of water.

3. The State program (a) abates water quality impairments from existing sources and (b) prevents significant threats to water quality from present and future activities.

The program is designed to remedy waters that the State has identified as impaired by nonpoint source pollution. Further, the program is designed to prevent new water quality problems from present and future activities and new nonpoint sources, especially in waters which currently meet water quality standards.

While it may take years to restore waters that are already impaired, it is also important for States to take appropriate steps expeditiously to protect clean waters from future degradation. State programs should place a priority on protecting waters from new nonpoint sources as soon as possible (generally within 5 years).

4. The State program identifies waters and their watersheds impaired by nonpoint source pollution and identifies important unimpaired waters that are threatened or otherwise at risk. Further, the State establishes a process to progressively address these identified waters by conducting more detailed watershed assessments and developing watershed implementation plans, and then by implementing the plans.

The State identifies waters impaired by nonpoint source pollution based on currently available information (e.g., in reports under sections 305(b), 319(a), 303(d), 314(a), and 320), and revises its list periodically as more up-to-date assessment information becomes available. The State also identifies important unimpaired waters that are threatened or otherwise at risk from nonpoint source pollution.

In addition the State identifies the primary categories and subcategories causing the water quality impairments, threats, and risks. At 5-year intervals, the State updates the identification of waters and their watersheds impaired or threatened by nonpoint source pollution preferably as

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part of a single comprehensive State water quality assessment which integrates reports required by sections 305(b), 319(a), 303(d), 314(a) and 320.

The factors used by the State to progressively address its waters may include a variety of relevant considerations, including, for example:

- human health;
- ecosystem health including ecological risk;
- the beneficial uses of the water;
- value of the watershed or ground-water area to the public;
- vulnerability of the surface or ground water to additional environmental degradation;
- likelihood of achieving demonstrable environmental results;
- implementability;
- extent of alliances with other Federal agencies and States to coordinate resources and actions; and
- readiness to proceed.

The State links its prioritization and implementation strategy to other programs and efforts as appropriate. Examples include total maximum daily loads, clean lakes programs, comprehensive ground-water protection programs, source water protection programs wetlands protection programs, national estuary programs, ambient monitoring programs, and pesticides management programs as well as related programs administered by agricultural, forestry, highway, and other agencies. In establishing priorities for ground-water activities, the State considers wellhead protection areas, ground-water recharge areas, and zones of significant ground water/surface water interaction.

More detailed information on priority setting is also contained in pp. 11 and 12 of the December 1987 Nonpoint Source Guidance; Setting Priorities: The Key to Nonpoint Source Control (EPA, 1987); Selecting Priority Nonpoint Source Projects: You Better Shop Around (EPA, 1989); Geographic Targeting: Selected State Examples (EPA, 1993) and Watershed Protection: A Project Focus (EPA, 1995).

5. The State reviews, upgrades, and implements all program components required by section 319(b) of the Clean Water Act, and establishes flexible, targeted, and iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable. The State programs include:

o Technology-based or water quality-based programs aimed at achieving and maintaining beneficial uses of water;

o A mix of regulatory, non-regulatory, financial and technical assistance as needed; and

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o Baseline programs to the extent that they are currently required by Federal or State law, including coastal nonpoint programs required by section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990.

The State reviews and upgrades the components of its approved nonpoint source management program, including:

(I) An identification of the best measures (i.e., systems of practices) that will be used to control nonpoint sources of pollution, focusing on those measures which the State believes will be most effective in abating and preventing nonpoint source pollution problems. These measures may be individually identified or presented in manuals orcompendiums, provided that they are specific and are related to the category or subcategory of nonpoint sources);

(ii) A identification of programs to achieve implementation of the measures, including, as appropriate, nonregulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer, and demonstration projects. States should establish a flexible, targeted approach to solve their water quality problems. States have the freedom to decide the best approaches for solving the problems that they identify under key element 4 above. These approaches may include one or all of the following:

- iterative, technology-based approaches based on the best available economically achievable practices, applied on either a categorical or site-specific basis;
- water quality-based approaches aimed at meeting water quality standards directly; or
- an appropriate mix of these approaches.

(iii) A description of the processes used to coordinate and, where appropriate, integrate the various programs used to implement nonpoint source pollution controls in the State;

(iv) A schedule with goals, objectives, and annual milestones for implementation at the earliest practicable date: legal authorities to implement the program; available resources; and institutional relationships;

(v) Attorney General certification (if the State program is changed substantially);

(vi) Sources of funding from Federal (other than section 319), State, local, and private sources;

(vii) Federal land management programs, development projects and financial assistance programs (see key element 8 below); and

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(viii) A description of the monitoring and other evaluation programs that the State will conduct to help determine short- and long-term program effectiveness.

Further, State nonpoint source programs must incorporate existing baseline requirements required by Federal or State law to the extent that they apply and are relevant. For example, coastal States and Territories should include or cross-reference approved coastal nonpoint source programs required by section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. In this manner, States can make sure that these coastal nonpoint source programs, and other relevant baseline programs are integrated into section 319 programs and that they are eligible for section 319(h) grant funding, which is limited by section 319(h)(1) to "the implementation of approved section 319 programs."

6. The State manages and implements its nonpoint source program efficiently and effectively, including necessary financial management.

The State implements its program to solve its water quality problems as effectively and expeditiously as possible. Timeliness is key to accomplishing environmental objectives and demonstrating results as soon as possible. To help assure that priority water quality problems are addressed cost-effectively and in a timely manner, the State includes in its program a process for identifying the critical areas requiring treatment and protection within watersheds selected for implementation activities, and assigns the highest priority to addressing those areas.

The State employs appropriate programmatic and financial systems that ensure that section 319 dollars are used consistently with its legal obligations, and generally manages all nonpoint source programmatic funds to maximize environmental benefits.

7. The State strengthens its working partnerships and linkages to appropriate State, Tribal, regional, and local entities, private sector groups, citizens groups, and Federal agencies.

The State uses a variety of formal and informal mechanisms to form and sustain these partnerships. Examples include memoranda of agreement, letters of support, cooperative projects, sharing and combining of funds, and meetings to share information and ideas.

The State nonpoint source lead agency actively involves other key State and local nonpoint source entities in the development and implementation of the section 319 management program. Representative advisory groups on nonpoint source task forces have proven effective in many States for accomplishing these linkages, especially where they meet on a regular basis and are managed in a collaborative and inclusive manner.

Further, the State seeks public comment on significant proposed program changes and engages in public education activities to promote public awareness of nonpoint source pollution

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and its solutions. The State maintains the interest and involvement of groups whose participation is essential to the success of nonpoint source projects.

8. The State identifies Federal lands and activities which are not managed consistently with State nonpoint source program objectives. Where appropriate, the State seeks EPA assistance to help resolve issues.

The State commits to reviewing and identifying those Federal land management programs, development projects and financial assistance programs that are or may be inconsistent with the State's nonpoint source management program.

As a Federal agency, EPA has a special role to play in support of State nonpoint source programs by working with other Federal agencies to enhance their understanding of the significance of nonpoint source pollution and of the need to work cooperatively with States to solve nonpoint source problems. Where appropriate, EPA will help develop memoranda of agreement among States and Federal agencies to help reduce nonpoint source pollution on Federal lands and to better address nonpoint source pollution in Federal assistance programs and development projects. In addition, where appropriate, EPA will assist in resolving particular issues that arise between the State and Federal agencies with respect to Federal consistency with the State nonpoint source management program.

9. The State periodically reviews and evaluates its nonpoint source management program using environmental and functional measures of success, and revises its nonpoint source assessment and its management program at least every five years.

In its upgraded program, the State establishes appropriate indicators of progress in meeting its programmatic and environmental goals and objectives identified in key element #1 above. The State also describes a monitoring/evaluation strategy and a schedule to measure success in meeting those goals and objectives.

Appendix A presents a guide for evaluating the effectiveness of State nonpoint source management programs, based on these nine key elements. Approaches to environmental indicators and monitoring and described below.

a. Environmental Indicators

States are encouraged to use several sets of measures to fully indicate their success in implementing their nonpoint source programs. These include measures that indicate progress towards achieving and maintaining beneficial uses of water; towards long-term goals (e.g., installing appropriate technology at all animal waste facilities that need to be upgraded, or implementing particular watershed projects); and towards shorter-term goals and objectives (e.g., successfully implementing a particular technology).

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Appendix B contains an illustrative set of indicators that can help the States and the public gauge the progress and success of their programs. States may identify and use other indicators that are most relevant to their particular nonpoint source problems, programs, and projects. However, States are encouraged to use environmental endpoints as indicators to the greatest extent feasible, so that the State and the public may best recognize the State's progress in addressing water quality problems in terms that are most relevant to the public's concerns. In addition, as discussed in section IV-D of this guidance, States must include in its annual reports at least the three measures of progress that are identified in section 319(h)(11), including implementation milestones, available information on reductions in nonpoint source pollutant loadings, and available information on improvements in water quality.

EPA is currently developing a broad strategy for the use of environmental indicators for its various environmental programs, including its water programs. The list in Appendix B, while providing more detail on indicators that are of particular relevance to State nonpoint source programs, is consistent with the environmental indicators adopted nationally by EPA to measure progress towards environmental goals.

b. Monitoring in Watershed Projects

Appropriate monitoring of watershed project implementation is an essential tool to enable States to identify nonpoint source pollution problems and to evaluate nonpoint source program effectiveness. First, States need to identify sources, document the effectiveness of individual measures and BMP systems, and develop watershed-level strategies to prevent and control nonpoint source pollution. Second, in the case of watershed projects intended to demonstrate a new or innovative technical or institutional approach to resolving nonpoint source water quality problems, monitoring is needed to developing the information and data necessary to demonstrate the project's effectiveness and the applicability of the approach elsewhere. Third, monitoring is needed to help States meet the annual reporting requirements of section 319(h)(11), especially information on reductions in nonpoint source pollutant loading and improvements in water quality. Therefore, an appropriate type of monitoring should be considered for watershed projects funded with section 319 grants.

Major watershed projects should include some form of monitoring to evaluate effectiveness. Watershed implementation plans should include clearly stated monitoring objectives and an evaluation strategy making clear what the State expects to learn as a result of its evaluation of the project. The evaluation approach may be tailored to the specific project, based on factors such as the project's size and objectives. Approaches that can be used to meet the project evaluation needs include ambient water quality monitoring (e.g., edge-of-field, small watersheds, multiple watersheds, in-lake, in-aquifer monitoring), beneficial use assessment (e.g., biological/ habitat assessment, attainment of water quality standards), implementation monitoring (e.g., audits, activity tracking, geographic information system tracking of land use and land management), model projections, and photographic evidence. Ambient monitoring and beneficial

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use assessment tracking should be included for projects wherever feasible.

While States may use section 319(h) grant funds for monitoring activities for particular watershed projects, States are encouraged to also explore other approaches to conducting monitoring. For examples, the U.S. Geological Survey and the National Oceanic and Atmospheric Administration hold an array of ambient data and can provide support for various monitoring activities, and volunteer monitoring programs are a useful resource in many States.

c. National Monitoring Program

To provide a credible national documentation of the feasibility of controlling and preventing pollution resulting from nonpoint sources, and to improve technical understanding of nonpoint source pollution and the effectiveness of nonpoint source control technology and approaches, EPA has established a more rigorous and standardized monitoring framework that can be used for a representative subset of watershed projects funded under section 319. This monitoring will be continued for this subset of selected watershed projects for appropriately long periods of time e.g., 6-10 years. States are strongly encouraged to conduct intensive water quality monitoring of one or more projects within the State as part of this national evaluation.

EPA has developed a framework for selecting national monitoring projects, issued guidelines for minimum monitoring activities, and developed software for managing and reporting data (see Appendix H for references). A number of high-quality national projects have been selected across the country through a rigorous but collaborative process involving the State the EPA Region, and EPA Headquarters. A small number of additional high-quality monitoring projects will be selected in future years using the same collaborative process. For all projects, EPA provides specialized technical support in project development, monitoring design, data management and analysis, and reporting. From time to time, and in close collaboration with relevant States and project managers, EPA will publish progress reports and results.

Prior to Fiscal Year 1996, a small set aside was provided from section 319 grants for these national monitoring projects. Beginning in FY 1996, this set aside was eliminated along with all other discretionary set asides. Therefore, States are now strongly encouraged to give priority to projects in the National Monitoring Program. By the nature of nonpoint source pollution, long term monitoring results are crucial to determine successes and BMP effectiveness, which in turn requires sustained year-to-year funding. For those not familiar with this program, a list and description of the national monitoring projects is available from EPA.

B. Tier I Nonpoint Source States

EPA and the designated State lead nonpoint source agencies agree that EPA's administration of section 319 grants should reflect different levels of capability and accomplishment among States. A two-tiered structure will be used.

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A State which incorporates all nine key elements in its revised nonpoint source management program and which has proven a track record of effective implementation of its nonpoint source programs will be formally recognized by the Regional Administrator and the Assistant Administrator for Water as a Tier I Nonpoint Source State. Tier I States will be afforded substantially less oversight and more flexibility than Tier II States which are still improving their programs to a Tier I level. Thus, while EPA has greatly streamlined the section 319 grants program for all States, EPA is providing further flexibility to the Tier I Nonpoint Source States with complete programs and proven track records.

The following chart summarizes the key differences that will distinguish Tier I Nonpoint Source States from Tier II States.

TIER I NONPOINT SOURCE STATES	TIER II NONPOINT SOURCE STATES
1. Recognition by EPA Assistant Administrator for Water and the Regional Administrator	
2. Full allotment	2. Full allotment
3. EPA and State place priority on developing multi-year grant work plans	3. Grant work plans negotiated annually
4. Minimal EPA review of grant work plans	4. Detailed EPA review of grant work plans. If there are problems, EPA continues to work with State prior to awarding the full grant amount.
5. Amount and frequency of reporting reduced to minimum	5. Baseline reporting in accordance with Section IV-D of this guidance
6. Reduced intensity and frequency of EPA oversight. EPA broadly reviews States' self-assessments, performance, and environmental progress. Greater deference to State judgement.	6. Normal EPA oversight in accordance with this guidance. EPA conducts detailed periodic assessments.
7. EPA focuses on providing advanced	7. EPA provides basic technical and

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technical expertise and assistance	other assistance, e.g., developing good watershed projects
8. Senior EPA managers assign greater priority to helping States resolve issues and problems on Federal lands and with Federal agencies	8. Senior EPA managers assign normal priority to helping States resolve issues and problems on Federal lands and with Federal agencies
	9. EPA-State differences and issues are elevated to more senior management levels

It is our goal that within a few years, all or most States will have improved their programs to the extent that they are recognized as Tier I Nonpoint Source States.

The EPA Regional Office will determine whether a State should be recognized as a Tier I Nonpoint Source State, based on a timely and collaborative process involving the State and EPA Headquarters. Information, questions and issues will be discussed and shared among all these parties. EPA's recognition will be provided by the Regional Administrator and the Assistant Administrator for Water, accompanied by a public announcement and explanation.

Once a State has been recognized as a Tier I Nonpoint Source State, it will retain that status unless EPA determines that it no longer qualifies. Using the timely and collaborative process described above, the EPA Region will review a State's Tier I status every few years as needed to assure that the nonpoint source management program continues to include all nine key elements and that it maintains a proven track record of implementation.

EPA's role will increasingly be focused on helping States to develop complete and well-designed nonpoint source management programs. Further, EPA will focus increasingly on providing appropriate technical assistance and support to States to help them implement their approved nonpoint source management programs. Within its resource constraints, EPA will provide more sophisticated assistance such as advanced modeling and monitoring tools, and sound design of high-quality watershed projects. Where necessary and appropriate, EPA will also provide special assistance on matters involving Federal agencies and Federal lands.

IV. GRANTS

A fundamental principle of this guidance is that States should have the flexibility to use section 319 grant funds in a manner that they determine will best implement their nonpoint source management programs effectively to achieve the vision established at the beginning of this guidance and to achieve the specific goals and objectives established in their State nonpoint

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source management programs. Moreover, EPA and States will continue to reduce administrative responsibilities to the lowest level possible to assure that the funds are being used effectively and in a legally appropriate manner.

A. Funding Process

1. General Approach to Awarding Funds

Beginning in FY 1997, EPA will no longer use a competitive process for awarding section 319 grants. Rather, EPA will use the allocation formula presented in Appendix G to determine the amount to be awarded to each State (this formula remains unchanged from previous guidance but may be updated in the future to reflect up-to-date statistics). Each year, the Congressional appropriation for section 319 will be multiplied by the applicable percentage presented in Appendix G to determine each State's allocation for that year. As soon as the annual section 319 appropriation is made by Congress, EPA Headquarters will immediately notify the EPA Regional offices of each State's allocation, and the Regions will immediately notify the States.

Consistent with historical practice, EPA will continue to award all appropriated section 319 funds under section 319(h) and will not award separate grants under section 319(I), "grants for protecting ground water quality". Ground-water protection projects and activities will continue to be funded under section 319(h).

2. Expedited Schedule

In FY 1994 and 1995, EPA and the States gradually expedited the section 319 grants award schedule to provide for awarding the grants by February 1. This guidance further expedites this schedule over FY 1997 and 1998. By FY 1998 at the latest, the schedule will provide for award of the grants by October 1, thus making the 319 award date compatible with the October 1 date used to award water pollution control grants to States under sections 106 and 604(b) of the CWA. The schedules for FY 1997 and for FY 1998 and beyond are presented in Appendix D.

A primary advantage of further expediting the section 319(h) grant award process is to bring section 319 grants into a cycle consistent with other State grant programs for water, especially funding under sections 106 and 604(b) of the Clean Water Act. These grant programs initiate planning in the Spring based on the President's budget request for the next fiscal year. Several other advantages for expediting the 319(h) grant award schedule include:

- ability to use grant funds in the same year in which they were appropriated; avoiding missing an entire construction season and/or cropping season;
- maintaining momentum and enthusiasm for implementation projects at the local level; and

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- allowing monitoring projects to get underway earlier.

A few States may determine that it is in their best interest or infeasible not to combine section 319 and other grants and not to expedite their grants award schedules. In that case, the Region and State may agree on a different schedule, but in every case, this different schedule should be based on an open, collaborative discussion and be based on the needs of the State.

In all cases, Federal funds need to be put to work expeditiously, so States are strongly encouraged to expedite award schedules.

3. Six-Step Process

The following process will generally be used to award all section 319 grants. However, Tier I Nonpoint Source States will be accorded priority for negotiating multi-year work plans, which will further reduce administrative costs for those States. (Note: Please see Appendix D for the schedules for this six-step process.)

- Step 1: EPA provides a planning target to each State.
- Step 2: States submit draft grant applications.

Each State will submit a draft grant application, including a draft work plan. As part of the draft work plan, each State should submit a brief (3-4 paragraph) introductory narrative explaining the State's strategy for using section 319 funds in the current fiscal year.

Each Region will work closely and collaboratively with each State at this stage to promote the development and submission of high-quality work plans that: (1) conform to all applicable legal requirements of section 319, 40 CFR Part 31, and 40 CFR Part 35, Subpart A; and (2) are consistent with the goals, objectives and priorities in the State nonpoint source management program.

Work plans should briefly but clearly describe each task, the funding to be used to accomplish each task, and the outputs to be produced by performance of the task. This will not only assure that the State and EPA have shared expectations, but will also assure that the State's subsequent performance can be assessed objectively. Outputs for tasks should always be quantified, as described below in Section IV-C and Appendix B.

Work programs for lengthy projects (i.e., multi-year projects) should include both interim milestones and final dates for completion of tasks. Interim milestones should be sufficiently frequent to assure timely performance throughout the project period, so that the State can identify problems and correct them expeditiously.

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- Step 3: Regions conduct their reviews of State applications

The Region will review each State's application and meet or conduct a telephone conversation with each State to resolve any technical or administrative issues. Following this collaboration, Regions should provide a written reply. The Regional response should include written comments on the State's application, paying particular attention to applicable legal requirements and its consistency with the goals, objectives, and priorities established in the State management program. The written reply should also include any agreements reached with States concerning additional steps the State will take to become a Tier I Nonpoint Source State.

For Tier I Nonpoint Source States, the scope of EPA Regional reviews of grant applications will be more limited than Tier II States, and be more deferential to State judgements, priorities, and chosen means of implementation. For Tier I States, EPA's review of the section 319 nonpoint source grant applications will focus primarily on assuring that it meets legal minimums and that it does not contain significant errors.

- Step 4: States submit final work plans and grant applications to EPA Regions

After receiving the Region's response, the State will then complete and submit final work plans. Final watershed implementation plans should be included for any watershed projects to be conducted with grant funds. Appendix C lists the elements that should generally be included in watershed implementation plans. Outputs for tasks should always be quantified as described below in Section IV-C and Appendix B of this guidance.

- Step 5: Regions award grants

Each Region will review its States' final work plans. If a State's work programs meet all applicable requirements, the Region will award the final grant as quickly as possible. Where issues remain, the Region will elevate discussions to more senior management levels quickly to achieve a satisfactory resolution of the problem. In the unlikely event that funds cannot be fully awarded to a particular State, they must be returned to Headquarters for reallocation by August 1 of the fiscal year for which funds are appropriated.

- Step 6: States obligate funds

States will obligate the awarded funds as quickly as possible and conduct funded activities according to the schedules in approved work plan. EPA has interpreted section 319(h)(6) to provide that section 319(h) funds granted to a State shall remain available for obligation by the State for one year from the grant award. For example, grant funds awarded to a State on December 1, 1996, remain available for obligation until December 1, 1997. The amount of any such funds that cannot be obligated by one year from the grant award shall be available to EPA for granting to other States. Regions should include grant condition language calling for the grant

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recipient to award all proposed contracts and interagency agreements within one year after the grant award.

The term "obligate" does not mean to "expend." It means that the State must commit the section 319(h) funds to be expended. EPA defines an "obligation (by a recipient)" as "the amount of funds which a recipient legally earmarks for expenditure through orders placed, payrolls, subagreements awarded, travel authorizations, and other transactions."

4. Multi-Year Work Plans

EPA and Tier I Nonpoint Source States will place priority upon developing multi-year work plans for section 319 grants. For example, the State may wish to present a three-year work plan which would guide the State's grant activities for the next three years. This work plan, when approved by EPA, would not have to be resubmitted and reapproved except to the extent that the State wishes to change it to address new circumstances. This approach will reduce paper work and will improve the State's ability to engage in long-term planning and implementation with respect to both programmatic activities and specific watershed projects. These Tier I States will, however retain the option of developing aspects of their programs or projects on an annual basis where it deems appropriate.

Tier II Nonpoint Source States may also work with EPA to develop multi-year work plans for certain components of their grants. However, until a Tier II State is recognized as a Tier I State, it is likely that most of its activities will require a more careful evaluation by EPA and that a new grant work plan will be required for the coming year.

B. Grant Eligibility

Section 319 grant funds are to be directed towards the vision that all States implement dynamic and effective programs designed to achieve and maintain beneficial uses of water. Approved State nonpoint source management programs provide the framework for determining what activities are eligible for funding under section 319(h). Therefore, States may use section 319 funds for nonregulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. Certain lake restoration and remediation activities are eligible for funding under section 319(h), to the extent that they are nonpoint source-related and included in an approved State nonpoint source management program.

1. Revising Management Programs and Assessments

In addition to the eligible activities listed above, States may use section 319 funds to update and refocus their State nonpoint source management programs and nonpoint source

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assessments to improve program effectiveness. To assist States in these efforts, States may use up to 20 percent of their section 319(h) funds or $250,000, whichever is less, to update and refine their programs and assessments.

In refining their programs to reflect the most pressing needs and highest-priority water quality problems in the State, States may need to carry out additional activities and analyses. Based on the key elements of State programs that are described in the preceding section of this guidance, program revisions that may be supported with section 319 grants include: establishing appropriate indicator and milestones to gauge program progress; developing total maximum daily loads and other watershed-scale strategies to reduce nonpoint source pollution; focusing on determination of the most effective measures and practices to abate or prevent nonpoint pollution; strengthening links with Federal land management agencies; developing enhanced processes to involve public, private, and Federal partners in the design and implementation of State nonpoint source management programs; and instituting systems to assess program effectiveness and make appropriate revisions.

In addition, States may need to carry out a number of activities that have generally been associated with nonpoint source assessments. For example, States may require additional assessment work either as part of specific watershed projects, or as part of an overall Statewide, regional, or ecoregional effort. Such additional assessment work will enable States to more clearly identify and prioritize their nonpoint source problems, evaluate the effectiveness of their nonpoint source management programs, and measure progress toward environmental goals.

2. Ground-Water Activities

Ground-water activities are eligible for section 319(h) grants to the extent that they are identified directly in the State's nonpoint source management program or through incorporation in the management program by reference to the State's Ground-Water Protection Strategy or Comprehensive State Ground-Water Protection Program. If such activities are not currently included in the State's nonpoint source management program, the program should be amended to include them.

3. Urban Storm Water Runoff

Section 319 funds may be used to fund any urban storm water activities that are not specifically required by a draft or final NPDES permit. EPA has issued several regulations defining what activities are subject to the NPDES permit requirements of section 402(p)(2) of the CWA. The most significant of these was the publication of permit application requirements in November 1990 for "Phase I" storm water dischargers, that is, municipal separate storm sewers serving large or medium-sized populations (greater than 250,000 or 100,000 people, respectively), and storm water discharges associated with industrial activity. See 55 FR 47990.

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EPA is currently in the process of determining what storm water discharges will be covered by "Phase II" of the storm water program. Until EPA issues regulations specifying what additional storm water discharges are subject to NPDES permit application requirements, States may use section 319(h) funds for those urban storm water discharges that are not addressed by existing, Phase I storm water program requirements. These include both Phase II discharges as well as aspects of Phase I activities that support but do not directly implement activities required by Phase I permits.

EPA and the States recognize the benefits of integrating nonpoint source funds and storm water activities as much as is legally allowable. Listed below are a variety of urban runoff management activities that could be eligible for section 319(h) funding.

- Technical assistance to State and local storm water programs;
- Monitoring needed to design and evaluate the effectiveness of implementation strategies;
- Best management practices for pollution prevention and runoff control (except for BMPs required by a draft or final NPDES permit);
- Information and education programs;
- Technology transfer and training; and
- Development and implementation of regulations, policies, and local ordinances to address storm water runoff. (These may apply to areas covered by NPDES permits, provided that the regulations, policies and ordinances apply to non-permitted areas as well.)

Historically, urban storm water management control efforts have focused on water drainage problems i.e., water quantity. Now many storm water control BMPs are designed to control both water quantity and water quality. Section 319(h) funds may be used to assist in the incremental funding of certain water quality components of such practices, except as described below.

Section 319(h) nonpoint source control funds may not be used to implement specific requirements of draft or final NPDES storm water permits, nor to implement permit application requirements of EPA's storm water regulations. For example, section 319(h) funds may not be used to meet permit application requirements such as mapping storm water systems, identifying illicit connections, characterizing storm water discharges, or monitoring required by permits. Section 319(h) grant funds may not be used to pay for BMPs or "end of pipe" treatments which are required as part of a draft or final NPDES permit.

These prohibitions are based on the statutory limitations on the use of section 319 funds,

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including Congressional intent that these funds be used to address nonpoint sources, rather than permitted point sources. Congress determined that permitted point sources (other than publicly owned treatment works that obtained construction grants under section 212 of the CWA) would generally comply with NPDES permit requirements without Federal financial assistance.

4. Abandoned Mine Lands

As in the case of urban storm water regulated by NPDES permits, many abandoned mine land reclamation projects that are designed to protect water quality are eligible for section 319 funding, except section 319 funds may not be used to implement specific requirements in a draft or final NPDES permit. For example, section 319 funds cannot be used to build treatment systems required by an NPDES permit for an inactive mine, but they may be used to fund a variety of other remediation activities at the same mine. Examples of fundable activities include:

- Remediation of water pollution from abandoned mines that have not yet been issued a draft or final permit;
- Remediation of water pollution from portions of abandoned mine sites that are not covered by a draft or final permit;
- Mapping and planning remediation at abandoned mine land sites;
- Monitoring needed to design and evaluate the effectiveness of implementation strategies;
- Technical assistance to State and local abandoned mine land programs;
- Information and education programs;
- Technology transfer and training; and
- Development and implementation of policies to address abandoned mine lands.

C. Criteria That Apply to the Award of Section 319 Grants

Section 319 grants must meet certain statutory, regulatory and other administrative criteria that have been established to assure that section 319 funds are used in a fiscally prudent manner. All section 319 grants must be consistent with applicable provisions of EPA's general grant regulations, 40 CFR Part 31, Part 35 Subpart A, and the Agency's guidance on Performance Partnership Grants. The most important of these criteria are discussed below.

- 1. The Work Plan Must Demonstrate That Each Funded Element Will Implement Specific Activities Identified in the Approved Management Program

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Section 319(h) of the CWA provides that section 319(h) grants are to be made "for the purpose of assisting the State in implementing such management program." The grant work program must therefore "implement" the approved nonpoint source management program; each funded program activity or project will in fact lead to accomplishment of identified management program objectives. Grant work plans should link the funded activities or projects to the relevant element or elements of the States nonpoint source management program. (Specific ground-water protection activities that are not described in the nonpoint source management program are eligible if the activities are included in a State's Ground-Water Protection Strategy or Comprehensive Program, and the State's nonpoint source management program makes reference to these documents or programs.) Work plans should also indicate which State and local agencies are responsible for implementing each project or activity.

- 2. Section 319 Grants Must be Awarded as Continuing Environmental Program Grants

All section 319(h) grants should be awarded as continuing environmental program grants, consistent with 40 CFR, Part 35, Subpart A. Section 319(h) grants have some unique administrative characteristics i.e., multi-year vs. one-year budget and project periods, which are different from other EPA continuing environmental grant programs.

Unlike most other continuing environmental grants, section 319(h) grants are not required to be closed out annually. Regions are encouraged to award new continuing environmental program grants each year rather than to add funds to an existing State grant through amendments. This should allow for greater program accountability over the multi-year duration of these grants. The Regions must also ensure that all existing State grants are properly closed out at the conclusion of the project period.

- 3. The Non-Federal Share Must Be At Least 40 Percent

Section 319(h)(3) provides that the Federal share shall not exceed 60 percent of the management program implementation cost and shall be made on the condition that the non-Federal share is provided from non-Federal sources. The match need not be on an item-by-item basis, but rather should be a single figure that covers the entire non-Federal share of the costs for implementation activities. The non-Federal match does not need to be contributed at the time of the grant award but the funds must be contributed in a timely manner as needed to meet the schedules established in work plan milestones. EPA Regions must verify that grantees have satisfied the match requirements upon review and submittal of the grantee's final financial status report.

- 4. Section 319 May Provide Cost Sharing to Individuals Only in the Case of Demonstration Projects

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Section 319(h)(7) provides that States may use section 319(h) funds to provide financial assistance to individuals only if the costs are related to implementing "demonstration projects." This provision indicates that Congress did not intend for section 319 funding to be used for general cost sharing to individuals to support the implementation of BMPs. However, this does not mean that a project may be funded only in one location. A similar approach may need to be demonstrated in many locations to indicate its widespread utility in a variety of hydro-geological and sociological settings. Moreover, projects should be demonstration in a variety of locations so that they may in fact be demonstrated meaningfully to others who may wish to avail themselves of the same approaches used in the projects.

In particular, EPA does not believe that Congress intended to preclude the funding of demonstration watershed projects that may require cost-sharing a particular practice or set of practices at a number of sites within the watershed in order to demonstrate the overall effectiveness of the adopted approach in solving the water quality problem.

- 5. <u>States Must Maintain their Level of Effort</u>

Section 319(h)(9) of the CWA requires any State applying for section 319 grants to establish and maintain its aggregate annual level of State nonpoint source pollution control expenditures for improving water quality at the average level of such expenditures in FY 1985 and 1986. This is referred to as the State's "Maintenance of Effort" (MOE) requirement. States should establish their FY 1985 and 1986 level and annual levels based on expenditures by the lead State agency or agencies responsible for the State's nonpoint source pollution control activities. Federal funds may not be included in calculating the MOE base level.

- Calculation of expenditures is based on activities of the State lead nonpoint source agency or agencies responsible for the State's nonpoint source pollution control activities, not on what might be termed related activities of other State agencies with primary missions other than nonpoint source control. For example, if the State water quality agency and agricultural agency both have specific nonpoint source water quality control programs, these should be counted in the MOE. State soil conservation programs having water quality improvement or maintenance as a primary objective also should be included in a State's MOE.

- The MOE base level or annual level cannot include the MOE or matching expenditures for other Federal programs, such as sections 106, 319, 205(j)(5), 314, and 117.

- Determination of whether the State expenditures meet the MOE level for purposes of awarding a section 319(h) grant will be based on the grantee expenditures projected in the grant application. (The State will report whether it has met its

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MOE requirements in its final Financial Status Report at the end of the budget year.)

See memorandum Nonpoint Source FY-88-39, issued by EPA's Office of Water on July 12, 1988 for additional guidance regarding MOEs.

- 6. Administrative Costs Funded by Section 319 Funds May Not Exceed 10% of the Grant Award

Pursuant to section 319(h)(12), administrative costs in the form of salaries, overhead, or indirect costs for services provided and charged against activities and programs carried out with the grant shall not exceed 10 percent of the grant award. The costs of implementing enforcement and regulatory activities, education, training, technical assistance, demonstration projects, and technology transfer are not subject to this limitation.

- 7. The State Must Demonstrate Satisfactory Progress

Section 319(h)(8) provides that no section 319 grant may be made unless EPA determines that the State has made satisfactory progress during the previous fiscal year in meeting the schedule of milestones specified by the State in its nonpoint source management program. The Region will determine, based on review of annual reports, other documents and discussions with the State, whether the State's progress for the previous fiscal year was satisfactory.

D. Reporting Requirements to be Included in all Grants

All section 319(h) grants are subject to EPA's general grant regulations, 40 CFR Parts 31 and 35, which specify a variety of basic grant reporting requirements for awarding grants to States and localities. The unified grant regulations, 40 CFR Part 31.40 in particular, outline a range of administrative reporting requirements, including performance and financial reports.

Section 319(h) contains additional provisions relating to reporting. These include: (1) section 319(h)(10), which authorizes EPA to request information, data and reports as necessary to determine a State's continuing eligibility to receive section 319 grants; and (2) section 319(h)(11), which requires States to report annually on their progress in meeting milestones, and to report available information on reductions of nonpoint source pollutant loadings and on improvements to water quality through implementation of nonpoint source management programs.

Regions and States should work together to assure that appropriate reporting requirements are incorporated into each grant, either through specific grant conditions, or within the actual work program document (see Appendix F for generic grant condition language. The specific reporting requirements reflected in that language are discussed immediately below). The

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Regions and States are encouraged to assess the effectiveness of the reporting process and determine annually if adjustments or modifications are necessary and mutually beneficial.

In general, reporting should be sufficiently detailed to enable a reviewer to ascertain whether outputs and milestones are being achieved on schedule, to identify any problems that may be developing in carrying out tasks in the grant work plan, to identify corrective actions to address such problems expeditiously, and to adequately account for all Federal funds expended.

1. Basic Reporting Requirements

Recipients of funds awarded under section 319(h) of the CWA are required by applicable laws and regulations to provide information to EPA under the following reporting categories described below: (a) performance reports; (b) nonpoint source program progress grant reports; and (c) financial status reports.

Grantee Performance Reports. 40 CFR section 31.40(b)(1) requires States to submit performance reports on the status of section 319(h) grants. In general, States should submit these reports on a semi-annual basis by a date agreed to by the Region and the State. An abbreviated two or three page report per grant should generally suffice to meet this requirement. Tier I Nonpoint Source States should submit performance reports only once per year.

In addition, final reports are due 90 days after the expiration or termination of grant support, pursuant to 40 CFR Part 31.

Performance reports should include at a minimum:

- Performance/Milestone Summary: A listing of major program and project accomplishments for the period (based on the project and program milestones or commitments contained within approved work plans, grant agreements, or special conditions/agreements), as well as progress made toward meeting future milestones. (The State may accomplish some or all of this reporting requirement through its annual report discussed below.)

- Slippage Reports: Provide reasons for delays in meeting scheduled milestones/commitments and discuss what actions (State, Federal or other) will be taken to resolve any current or anticipated problems.

- Additional pertinent information including, when appropriate, analysis and explanation of cost overruns, unanticipated events/consequences, etc.

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Nonpoint Source Progress Reports. Section 319(h)(11) of the CWA requires States to report annually on progress in meeting nonpoint source management program milestones, and report available information on reductions in nonpoint source loadings and on improvements in water quality resulting from program implementation. EPA suggests that this information be provided in the following streamlined format:

1. A brief summary of progress in meeting approved milestones, and to the extent information is available, summary of reductions in nonpoint source loadings and improvements in water quality that have resulted from implementation of the State's nonpoint source management program.

2. A matrix displaying milestones from the current year for the approved State program with the following information for each milestone:

   a. Applicable project or program
   b. Brief description of project or program
   c. Scheduled project completion date
   d. Percent completed

3. A brief discussion of the extent to which Federal agencies, lands and activities within the State are supporting the State in meeting approved milestones.

4. To the extent information is available, reductions in nonpoint source loadings achieved.

5. To the extent information is available, the amount of improvement in water quality (including aquatic habitat quality) as the result of nonpoint source program activity.

6. Where information is not yet available under items 4 and 5 above for waters or watersheds where implementation is being assisted, surrogate measures of environmental progress should be used and progress should be reported in terms of the degree or percentage of completion of the project.

In the past, some States have chosen to include additional information in their annual report, using the report as a means of assessing progress to date and the need to modify the program; providing case studies of particular projects; and conveying information to a broader audience on the activities being conducted by the State. States and Regions may agree to continue to include such additional information, as a supplement to the basic information required by law. States may wish to include the following types of information in their reports:

1. Listing of further actions necessary to achieve CWA goals, including any recommendations for future EPA programs to control nonpoint source pollution.

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2. Brief case studies of any particularly successful nonpoint source control efforts. (In November 1994, EPA published Section 319 Success Stories, providing information on the effectiveness of a variety of State programs and projects in each State. EPA intends to continue to publish success stories periodically to nelp broaden public understanding of the accomplishment of this program. States that choose to include success stories in their annual reports would thereby assist EPA in this effort.)

3. Slippage reports providing reasons for delays in meeting scheduled milestones.

4. Information on increases in public awareness of nonpoint source pollution and public involvement in addressing it.

5. Copies of products produced by the State program (e.g., outreach materials or BMP documents).

Financial Status Reports. 40 CFR Section 31.41(b) requires grantees to submit financial status reports using Standard Form 269 or 269(a) to report the status of funds under each grant. In general, financial status reports should be required semi-annually. In the case of Tier I Nonpoint Source States, financial status reports should be required only annually. Final financial status reports are due within 90 days after the expiration or termination of the grant agreement.

2. Reporting Procedures and GRTS

The Regions are encouraged to work with their States to design reporting procedures that will promote efficiency and reduce unnecessary duplication of work. For example, States could choose to prepare a consolidated annual report that satisfies both requirements for both annual performance reports as well as the annual section 319(h)(11) progress report requirement. In addition, the Regions should explore ways to coordinate and synchronize the submittal of performance reports of other EPA programs managed within the same State office, e.g., sections 106, 104(b)(3), 305(b), and 604(b).

EPA has developed a computerized system, the section 319 Grants Tracking and Reporting System (GRTS), for use by States and EPA for managing and reporting data on section 319 grant. The GRTS system is broad and flexible. States are required to use GRTS only to report the specific nationally mandated data elements listed in Appendix G. These consist of the bare minimum of information needed by EPA to track State grants implementation nationally and regionally. However, State are encouraged to use GRTS more broadly to meet reporting requirements such as the grantee performance reports submitted pursuant to 40 CFR section 31.40(b)(1) as discussed above. States may also wish to use GRTS for internal reporting and project tracking purposes.

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The GRTS system currently contains four basic levels of grantee information:

(1) basic information such as grantee name, grant amount, date of award and amount of matching State funds;
(2) project descriptions, schedules, and individual project costs;
(3) project milestone data comparing proposed schedules with actual events; and
(4) sub-milestones which further delineate milestone information.

Since GRTS is an official reporting vehicle for programs or projects conducted by States under section 319(h) grants, its implementation is itself eligible for funding under section 319. Regions and States should work together to ensure that the States are provided sufficient resources in their 319 grants to meet these reporting requirements and management support needs. Examples of GRTS system support needs include: providing adequate staff support; purchasing of necessary ADP equipment, materials, and supplies; EPA mainframe access capability; and attending GRTS system conferences and training.

3. Reporting and Record keeping for Sub-State Organizations

Just as the grant agreement specifies outputs and milestones to be achieved by the States, States should assure that agreements with sub-State organizations specify outputs, milestones, and reporting and record keeping requirements in memoranda of agreement, contracts or other appropriate documents.

Where a sub-grantee will be providing a portion of the State's match, the State should ensure that adequate records are kept with respect to that portion. 40 CFR Section 31.41(a)(2) specifies that grantees shall not impose more burdensome requirements on sub-grantees than they are subject to themselves.

V. MANAGEMENT AND OVERSIGHT OF SECTION 319(h) GRANTS

As part of its improvement of both the 319 grants program and other EPA grants programs, EPA will use a differential oversight approach that reduces oversight for Tier I Nonpoint Source States and focuses attention and assistance on other States. In all cases, EPA's approach will emphasize cooperative partnerships based upon EPA's and States' mutual goal of implementing dynamic and effective national nonpoint source programs designed to achieve and maintain beneficial uses of water.

Regions should strive to use uniform approaches in conducting their evaluations of State programs, progress and problems. To assist Regions in preparing for and conducting their State program reviews, Appendix A contains an outline of evaluation criteria that may be considered by Regions and States in conducting the reviews. Regions should provide a written outline to States

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in advance of any States program evaluation. States are encouraged, but are not required, to provide written responses to the Regions in advance of the reviews.

For Tier I Nonpoint Source States, EPA will rely primarily on the State's own self-assessment, based on the outline presented in Appendix A and supported by the various reports outlined in Section IV-D above. EPA will review the self-assessment and State reports, and then contact the States if EPA desires additional information. EPA will meet with Tier I States to discuss the State's progress in implementing their nonpoint source management programs only once every two or three years, unless particular issues arise that warrant more frequent meetings.

For Tier II Nonpoint Source States, in addition to reviewing the State's reports, EPA will meet with the State at least annually to discuss the State's progress in implementing its program. Appendix A will be used as a basis for evaluating the progress made by the State in reviewing, upgrading, and implementing its nonpoint source management program. EPA and the State will also discuss ways in which EPA can better assist the State during the forthcoming year in implementing the State's program. Types of assistance to be considered include support for State efforts to assess water quality problems; support for State design and implementation of watershed projects; technical assistance to help the State monitor the progress and results of watershed projects; and assistance in the development of outreach tools.

Subsequent to its annual meeting with a Tier II State, EPA will produce a report, with State input and review, that assesses the progress and problems experienced by the State in implementing its program during the preceding year. This assessment will also include EPA's evaluation of the State's progress towards becoming a Tier I Nonpoint Source State.

When evaluation results show that grant and contract provisions have not been substantially achieved, the State and Region should work cooperatively to take corrective action. If performance by the State is poor, the Region may be required to determine that the State has not made "satisfactory progress" under section 319(h)(8) and to deny the State's grant application the following year. Other forms of corrective action are described at 40 CFR 31.43.

Where a State lead nonpoint source agency is providing EPA grant funds to other State or local agencies to carry out the terms of a nonpoint source grant, the lead agency remains responsible for all outputs in its section 319(h) work program. Thus, if a local agency has difficulties performing particular funded activities, the Region should work with the State lead agency to resolve the problem.

VI. GRANTS TO INDIAN TRIBES

This guidance is not specifically directed to Tribal nonpoint source management programs, however, but with the agreement of EPA and the eligible Tribe this guidance may be

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used for administering section 319 programs and grants. Alternatively, A Tribal Guide to the State Section 319 Nonpoint Source Management Program (USEPA, Office of Water, September 1994) may be used.

Section 518(f) states that the Administrator may reserve for Indian Tribes treated as States not more than one-third of one percent of the amount appropriated for any fiscal year under section 319(j) for section 319(h) and (I). EPA intends to continue to make one-third of one percent of each appropriation available for 319(h) grants to Tribes.

To be eligible for such grants, Tribes must meet the requirements in section 518(e) of the Clean Water Act, 40 CFR 130.6(d) and 130.15, as well as applicable provisions of 40 CFR Part 35. A succinct explanation of the new streamlined approach for Tribes to be treated in substantially the same manner as States are treated for purposes of obtaining various types of financial assistance is presented in 59 FR 13814-18 (March 23, 1994). A step-by-step guide for Tribes seeking section 319 grants is presented in A Tribal Guide to the Section 319(h) Nonpoint Source Grant Program (EPA 841-S-94-003, September 1994).

Tribes, like States must have EPA approved nonpoint source assessments and management programs in order to be eligible for section 319(h) grants. Though all portions of the assessment must be completed in order to be approved by EPA, the Agency may approve a portion of a Tribes' management program. Once a portion is approved, a section 319(h) grant can be awarded for those portions of the management program that have been approved by the Agency. EPA encourages Tribes that are currently unable to develop complete nonpoint source management programs, to focus on their highest priority nonpoint source problems and develop approvable portions of nonpoint source programs to address those problems. In addition, sections 106 and 104(b)(3) funds are available to Tribes for developing assessment reports; section 106 funds may also be used to develop management programs. Technical assistance with the development of assessment and management programs is available from EPA.

Indian Tribes are required to meet the matching and maintenance-of-effort requirements under section 319(h); however, if a Tribe can demonstrate financial cause, the Federal share of 319(h) funds can be increased to 90 percent. In addition, Tribes may use in-kind contributions to meet matching requirements.

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APPENDIX A

SUGGESTED OUTLINE FOR ASSESSMENTS OF STATE PROGRAMS

The following suggested outline is designed for use by States and EPA Regional offices in evaluating the progress being made by States in reviewing, updating, revising, and implementing their State nonpoint source programs. The outline reflects the nine key program elements of successful State programs presented in Section III-A of this Guidance. The outline below breaks these elements down into component parts that will assist reviewers in evaluating State program effectiveness in achieving these nine program elements.

This outline may be used as a guide by Tier I Nonpoint Source States for their self-assessments (see Section IV-A of this guidance) and by any other State that chooses to conduct a self-assessment, as well as by EPA Regions that conduct assessments of State programs. Regions and States choosing to use this outline may wish to tailor the components of particular elements to ensure that they most appropriately addresses particular regional or State needs.

1. The State program contains explicit short- and long-term goals, objectives, and strategies to protect surface and ground water.

o State program includes a vision statement.

o State has specific long-term goals that are linked to its vision and are directed towards the expeditious achievement and maintenance of beneficial uses of water.

o State has specific short-term (e.g., 1-5 year) objectives, expressed as activities, that are linked to its goals.

o State has identified measures and indicators that will be used to assess the State's success in achieving its goals and objectives.

o State has identified specific, expeditious milestones for its activities.

o State has identified implementation steps and the expected effects of those steps on its water resources.

2. The State uses a balanced approach that emphasizes both State-wide nonpoint source programs and on-the-ground management of individual watersheds where waters are impaired and threatened.

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o Annual work plans contain nonpoint source implementation actions directed at both specific priority watersheds and activities of a State-wide nature.

o State tracks both State-wide activities and watershed projects.

o State has institutionalized its program beyond the annual implementation of 319-funded activities and projects.

o State uses an integrated watershed approach for assessment, protection and remediation that is well integrated with other water or natural resource programs.

3. The State program (a) abates water quality impairments from existing sources and (b) prevents significant threats from present and future activities.

o State has comprehensively characterized water quality impairments and threats throughout the State which are caused or significantly contributed to by nonpoint sources.

o State has comprehensively characterized those water quality impairments and threats that are likely to be caused by new nonpoint sources.

o State program addresses all significant nonpoint source categories and subcategories.

o State program is designed to remediate existing sources of nonpoint source pollution that are identified in its assessments.

o State has identified specific programs to protect against future impairments by new sources.

4. The State program identifies waters and their watersheds impaired by nonpoint source pollution and identifies important unimpaired waters that are threatened or otherwise at risk. Further, the State establishes a process to progressively address these identified waters by conducting more detailed watershed assessments and developing watershed implementation plans, and then by implementing the plans.

o State water quality assessments (including those performed under section 305(b), 319(a), 303(d), 314, and others), along with analysis of changing land uses within the State, form the basis for the identification of the State's planned nonpoint source activities and projects.

o State activities focus on remediating the identified impairments and threats, and on protecting the identified at-risk waters.

o State has provided for pubic participation in the overall identification of problems to be addressed in the State program, and in the establishment of a process to progressively address

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these problems.

o State nonpoint source priorities are communicated to, consistent with, and reflected in program planning and implementation activities by other water resource management agencies operating within the State.

o State revises its identification of waters and revisits its process for progressively addressing these problems periodically (e.g., once every 5 years).

5. The State reviews and upgrades all program components required by section 319(b) of the Clean Water Act, and establishes flexible, targeted, and iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable. The State programs include:

o Technology-based or water quality-based programs aimed at achieving and maintaining beneficial uses of water;

o A mix of regulatory, non-regulatory, financial and technical assistance as needed; and

o Baseline programs to the extent that they are currently required by Federal or State law, including coastal nonpoint programs required by section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990.

o The State includes in its program and implements the following eight items:

oo Identification of the measures to be used to control nonpoint sources of pollution, focusing on those measures which will be most effective to address the specific types of nonpoint source pollution prevalent within the State (manuals or compendiums of best management practices will usually suffice, provided that they are specific and are related to the category or subcategory of nonpoint sources);

oo Identification of programs to achieve implementation of the measures;

oo Processes used to coordinate and, where appropriate, integrate various programs used to implement nonpoint source controls in the State;

oo A schedule with goals, objectives, and annual milestones for program implementation; legal authorities to implement the program; available resources; and institutional relationships;

oo Attorney General certification (if program is changed substantially);

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oo Sources of funding from Federal (other than 319), State, local, and private sources;

oo Identification of Federal programs and projects that the State will review for their effects on water quality and their consistency with the State program; and

oo Monitoring and other evaluation programs to help determine short- and long-term program effectiveness.

6. The State manages and implements its nonpoint source program efficiently and effectively, including necessary financial management.

o The State's plans for watershed projects and State-wide activities are well-designed, with sufficient detail to assure effective implementation.

o The State's watershed projects focus on the critical areas, and critical sources within those areas, that are contributing to nonpoint source problems.

o State implements its activities and projects, including all tasks and outputs, in a timely manner.

o State has established systems to assure that the State meets its reporting obligations.

o State utilizes the Grants Tracking and Reporting System effectively.

o State has developed and uses a fiscal accounting system capable of tracking expenditures of both 319 funds and non-Federal match.

o Nonpoint source projects include appropriate monitoring and/or environmental indicators to gauge effectiveness.

7. The State strengthens its working partnerships and linkages with appropriate State, Tribal, regional, and local entities, private sector groups, citizens groups, and Federal agencies.

o The State uses a State-wide nonpoint source advisory group, including representatives of Federal, State, and local agencies, private sector groups and citizens groups, to make recommendations regarding program direction, project selection, and other similar aspects of program administration.

o The State program specifies procedures to provide for periodic public input into the program.

o The State effectively incorporates a variety of organizations and interests into its implementation of nonpoint source activities and projects.

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o The State uses its partnerships effectively to avoid the transfer of problems among environmental media.

8. The State identifies Federal lands and activities which are not managed consistently with State nonpoint source program objectives. Where appropriate, the State seeks EPA assistance to help resolve issues.

o The State reviews Federal financial assistance programs, development projects, and other activities that may result in nonpoint source pollution for consistency with the State program.

o The State works with Federal agencies to resolve potential inconsistencies between Federal programs and activities and the State programs.

o Where the State cannot resolve Federal consistency issues to its satisfaction, it requests EPA assistance to help resolve the issues.

o The State coordinates with Federal agencies to promote consistent activities and programs, and to develop and implement joint or complementary activities and programs.

9. The State periodically reviews and evaluates its nonpoint source management program using environmental and functional measures of success, and revises its nonpoint source assessment and its management program at least every five years.

o The State has and uses a process to periodically assess both improvements in water quality and new impairments or threats.

o The State uses a feedback loop, based on monitoring and other evaluative information, to assess the effectiveness of the program in meeting its goals and objectives, and revises its activities and tailors its annual work plans, as appropriate, in light of its review.

o Using its feedback loop, the State periodically reviews and assesses the goals and objectives of the nonpoint source management program, and revises the program as appropriate in light of its review.

o The State's annual report successfully portrays the State's progress in meeting milestones, implementing BMPs, and achieving water quality goals.

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APPENDIX B

INDICATORS OF PROGRESS AND SUCCESS

To measure the progress and success of their nonpoint source programs, States will generally need to use at least three sets of measures. These include measures to indicate progress towards (1) the State's overall water quality vision of achieving and maintaining beneficial uses of water, (2) the long-term goals set by the State in its program (e.g., installing appropriate technology at all animal waste facilities that need to be upgraded, or implementing particular watershed projects) and (3) the shorter-term goals and objectives set by the State (e.g., successfully implementing a particular technology).

The following list illustrates measures which States may choose from or add that will help the States and the public measure the progress and success of their programs. States may identify and use other indicators that are most relevant to their nonpoint source problems, programs, and projects. However, States must at least use the three measures of progress that are identified in section 319(h)(11), i.e., implementation milestones, available information on reductions in nonpoint source pollutant loadings, and available information on improvements in water quality.

Further, well-designed State programs will usually include several appropriate measures from each of the categories set forth below for each of their projects or program activities. For overall program status and trends, States will generally include measure 1.A. below as part of their section 305(b) reports.

The categories below are approaches which have been successfully used as water-quality and implementation measures, as well as measures of enhanced public education, awareness and action. They are presented as examples, not requirements, and should be used as starting points for discussion.

1. Water Quality Improvement from Nonpoint Source Controls

a. Number (or percentage) of river/stream miles, lake acres, and estuarine and coastal square miles that fully support all designated beneficial uses.

b. Number (or percentage) of river/stream miles, lake acres, and estuarine and coastal square miles that come into compliance with one or more designated uses (e.g., a river segment that is neither fishable nor swimmable becomes fishable), or with one or more numeric water quality criteria (e.g., achieves a criterion for phosphorus while continuing to exceed a criterion for nitrogen).

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c. Demonstrable improvements in relevant surface and ground water quality parameters.

d. Demonstrable improvements in biological or physical parameters (e.g., increase in diverse fish or macroinvertebrate populations, or improved riparian areas or other measures of habitat).

e. Opening of previously closed shellfish beds

f. Lifting of fish consumption advisories)

g. Prevention of new impairments (e.g., number of river miles removed from the "threatened" lists, or number of miles of high-quality waters protected).

2. **Nonpoint Source Pollutant Load Reduction**

a. Reductions in pollutant loadings (e.g., by pounds or percentage) from nonpoint sources in impaired/threatened watersheds.

b. Reductions in pollutant loadings (e.g., by pounds or percentage) from nonpoint sources in priority watersheds identified by the State.

c. State-wide reduction in pollutant loadings from nonpoint sources.

d. In the case of new activities (e.g., land development, road-building, timber harvesting, and construction of new or significantly expanded animal waste facilities), prevention or minimization of new loadings, and/or offset of new loadings by reductions from existing sources.

e. Reductions in frequencies, or prevention of increases, of peak flows in developing or developed areas.

3. **Implementation of Nonpoint Source Controls**

a. Number of measures implemented in watersheds of impaired/threatened waters (e.g., number of on-the-ground practices implemented that reflect, for example, the "best practicable" approach to solve the identified problem.)

b. Percentages of "needed" measures implemented in watersheds of impaired/threatened waters (e.g., where watershed analysis has shown the need to implement measures at 20 sites, annual progress in implementing a watershed project can be shown by the number of BMPs installed.)

c. Combination of 2.b and 3.b.

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d. Number of approved or certified plans written to address, e.g., erosion and sediment control, storm water, nutrient management, or pest management.

e. Percent of watershed covered by plans described in item 3d.

f. Percent of facilities covered by plans described in item 3d.

g. Statistically-based survey of implementation rates, based on periodic "compliance surveys."

h. Percent of priority ground water addressed by nonpoint source controls.

4. **Public Education, Awareness, and Action**

a. Participation rates in education programs specifically directed to solving particular nonpoint source pollution problems.

b. Statistically-based survey of public awareness, knowledge, and action to measure changes in attitudes and action over time.

c. Participation rates in various nonpoint source activities, such as citizen monitoring and watershed resource restoration activities.

d. Participation rates in various public awareness and education efforts.

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APPENDIX C

ELEMENTS OF A WELL-DESIGNED WATFRSHED IMPLEMENTATION PLAN

A well-designed plan for a successful watershed implementation project typically includes the following:

1. **Define the Problem**

   - Identification of water quality threat or problem - Information is provided on whether the water resource is threatened or its use is impaired from the nonpoint source assessment report, 303(d) list , 305(b) report, or a consolidated State water quality assessment report. A State's comprehensive State Ground Water Protection Program or ground water protection strategy may also be a useful sources of information.

   - Critical areas - The approximate size of the critical areas to be treated is identified on a map and quantified. The critical areas are of an appropriate size to ensure that the measures implemented will have a significant impact on restoring or protecting designated beneficial uses within the watershed.

2. **Build a Project Team and Public Support**

   - Institutional roles and responsibilities - Roles and responsibilities of agencies active within the watershed are identified, regardless of funding source. Where possible, one agency at the local level is identified as the lead agency for the watershed project.

   - Information/education and public participation component - The nonpoint source watershed plan documents how interested and affected publics are or will be involved in the selection, design and implementation of the watershed project. Additionally the educational activities to be conducted in the watershed project are identified, including a schedule. The project also includes a plan for communicating lessons learned to other areas of the State through the Statewide nonpoint source information and education program.

3. **Set Goals and Identify Solutions**

   - Nonpoint source control objectives - The nonpoint source watershed plan describes what is expected to be accomplished in a two to five year period. Objectives relate t all the identified water quality problems, are quantitative, and make progress towards achieving implementation of technology-based measures or

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achieving or maintaining State water quality standards. For example, where water quality standards are violated and a 75 percent reduction is needed to attain/maintain water quality standards, an objective might be to reduce fecal coliform loadings to a waterbody of 75 percent.

4. **Implement Controls**

- Implementation schedule - A schedule describing the location and type of BMPs and programs to be implemented within the watershed and the time of implementation are provided within the plan.

5. **Measure Success**

- Monitoring and evaluation - Utilizing the project goals identified in the work plan, the plan should also provide an appropriate monitoring component to evaluate effectiveness, including ambient effects monitoring, beneficial use assessments, and environmental indicators (see Section II-A of this guidance and Appendix B).

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APPENDIX D

SCHEDULE FOR ISSUANCE OF SECTION 319(h) GRANTS

	FY 97	FY 98 & BEYOND
EPA issues brief national guidance including annual planning targets (for planning purposes the President's request level will be assumed)	3/1/96	3/1
States submit draft work plans to EPA Regions	6/1	5/1
EPA Regions provide response to work plans	7/15	6/15
States submit final work plans and grant applications to EPA Regions	9/15	8/1
EPA Regions approve work plans and award grants	11/15	10/1

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APPENDIX E

GENERIC GRANT CONDITION ESTABLISHING STATE REPORTING REQUIREMENTS

The recipient (name of State lead nonpoint source agency) agrees to comply with all reporting requirements required by EPA regulation and guidance. All reporting information will be submitted according to the schedule(s) required in the Parts 31 and 35 regulations and in national guidance. The three basic reporting categories include: Grantee Performance Reports [40 CFR, Part 31.40(b)(1)]; Nonpoint Source Progress Reports [CWA, section 319(h)(11)]; and Financial Status Reports [40 CFR, Part 31.41(b)].

The recipient agrees to use the Agency's Grants Reporting and Tracking System (GRTS) to provide all nationally mandated data elements listed in Appendix F of the national nonpoint source grants guidance (citation). Failure to comply with the above referenced reporting requirements may result in a disruption of grantee funding and/or early termination of the grant agreement(in accordance with 40 CFR, Part 31.43.

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APPENDIX F

NATIONALLY MANDATED DATA ELEMENTS UNDER SECTION 319 GRANTS REPORTING AND TRACKING SYSTEM (GRTS)

Data Element Names

- Work Program Received Code/Date
- Work Program Approved Code
- NPS Category
- NPS Functional Category
- NPS Waterbody Type (includes ground-water)
- NPS Hydrologic Unit Code
- NPS Budget 319(h) Funds
- NPS Project Title
- NPS Quality Assurance Plan Approved Code/Date
- NPS (Project) Start Code/Date
- NPS (Project) Completion Code/Date

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APPENDIX G

STATE 319 GRANT ALLOCATIONS

State		Region	Percentage of National 319 allocation	Amount of Allocation (Assuming $100M total allocation)
ALABAMA	AL	4	1.9591	$1,952,617
ALASKA	AK	10	1.2160	$1,212,026
ARIZONA	AZ	9	1.6400	$1,634,599
ARKANSAS	AR	6	1.9638	$1,957,342
CALIFORNIA	CA	9	5.3280	$5,310,372
COLORADO	CO	8	1.2635	$1,259,327
CONNECTICUT	CT	1	0.9761	$972,854
DELAWARE	DE	3	0.7159	$713,586
DIST. OF COL.	DC	3	0.6235	$621,434
FLORIDA	FL	4	3.9116	$3,898,739
GEORGIA	GA	4	2.3338	$2,326,097
HAWAII	HI	9	0.7705	$767,910
IDAHO	ID	10	1.2339	$1,229,794
ILLINOIS	IL	5	4.1105	$4,096,964
INDIANA	IN	5	2.2400	$2,232,621
IOWA	IA	7	2.2843	$2,276,769
KANSAS	KS	7	1.8454	$1,839,306
KENTUCKY	KY	4	1.7093	$1,703,663
LOUISIANA	LA	6	2.4293	$2,421,324
MAINE	ME	1	1.1702	$1,166,308
MARYLAND	MD	3	1.3321	$1,327,699
MASSACHUSETTS	MA	1	1.3524	$1,347,964
MICHIGAN	MI	5	2.9196	$2,909,963
MINNESOTA	MN	5	3.4481	$3,436,678
MISSISSIPPI	MS	4	1.9164	$1,910,078
MISSOURI	MO	7	2.3082	$2,300,543
MONTANA	MT	8	1.3219	$1,317,524
NEBRASKA	NE	7	1.8197	$1,813,673
NEVADA	NV	9	0.8491	$846,325
NEW HAMPSHIRE	NH	1	0.7623	$759,786
NEW JERSEY	NJ	2	1.6638	$1,658,328
NEW MEXICO	NM	6	1.2204	$1,216,340
NEW YORK	NY	2	3.3943	$3,383,064
NORTH CAROLINA	NC	4	2.3227	$2,315,001
NORTH DAKOTA	ND	8	2.4119	$2,403,984
OHIO	OH	5	3.0328	$3,022,763
OKLAHOMA	OK	6	1.5799	$1,574,679

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APPENDIX G

OREGON	OR	10	1.3838	$1,379,187
PENNSYLVANIA	PA	3	2.9372	$2,927,541
RHODE ISLAND	RI	1	0.6762	$673,986
SOUTH CAROLINA	SC	4	1.5586	$1,553,445
SOUTH DAKOTA	SD	8	1.6342	$1,628,790
TENNESSEE	TN	4	1.5906	$1,585,324
TEXAS	TX	6	4.7356	$4,719,996
UTAH	UT	8	0.9173	$914,264
VERMONT	VT	1	0.7387	$736,243
VIRGINIA	VA	3	1.9651	$1,958,653
WASHINGTON	WA	10	1.9176	$1,911,233
WEST VIRGINIA	WV	3	1.1002	$1,096,604
WISCONSIN	WI	5	2.5844	$2,575,893
WYOMING	WY	8	0.9741	$970,847
GUAM	GU	9	0.2695	$268,651
N. MAR.	NM	9	0.2695	$268,651
PAC TT	TT	9	0.2695	$268,651
PUERTO RICO	PR	2	0.5585	$556,697
AMER. SAM.	AS	9	0.2695	$268,651
VIR. IS.	VI	2	0.2695	$268,651

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FACTORS IN PLANNING TARGET FORMULA

FACTOR	DATA SOURCE	WEIGHTING	RATIONALE
I. National set-aside for Indian Tribes	§106 allocation formula	0.0033	§518(f)
II. Other*			
Minimum amount for the States and Territories	N/A	0.2643	All States, D.C. and territories receive funds to institutionalize NPS control activities & programs.
1988 Section 305(b) Report	1988 Draft - 10/89	N/A	National data used to determine the weighting factors for ag, urban, mining, & forestry as indicated below.
Population	1980 Census 1987 Census (est.)	0.2861	Factors include State fraction of national population, pop'n density, and pop'n growth.
Cropland Acreage	1987 Ag Census 1987 NRI Data 1980 Census Data 1986 ASIWPCA NPS Report	0.1581	Cropland is used as a surrogate for sediment and nutrient problems, which account for about 85% of ag NPS problems. Modeling approach based partly on 1986 ASIWPCA national data.
Pasture & Rangeland Acreage	1987 Ag Census	0.0205	Animal units & animal units/farm acre used as surrogate for BOD & bacteria problems, which account for about 11% of the ag NPS problem.
Forest Harvest Acreage	EPA	0.0429	Acreage of private & Federal forest harvested annually.
Wellhead Protection Areas	Wellhead Protection Program Allotment Formula - EPA	0.1135	Factors include relative risk to ground water, number of people potentially impacted, number of wellheads to be protected & size of states.
Critical Aquatic Habitats	Dahl, T.E 1990. Wetland Losses in the United States 1970's 1980's. U.S. Dept. of the Interior, Fish & Wildlife Service, Washington, D.C.	0.0500	State share of total wetland acreage is a meaningful surrogate for critical aquatic habitat since it covers both fresh and saline waters.
Other Use Impact - 319(a)	N/A	N/A	All NPS factors for ag, urban, forestry & mining are based upon land based activities, therefore addressing impaired & threatened waters.
Mining	1987 NRI 1980 RCA Appraisal	0.0572	State's fraction of mined acres as surrogate for mining.
Pesticides	1987 NRI 1986 National Pesticide Usage Data Base, RFF & EPA	0.0074	Amount & rate of application of active ingredients for pesticides recommended for inclusion in EPA's National Pesticide Survey

*The weighting for Other Factors is based on the allocation after National set-asides have been subtracted from the total appropriated funds. As a result, the sum of the weighting for Other Factors is unity.

NOTE: These factors are unchanged from EPA's current formula.

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APPENDIX H

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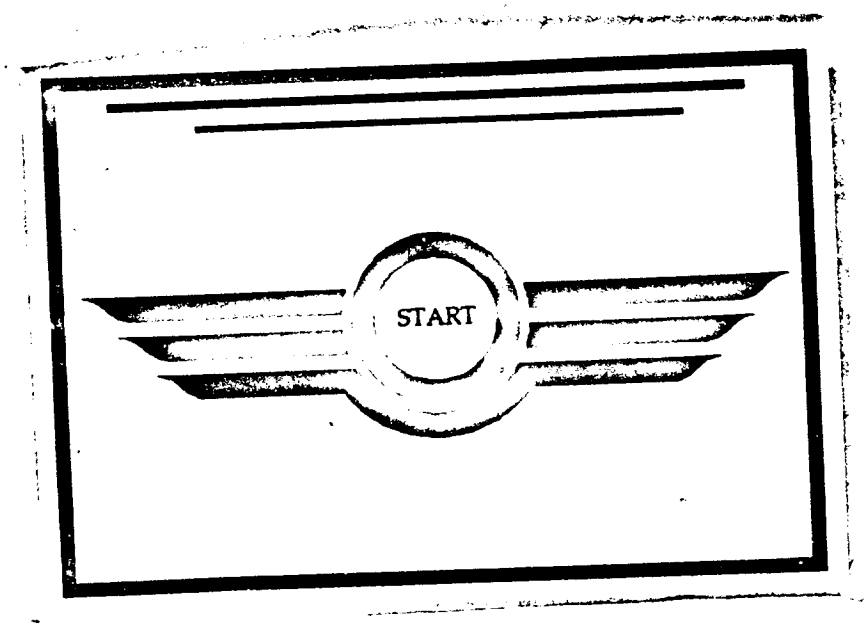

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FAX TRANSMISSION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

DATE: 7/26 **PAGES (including cover sheet):** 2

TO:
Name: Carlos Urrunaga
Organization: L.A. Regional Board
Office/Mail Code: Storm Water Permits
Fax Number: 213-266-7600
Verification Number:

FROM:
Name: Eugene Bromley
Mailcode: W-5-1
Phone Number: (415) 744-1906
Fax Number: (415) 744-

NOTE: Draft condition in AZ MS4 permits addressing review of SWPPPs by municipals - The municipals seem fairly comfortable with this.

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e) Review of Industrial Storm Water Pollution Prevention Plans (SWPPPs)

As part of the permittee's inspection program for industrial facilities covered by an individual or general NPDES storm water permit, the permittee shall review SWPPPs (if SWPPP preparation is required by the NPDES permit) to assist the permittee in determining the compliance status of the facility with the requirements of relevant local ordinances and permittee's storm water management program. SWPPPs may be reviewed prior to or during inspections. The permittee shall also take appropriate actions to ensure compliance by industrial facilities with local authorities and the permittee's storm water management program.

When the permittee observes significant deficiencies (based on the judgment of the permittee) in the SWPPPs, or their implementation at a particular facility, which the permittee believes would constitute noncompliance with the general or individual NPDES permit, such noncompliance shall be reported to ADEQ and Region 9 unless, after attempting to obtain compliance by the facility, the permittee is successful in obtaining compliance.

f) Storm Water Controls at Construction Sites

As part of the permittee's inspection program for construction sites covered by a general or individual storm water NPDES permit, the permittee shall review SWPPPs (if SWPPP preparation is required by the NPDES permit) to assist the permittee in ensuring compliance by construction sites with the objectives of the permittee's storm water management program. SWPPPs may be reviewed prior to or during inspections. The permittee shall also take appropriate actions to ensure compliance with local authorities and the permittee's storm water management program.

When the permittee observes significant deficiencies (based on the judgment of the permittee) in the SWPPPs, or their implementation at a particular construction site, which the permittee believes would constitute noncompliance with the general or individual NPDES permit, the permittee shall report such noncompliance to ADEQ and Region 9 unless, after attempting to obtain compliance by the construction site, the permittee is successful in obtaining compliance.

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Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

951 Turner Court, Hayward CA 94545-2698
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Member Agencies:
Alameda
Albany
Berkeley
Dublin
Emeryville
Fremont
Hayward
Livermore
Newark
Oakland
Piedmont
Pleasanton
San Leandro
Union City
Alameda County
Alameda County Flood Control and Water Conservation District
Zone 7 of the Alameda County Flood Control District

April 4, 1996

Dr. Thomas Mumley
San Francisco Bay Regional Water
Quality Control Board
2101 Webster St., Suite 500
Oakland, CA 94612

Subject: Transmittal of the Final *California Industrial/Commercial Stormwater Inspection Program Handbook*
(Federal Assistance Grant Award Number CP999179-01-0)

Dear ~~Dr. Mumley~~ Tom:

On behalf of the Alameda Countywide Clean Water Program and EOA, Inc., we are pleased to provide you with the final *California Industrial/Commercial Stormwater Inspection Program Handbook*. Enclosed are one reproducible copy, two bound copies, and one diskette containing the Handbook text in Word Perfect 5.1. Other copies have been distributed to the Handbook Review Committee and the State Water Resources Control Board as indicated on the attached list. This completes our scope of work under the subject contract.

Thank you for your support of and help with the preparation of this much needed guidance document. Additional copies may be ordered from Blue Print Services using the enclosed order form.

Very truly yours,

G. Robert Hale, PhD.
ACCWP Management Committee Chair

Jill C. Bicknell, P.E.
EOA, Inc.

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Enclosures

cc: Distribution List (attached)

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California Industrial/Commercial Stormwater Inspection Program Handbook

For Municipal Agencies

Final Document
March 1996

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A Consortium of Local Agencies

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Acronyms and Abbreviations

ACCWP	Alameda Countywide Clean Water Program
BMP	best management practice
CCCWP	Contra Costa Clean Water Program
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendments
EPA	(United States) Environmental Protection Agency
General Permit	General Industrial Activities Storm Water Permit
hazmat	Hazardous materials
HMBP	Hazardous materials business plan
MEP	maximum extent practicable
MOU	Memorandum of Understanding
NPDES	National Pollutant Discharge Elimination System
NOI	Notice of Intent (for State General Permit)
NPS	nonpoint source
POTWs	publicly-owned treatment works
Regional Board	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act of 1986
SCVNPSPCP	Santa Clara Valley Nonpoint Source Pollution Control Program
State Board	State Water Resources Control Board
STOPPP	(San Mateo Countywide) Storm Water Pollution Prevention Program
SWPPP	Storm Water Pollution Prevention Plan

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Introduction 1

Municipal NPDES Stormwater Permits in California

Alameda County *
Bakersfield
Contra Costa County *
Fairfield-Suisun
Fresno
Los Angeles *
Modesto
Orange County *
Riverside *
Sacramento *
Salinas †
San Bernardino *
San Diego *
San Mateo County *
Santa Clara Valley *
Santa Rosa †
South Lake Tahoe *
Stockton
Vallejo †
Ventura County *

* *Area-wide permit*
† *Soon to be issued*

Stormwater inspection and outreach programs for businesses are still in the early stages of development and are not consistent statewide.

BACKGROUND

The State of California has issued approximately 20 National Pollutant Discharge Elimination System (NPDES) permits to cities and counties for the discharge of stormwater from municipal storm drain systems. One of the key requirements of municipal stormwater permits is prevention and control of pollutants from industrial and commercial facilities that discharge to municipal storm drains. Implementation of pollution prevention measures and stormwater discharge controls is accomplished through site inspections and educational outreach to industrial and commercial facilities.

Traditionally, business inspection programs conducted by municipal agencies have not formally included inspections for preventing discharges of pollutants to storm drains. Some municipal stormwater programs, including those in Alameda, Santa Clara, San Mateo, and Los Angeles Counties, have begun conducting stormwater inspections as part of their NPDES permit compliance and programs in Contra Costa and Sacramento Counties are currently taking steps to establish inspection programs. But efforts by many municipalities with NPDES permits to develop and carry out inspection and outreach programs are still in the early stages of development and are not consistent statewide.

Industrial and commercial businesses are already subject to various other inspections related to control of hazardous materials, hazardous wastes, and discharges to the sanitary sewer. Inspections may be conducted by different agencies and have separate requirements and fees. In some instances, corrective actions resulting from one inspection may need to be coordinated to avoid conflicts with requirements of other regulatory programs. Some facilities are also subject to the requirements of individual or general NPDES permits which regulate stormwater discharges associated with industrial activity. In these cases, there is additional potential for redundant inspections at the State and municipal level.

Recognizing the need to address these issues, provide guidance to municipalities, and coordinate State and municipal stormwater programs, the State Water Resources Control Board (State Board) authorized the use

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of U.S. Environmental Protection Agency (EPA) 104(b) grant funds for development of a handbook of procedures for industrial/commercial stormwater inspection programs conducted by municipalities. The grant was awarded to the Alameda Countywide Clean Water Program, which has developed and implemented successful stormwater inspection and educational outreach programs through its member agencies.

PURPOSE OF THIS HANDBOOK

The purpose of the Industrial/Commercial Stormwater Inspection Program Handbook is to assist California municipalities in developing and conducting industrial and commercial stormwater inspection programs. The Handbook provides step-by-step procedures for municipalities of all sizes to use in developing programs and for inspectors to use in performing and documenting inspections. Many of these procedures are based on existing industrial and commercial stormwater inspection activities from throughout the State.

By following the steps presented in the Handbook, your municipality can:

- *establish an inspection program consistent with others statewide;*
- *reduce pollutant discharges to stormwater from the businesses in your community;*
- *achieve compliance with your NPDES permit.*

The goal of a stormwater inspection program is to control discharges from industrial and commercial facilities to storm drains, in order to protect water quality and beneficial uses of creeks, rivers, bays, and the ocean and comply with stormwater discharge permits. Conducting on-site inspections is only one component of the overall program. Other components of an inspection and educational outreach program should include:

- assessment of local businesses and their potential effects on stormwater quality;
- educational outreach to businesses;
- coordination of inspection agencies' responsibilities;
- follow-up and enforcement activities as needed to correct violations;
- training of inspectors and other municipal staff; and
- record keeping, reporting and program evaluation.

The Handbook presents examples and case studies of these elements of existing stormwater inspection programs that will allow you to draw on the experience of other municipalities when developing your program. The Handbook emphasizes incorporating stormwater

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inspections into existing inspection programs where possible and coordinating responsibilities with other inspection agencies. This approach helps to reduce the regulatory burden on businesses and promotes efficient use of available resources.

The intent of this Handbook is to provide the framework for municipalities to develop an inspection program that is appropriate for their situation. Inspection programs can be designed in many different ways; the ideas and examples presented in the Handbook will help you design a program that is efficient and effective. Use of the Handbook should also increase your awareness of the tools available to build a program that will comply with your NPDES permit.

ORGANIZATION OF THE HANDBOOK

Chapters 1, 2 and 3 of the Handbook provide information to stormwater managers for setting up inspection programs, whereas Chapter 4 is directed to inspectors. Specifically, Chapter 1 discusses the need for industrial and commercial stormwater inspection programs and presents an overview of Federal and State storm water regulations. Chapter 2 discusses the roles and responsibilities of municipalities, regulatory agencies, and businesses in controlling pollutants in stormwater discharges from businesses, and how municipalities and regulatory agencies can coordinate their inspection efforts.

Chapter 3 presents information for stormwater managers on the components of a stormwater inspection program. It provides step-by-step guidance and options for developing an effective inspection program that is tailored to your municipality's size, characteristics, and resources. Worksheets are provided to assist you in assessing current local conditions and selecting appropriate program elements. Chapter 3 also includes case studies of existing stormwater inspection programs.

Chapter 4 provides guidance to inspectors on the process of conducting inspections and providing educational outreach to businesses. It also discusses the inspector's role and responsibilities in conducting the inspections and communicating and coordinating with appropriate agencies.

Appendices to the Handbook present examples of various tools that municipal stormwater managers and inspectors may use to develop and conduct inspection programs. These include:

HANDBOOK ORGANIZATION

Chapter 1

- *Introduction and Purpose*
- *Need for Inspections*
- *Regulatory Overview*

Chapter 2

- *Roles and Responsibilities*
  - ✓ *Municipalities*
  - ✓ *Businesses*
  - ✓ *Regulatory Agencies*

Chapter 3

- *Information for Stormwater Managers:*

Steps for Developing an Inspection Program

Chapter 4

- *Information for Inspectors:*

Steps for Conducting Inspections and Outreach

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Typical Stormwater Pollutants and Their Impacts[1]

Sediment can be detrimental to aquatic life by interfering with photosynthesis, growth, and reproduction, and can transport other pollutants that attach to it.

Heavy metals, including lead, zinc, copper, cadmium, chromium, and nickel are toxic to aquatic organisms, and can potentially contaminate drinking water supplies.

Oil and grease contain a wide array of hydrocarbons, some of which are toxic to aquatic organisms at low concentrations.

Bacteria and viruses from animal excrement and sanitary sewer overflows threaten human health and can result in closure of recreation areas.

Oxygen demanding substances such as plant debris, litter, and organic matter, can depress oxygen levels in receiving waters.

Nutrients including phosphorus and nitrogen can cause excessive vegetation or algal growth, resulting in impaired use of lakes for aquatic habitat, recreation and water supply.

[1]*From California Storm Water Industrial/Commercial Best Management Practice Handbook, 1993.*

Effectively eliminating illicit discharges and encouraging businesses to adopt pollution prevention measures can result in significant benefits to water quality in urban and suburban communities.

- checklists and reporting forms;
- model ordinances, inspection agreements and enforcement protocols;
- examples of educational outreach materials;
- guidance on management of pollutant sources at municipal facilities, such as corporation yards; and
- a model Storm Water Pollution Prevention Plan for municipal facilities.

THE NEED FOR STORMWATER INSPECTION PROGRAMS

Studies have shown that runoff and non-stormwater discharges to storm drains from industrial and commercial facilities can be major causes of stormwater pollution. In fact, the most common problems observed during facility inspections are exposure of potential pollutants to stormwater runoff and illicit discharges. Sources of pollutants that may come in contact with stormwater include materials spilled in loading or handling areas, raw and processed materials and wastes stored outdoors, and litter. Pollutants also originate from parking lots, driveways, and vehicle and heavy equipment storage and repair areas.

Typical pollutants in stormwater from these areas include heavy metals, sediment, oil and grease, and other toxic chemicals (see sidebar). These pollutants are picked up by stormwater runoff and transported off-site to eventually discharge to creeks, rivers, lakes, marshes, bays, and the Pacific Ocean.

Illicit discharges from industrial and commercial facilities may include vehicle and equipment wash waters, process waters, fluids leaked from dumpsters, drums or tanks, and discharges through floor drains that are connected to storm drains instead of the sanitary sewer system. Improper disposal of used oil, oil filters, and other automotive fluids to storm drains and creeks is also a common pollutant source.

Polluted stormwater and non-stormwater discharges from industrial and commercial sites can represent a large part of the controllable pollutant load generated from an urban area. Inspection programs are the best means for identifying sources of pollutants discharged to storm drains and educating businesses about appropriate best management practices (BMPs) for eliminating or reducing these discharges at their facilities.

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Municipalities are required under the conditions of their NPDES stormwater permits to control stormwater discharges from industrial and commercial facilities to the maximum extent practicable (MEP). In most cases, this means implementing an industrial/commercial inspection program or delegating inspections to another agency through agreements with that agency. Whether or not facilities are regulated by industrial stormwater permits from the State Board or one of the nine Regional Water Quality Control Boards (Regional Boards), municipalities are ultimately responsible for the quality of discharges from their storm drain systems to receiving waters; thus, they need to have local control of industrial and commercial discharges to their systems.

Municipalities are ultimately responsible for discharges from their storm drain systems, so they must control discharges from businesses to their systems.

OVERVIEW OF STORMWATER REGULATIONS

The following presents a brief overview of the Federal and State regulations that pertain to municipal, industrial, and commercial stormwater discharges. For more information, please consult the references in Chapter 5 of the Handbook.

Federal NPDES Permit Program

In 1972, the Federal Water Pollution Control Act, also referred to as the *Clean Water Act* (CWA), was amended to prohibit the discharge of any pollutant to waters of the United States from a point source unless the discharge is authorized by a NPDES permit. However, stormwater discharges were not specifically regulated under the NPDES program until Congress amended the CWA in 1987. Section 402(p) of the 1987 amendments requires municipalities to effectively prohibit non-stormwater discharges to municipal storm drain systems and to implement controls to reduce pollutants in stormwater to the maximum extent practicable.

Phase I

On November 16, 1990, the U.S. EPA published NPDES permit application requirements for municipal and industrial stormwater discharges under Phase I of its stormwater program. These requirements include the following:

1) Municipalities which own and operate separate storm drain systems serving populations of 100,000 or more, or which contribute significant pollutants to waters of the United States, must obtain *municipal stormwater NPDES permits*.

What is "Maximum Extent Practicable" (MEP)?

The standard of MEP is not specifically defined in the Federal stormwater regulations, but the intent is to require municipalities to reduce the discharge of pollutants in stormwater rather than totally prohibit the discharge.

The California State and Regional Boards have interpreted MEP to mean selection and implementation of a sufficient number of appropriate BMPs which are effective for the pollutants of concern, technically feasible, and have a cost which bears a reasonable relationship to the pollution control benefits to be achieved.

The final determination regarding whether a discharger has reduced pollutants to the MEP can only be made by the State or Regional Boards.[1]

[1] *Memorandum from Elizabeth M. Jennings, Senior Staff Counsel, to Archie Matthews, Division of Water Quality, State Board, dated February 11, 1993.*

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This is the basis of the requirement that municipalities conduct inspections of industrial and commercial facilities.

TABLE 1
FACILITIES DEFINED BY EPA AS DISCHARGING STORMWATER ASSOCIATED WITH INDUSTRIAL ACTIVITY

i. *Facilities listed under 40 CFR Subchapter N*

ii. *Certain manufacturing facilities*

iii. *Oil and gas/mining facilities*

iv. *Hazardous waste treatment, storage and disposal facilities*

v. *Landfills, land application sites, and open dumps*

vi. *Recycling facilities*

vii. *Steam electric power generating facilities*

viii. *Transportation facilities*

ix. *Sewage or wastewater treatment works*

x. *Construction activities*

xi. *Certain manufacturing facilities where materials are exposed to stormwater*

(For additional information, see Appendix B)

2) To obtain a permit, a municipality must develop and implement a stormwater management program.

3) One element of a municipal stormwater management program must address the reduction of pollutants in industrial stormwater discharges and other discharges that are contributing a substantial pollutant load to their systems.

4) Facilities discharging stormwater associated with industrial activity, including construction activities which disturb 5 or more acres, must obtain ***industrial stormwater NPDES permit coverage*** (see sidebar and Appendix B).

On August 7, 1995, EPA amended the NPDES permit application requirements to address Phase II stormwater discharges, including discharges from commercial, light industrial, and institutional facilities, construction activities under five acres, and municipal storm drain systems serving populations under 100,000. Permit requirements are in two tiers. The first tier allows the State and Regional Boards to require permit applications from any source that contributes to water quality impairment or is a significant contributor of pollutants. Permit application requirements for the second tier, which includes all other Phase II dischargers, are essentially delayed for six years (until 2001). EPA has formed an advisory committee of stakeholders to assist in reviewing and revising the Phase II requirements during the next several years.

Future Stormwater Regulations

At the time this Handbook was written (1996), legislation was being drafted by Congress to amend and reauthorize the CWA. One of the proposed amendments would eliminate NPDES permitting for stormwater discharges and require states to develop and implement EPA-approved stormwater management programs. Other proposed amendments would affect the industrial permitting process and requirements. However, State and Regional Board staff have indicated that these proposed changes in Federal law are not likely to significantly affect the State's approach to control of municipal and industrial stormwater discharges.

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California NPDES Permit Programs

Industrial Permits

In California, the NPDES stormwater permitting program is administered by the State Board, with assistance from the nine watershed-based Regional Boards. The State Board elected to address EPA's industrial permitting requirements by issuing two statewide general permits: a general construction activities stormwater permit and a general industrial activities stormwater permit. The San Francisco Bay Regional Board also adopted a separate general industrial permit for Santa Clara Valley which is similar to the statewide permit. Regional Boards may also issue industry-specific general permits; for example, the San Francisco Bay Regional Board has issued e general permit for boat yards. A summary of industries which must obtain general permits is provided in Table 2 (see sidebar, page 1-8).

To obtain coverage under and comply with the State General Industrial Activities Storm Water Permit (General Permit), the owner or operator of an industrial facility must:

- Send to the State Board a Notice of Intent (NOI) to comply with the General Permit;
- Prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) which describes the site characteristics and pollutants which could impact stormwater quality, and identifies BMPs that the site owner/operator agrees to implement to control sources of stormwater pollution to the maximum extent practicable;
- Certify that any illicit connections to storm drains have been eliminated;
- Prepare and implement e Monitoring Plan to assess the effectiveness of BMPs through visual inspection of storm drains during wet and dry weather and sampling during storms;
- Keep the SWPPP and Monitoring Plan on site and available for regulatory agency staff and public inspection;
- Submit an annual report with monitoring results and certification of compliance by July 1 of each year; and

Useful Definitions

A Best Management Practice (BMP) is defined as any program, technology, process, criteria, operating method, measure, or device which controls, prevents, removes, or reduces pollution.[1]

A Notice of Intent (NOI) is a formal notice to the State Board submitted by the owner/operators of industrial facilities which provides information on the permittee, type of discharge, and discharge location, and certifies that the permittee will comply with the conditions of the General Industrial Permit.[1]

A Stormwater Pollution Prevention Plan (SWPPP) consists of a series of activities to characterize an industrial site and select and implement BMPs to prevent stormwater pollution.[1]

A Monitoring Plan is a plan for visual inspection, sampling, and analysis of stormwater discharges to assess BMP effectiveness.

[1] *From California Storm Water Industrial/Commercial Best Management Practice Handbook 1993.*

The General Permit allows a sampling and analysis exemption for facilities that are certified by a local agency as having an effective SWPPP.

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- Pay an annual fee of $500, or $250 if the facility discharges to a storm drain system that is regulated by a municipal NPDES stormwater permit.

The text of the State General Permit is provided in Appendix C.

Industries may request an individual NPDES permit instead of the General Permit. However, the Regional Boards usually only consider adopting an individual permit in cases where an individual facility has unique characteristics or poses a significant threat to stormwater. Industries which already have an NPDES wastewater discharge permit with stormwater requirements do not need a separate permit for stormwater discharges.

Municipal Permits

The municipal stormwater NPDES permit program in California is implemented through the Regional Boards. The State's approach has been to issue area-wide permits for urban areas which are significant sources of pollutants or contribute to violations of water quality standards. The area-wide permits cover all municipalities within the defined urban area, regardless of population.

In the late 1980's, several of the Regional Boards identified the need to control urban runoff in the Water Quality Control Plans or "Basin Plans" for their watersheds, and began to require municipalities to investigate sources of urban runoff pollutants, estimate pollutant loads, and implement control measures. This resulted in the issuance of a number of "early permits" for stormwater discharges in advance of the promulgation of EPA's NPDES permitting requirements (see sidebar).

Since the promulgation of EPA's requirements, more than a dozen additional municipal stormwater NPDES permits have been adopted in California for individual cities and districts as well as countywide programs with multiple co-permittees (see sidebar, page 1-1). These city and countywide programs have prepared comprehensive stormwater management plans and are implementing the plans as requirements of their permits. The stormwater management plans typically describe activities to control pollutants from industrial and commercial businesses during the five-year term of the permit. Most of the early permits have been or are in the process of being renewed and revised to be consistent with other municipal permits throughout the State.

TABLE 2[1]
FACILITIES COVERED BY THE STATE GENERAL INDUSTRIAL PERMIT

- *Heavy manufacturing facilities*
- *Manufacturing facilities where materials are exposed to stormwater*
- *Mining and oil and gas facilities*
- *Recycling facilities*
- *Transportation facilities*
- *Facilities subject to the requirements of 40 CFR Subchapter N*
- *Hazardous waste treatment, storage, and disposal facilities*
- *Landfills, land application sites, and open dumps*
- *Steam electric power generating facilities*
- *Wastewater treatment plants with design flows >1 mgd*

[1] *From California Storm Water Industrial/ Commercial Best Management Practice Handbook, 1993.*

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California Coastal Nonpoint Pollution Control Program

The Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 require states with coastal zones to develop and implement Coastal Nonpoint Pollution Control Programs. The intent of the program is for states and local authorities to work together to develop and implement management measures to control nonpoint source pollution, including urban runoff, to restore and protect coastal waters. In California, the Coastal Commission and the Regional Boards are responsible for development and implementation of the California Coastal Nonpoint Pollution Control Program.

CZARA provides guidance on required management measures to address various sources of nonpoint source pollution, including certain urban runoff but excluding discharges regulated by NPDES permit. CZARA requirements also apply to stormwater discharges that are not regulated under the current Phase I NPDES program.

One of the required CZARA management measures is pollution prevention and education to reduce pollutants generated from commercial activities, including parking lots, service stations, and other entities not under NPDES purview. Therefore, if your municipality is in a coastal zone, you may be required to inspect and control discharges from these commercial facilities, regardless of whether your municipality is covered by an NPDES stormwater discharge permit.

California Municipality "Early Permits"

Los Angeles
Orange County
Riverside
Sacramento
San Bernardino
San Diego
Santa Clara Valley

(All are area-wide storm water programs)

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Roles and Responsibilities 2

Case Study - Part 1:
Alameda Countywide Clean Water Program (ACCWP)

The ACCWP comprises 17 participating agencies who jointly developed a countywide Stormwater Management Plan and received a municipal storm water NPDES permit in 1991. The objective of the Plan's Industrial Discharger Component was to identify industrial and commercial dischargers in Alameda County and ensure that businesses are taking steps to reduce pollutant discharges to storm drains to the MEP.

The ACCWP took the following initial steps to assist its agencies in addressing industrial and commercial discharges:

- *Developed a facility database containing information on over 4,100 regulated industries in the County;*
- *Developed minimum qualifications, procedures, and standards for conducting inspections (to help municipalities select appropriate agencies or departments to conduct inspections);*
- *Notified and surveyed facilities by mail about stormwater requirements;*
- *Conducted three informational workshops for businesses on stormwater requirements and the ACCWP;*
- *Established a memorandum of understanding with the San Francisco Bay Regional Board regarding lead regulatory contacts for inspections (see page 2-6);*
- *Formed the Industrial & Illicit Discharge Control Subcommittee to help ensure consistent and effective facility inspection programs countywide;*
- *Developed and adopted countywide performance standards for conducting inspections (see page 3-8); and*
- *Developed an inspector training handbook and began annual inspector training workshops.*

This chapter discusses the roles and responsibilities of municipalities, local agencies, and businesses in stormwater inspection programs, and provides examples of ways municipalities can coordinate their efforts with other agencies and businesses.

REGULATORY FRAMEWORK

The Clean Water Act and the 1990 EPA regulations mandate the control of stormwater discharges from industrial and commercial facilities, as discussed in Chapter 1. However, the responsibilities for carrying out this mandate are split along two paths (see Figure 1). Municipalities with NPDES permits are responsible for controlling pollutants from industrial/commercial stormwater discharges to their storm drainage systems, usually through an inspection and outreach program. Industries must also obtain individual or general NPDES permit coverage to discharge stormwater and be subject to inspection and enforcement by the State and/or Regional Boards. Thus, there is potential for redundancy in the inspection roles of municipalities and state regulatory agencies at certain facilities. In addition, municipalities and other local agencies are responsible for conducting facility inspections related to hazardous materials management, fire code compliance, and source control and pretreatment of discharges to the sanitary sewer.

Given this situation of overlapping jurisdictions, it is essential to understand the roles and responsibilities of California municipalities, Regional Boards, other local agencies, and businesses in stormwater pollution prevention before developing a stormwater inspection program for your municipality.

THE MUNICIPALITY'S RESPONSIBILITIES

Federal NPDES permit application requirements require municipalities to include in their stormwater management plans an element addressing the control of pollutants in stormwater discharges from industrial facilities. "Industrial facilities" include:

- municipal landfills;

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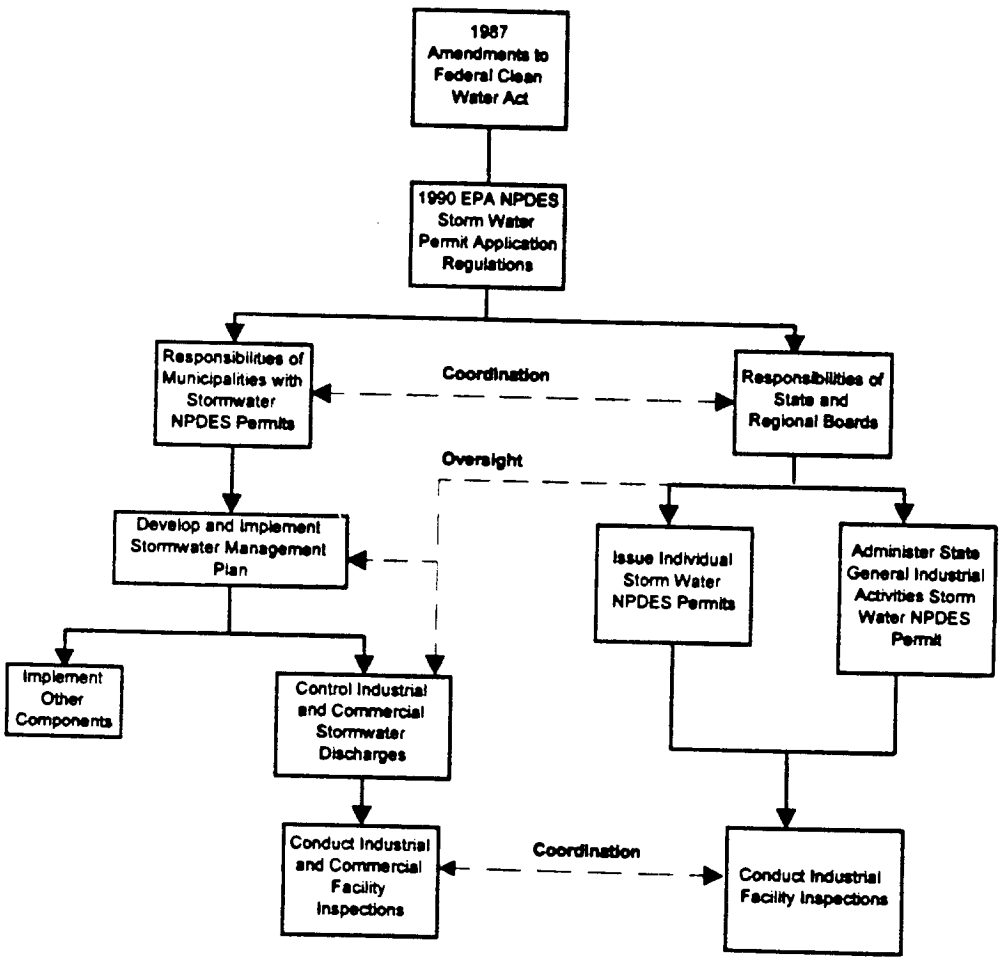
FIGURE 1
Regulatory Framework of Responsibilities for Control of Industrial/Commercial Stormwater Discharges in California



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- facilities that treat, store, or dispose of hazardous wastes;
- facilities that handle toxic chemicals (subject to SARA Title III); and
- "facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm [drain] system" (40 CFR 122.26(d)(2)(iv)(C)).

This latter category directs municipalities to consider a wide range of businesses when designing their inspection programs. For example, commercial facilities such as automotive shops and restaurants can be covered by this provision. As a result, many municipal stormwater management plans and permits require municipalities to evaluate the need to inspect commercial and other "non-NOI" facilities.

"NOI industries" are those required to file NOIs to obtain coverage under and comply with the State General Stormwater Permit.

Note that many of the facilities in the categories listed above are "NOI industries", i.e., those required to file NOIs to comply with and obtain coverage under the State General Permit (see discussion under "Businesses' Responsibilities"). Once these facilities have obtained State General Permit coverage, the regulatory burden does not completely shift to the State; municipalities are still responsible for what is discharged from these facilities to storm drains systems within their jurisdictions.

Municipalities are responsible for what is discharged from NOI facilities to storm drains in their jurisdictions, and need to inspect these facilities if they are likely to be significant pollutant sources.

The Federal stormwater regulations (40 CFR 122.26(d)(2)(i)(A) and (iv)(C)) indicate that, in implementing industrial/commercial stormwater control programs, municipalities are expected to:

- Identify priority businesses;
- Develop procedures for inspection of priority facilities;
- Obtain adequate legal authority to control the discharge of pollutants from industrial/commercial facilities to municipal storm drains through adoption of stormwater discharge ordinances or revisions to municipal codes;
- Establish and require businesses to implement control measures to reduce pollutants in stormwater discharges from their facilities; and

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Municipalities need to provide sufficient information about their inspection programs and appropriate BMPs, so that businesses can make a good faith effort to comply with storm water requirements.

- Monitor (or require businesses to monitor) pollutants in runoff from certain industrial facilities to municipal storm drains.

If municipalities are going to require businesses to implement stormwater BMPs, they also have a responsibility to inform, educate, and obtain input from the business community. Many "good-housekeeping" BMPs for stormwater pollution prevention are practices that businesses are already doing in order to comply with hazardous materials handling and storage requirements and pretreatment conditions for discharging to the sanitary sewer. However, other BMPs may require major changes in practices that an industry has been doing for years or expensive structural modifications. Municipalities need to adopt a flexible, cooperative approach to regulation of businesses and allow them to suggest appropriate alternatives that will achieve similar results at their sites.

For more information on applying for the General Permit or preparing a SWPPP, see:

- ✓ *General Industrial Activities Storm Water Permit, October, 1992 (Appendix C).*
- ✓ *California Storm Water Industrial/Commercial BMP Handbook, 1993.*
- ✓ *EPA Guidance on Developing Pollution Prevention Plans and BMPs, 1992 (see p. 5-3).*

BUSINESSES' RESPONSIBILITIES

The requirements imposed by Federal and State regulations on facilities that discharge stormwater associated with industrial activity (as defined by EPA) were discussed in Chapter 1. Owners or operators of certain industrial facilities (Appendix B) must either apply for individual NPDES stormwater permits or obtain coverage under the State General Permit (or other regional general permit), unless they can demonstrate that they do not discharge to waters of the United States under any circumstances.

Most industrial stormwater dischargers in California that have applied for NPDES permits have elected to obtain coverage under the State General Permit. To date, roughly 10,000 NOIs for General Permit coverage have been filed with the State Board. However, it is estimated that tens of thousands of businesses that require stormwater NPDES permits have not filed NOIs or have not completed all of the requirements of the General Permit (see page 1-7).

All businesses must comply with local stormwater discharge ordinances and other environmental codes related to stormwater pollution prevention.

Existing industrial dischargers should have applied for individual permits or General Permit coverage by March 30, 1992; new dischargers must apply prior to commencement of industrial activity. Industries that are supposed to have stormwater NPDES permits but have not yet applied or filed NOIs are liable for penalties during the period they do not have permit coverage.

Some categories of industries do not have to obtain General Permit coverage (or may obtain an exemption

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from monitoring) if their industrial activities are not exposed to stormwater. Industries which already have NPDES wastewater permits with stormwater requirements, and commercial businesses such as automotive shops and restaurants are also exempt from General Permit coverage. However, all businesses and other dischargers of stormwater must comply with local municipal codes or ordinances, regardless of whether they have NPDES permit coverage. Most municipalities with NPDES stormwater permits have stormwater discharge ordinances which prohibit illicit discharges and illegal dumping to storm drainage systems and/or require implementation of certain BMPs to minimize pollutants in stormwater runoff from facilities.

THE REGIONAL BOARD'S RESPONSIBILITIES

The issuance and enforcement of NPDES permits in California was delegated by EPA to the State Board and the Regional Boards. Once NPDES permits are adopted, the traditional role of the Regional Boards has been to monitor, inspect, and enforce permit conditions. Although the State Board has issued the State General Permit, the Regional Boards are responsible for implementation and enforcement of compliance with the State General Permit by industries that have filed NOIs. However, the resources available to the Regional Boards are limited and, as a result, they have had to prioritize the types of industrial dischargers on which they will concentrate their efforts.

Regional Board staff have initially focused on outreach to "nonfilers" (i.e., industries who have not filed NOIs) to get them involved in the State General Permit program. Their approach has been to offer assistance to industries in developing and implementing SWPPPs rather than taking enforcement action against those who are not participating. Regional Board staff have also added stormwater quality control requirements to NPDES permits for publicly-owned treatment works (POTWs) and landfills, as those permits came up for renewal.

COORDINATION BETWEEN MUNICIPALITIES AND THE REGIONAL BOARD

The Federal stormwater regulations encourage NPDES permitting authorities and municipalities to cooperate in developing programs to monitor and control pollutants in industrial stormwater discharges to municipal systems. Because of the overlapping responsibilities of the municipalities and the Regional Boards, it is essential that

Regional Board staff rely on the municipalities with stormwater permits to conduct inspections of their local NOI facilities. In exchange, they will provide backup enforcement power to municipal programs that encounter uncooperative businesses, after local enforcement efforts have failed.

Benefits of Coordinating Inspection Efforts

- *Minimize burden on businesses by avoiding duplication of information requests and redundant inspections*
- *Minimize conflicts in discharge requirements imposed on businesses*
- *Make effective use of limited resources and staff time*

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Key Provisions of the Alameda/Regional Board MOU[1]:

- *The Regional Board will be the lead regulatory contact for POTWs, municipal landfills, existing individual NPDES-permitted facilities, state and federal facilities, and any other industrial discharger it chooses.*
- *The municipal stormwater program member agencies will be the lead regulatory contacts for other businesses that they have assigned a high priority for inspection.*
- *The Regional Board staff and municipal agencies will share information on facilities that they are each responsible for.*
- *The Regional Board staff and municipal agencies agree to emphasize educational outreach, take appropriate enforcement actions as needed, and coordinate enforcement activities to minimize regulatory overlap.*
- *The municipal agencies agree to inform industries about their responsibilities for obtaining General Permit coverage and to work with appropriate industries to coordinate pollutant monitoring efforts.*

(A copy of the complete MOU is provided in Appendix D)

[1] *MOU to Coordinate Industrial/Business Stormwater Pollution Control Activities Conducted by the Alameda Countywide Clean Water Program and the San Francisco Bay Regional Board, June 23, 1992*

there be agreement on a coordinated approach to regulate stormwater discharges from businesses.

One method of ensuring coordination of a municipality's and another agency's inspection efforts is for the two agencies to adopt a Memorandum of Understanding (MOU) or other type of agreement to define their mutual roles and responsibilities in implementing stormwater pollution control activities. Both the Alameda and San Mateo countywide stormwater programs have executed MOUs with the San Francisco Bay Regional Board. These MOUs define which public agency will be the "lead regulatory contact" (the agency with primary responsibility for inspecting, communicating, and enforcing stormwater pollution prevention requirements) for various facilities.

The MOU approach has been successful in establishing the general responsibilities of each agency, which helps municipalities set priorities for inspection of businesses within their jurisdiction. An MOU does not need to be a formal, legally binding document; its purpose should be to outline agreements on roles and responsibilities, while allowing municipalities flexibility in developing and implementing their inspection programs.

The Alameda/Regional Board MOU was developed to allow a flexible approach, but some municipalities wanted more specific guidance on the responsibilities of municipal inspectors, especially when inspecting NOI industries. In addition, there are areas of overlap in inspection responsibility that need to be worked out. The original Alameda MOU has been supplemented by two letters of clarification, and is expected to continue to evolve through continued dialogue between the municipalities and the Regional Board staff.

COORDINATING WITH OTHER AGENCIES AND PROGRAMS

In addition to the Regional Board, there are a number of other agencies that are conducting inspections of industrial and commercial businesses. The Cal/EPA Department of Toxic Substances Control is another state agency that conducts inspections as part of its regulation of hazardous waste treatment, disposal, and recovery facilities. Inspection agencies at the county and local levels include hazardous materials/waste management programs (County and local), County health departments, wastewater treatment agencies, fire departments, and public works staffs.

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Coordination Benefits and Requirements

There are many benefits from coordinating stormwater inspections with the inspection activities of these departments or agencies. First, it may be more efficient and economical to incorporate the stormwater inspection program into an existing inspection program with the resources to handle the extra work. It also reduces the number of inspections that a business is subject to and minimizes duplicative inspection fees. In addition, incorporating stormwater controls into an agency's existing requirements reduces the possibility of conflicting requirements being imposed on businesses. In many cases, other agencies' inspectors have already become familiar with local business facilities and have developed a rapport with the business owner or operator.

It is important that municipalities identify the agencies and city departments that currently inspect local business before embarking on a stormwater inspection program. One reason is to help evaluate who might be best suited to conduct stormwater inspections along with their regular business inspection duties (this is addressed further in Chapter 3). However, even if a municipality decides to conduct stormwater inspections with a dedicated staff, it is still essential that the municipality coordinate with internal departments and outside agencies to define their respective roles and to resolve any possible conflicts. An understanding should be reached between the municipality and other inspection agencies or departments regarding mutually acceptable requirements and standards, what information is to be shared, and under what conditions notification or referrals should be made regarding observed violations.

Potential Conflicts

In general, most stormwater controls and pollution prevention BMPs are consistent with proper hazardous materials storage and handling practices and hazardous waste disposal practices. The primary area where conflicts are encountered is in determining whether a particular discharge can go to the storm drain or the sanitary sewer, whether it must be treated before discharge, or whether it must be disposed of on-site. For example, a business may be asked by an inspector to redirect a wash water discharge away from the storm drain and into the sanitary sewer, which may only be acceptable to the local wastewater treatment agency under certain conditions.

Stormwater Inspection Partnerships

Examples of how municipal stormwater programs are currently working with other agencies to conduct stormwater inspections include the following:

1. *Los Angeles County is conducting stormwater inspections as part of industrial waste inspections at sites regulated by its Industrial Waste Control Program (IWCP). The Program coordinates its activities and exchanges information with other agencies through a County Hazardous Materials Coordinating Committee.*

2. *In San Mateo County, the County Environmental Health Division conducts stormwater inspections of businesses in unincorporated areas in conjunction with hazardous material business plan, hazardous waste generator, and underground storage tank inspections, and food handling facility inspections. The Environmental Health Division also contracts with 12 cities in the County to conduct similar inspections at businesses within each city.*

3. *In the City of Richmond, pretreatment inspectors from the local wastewater treatment agency conduct all of the City's stormwater inspections at 150 facilities annually, including NOI facilities and other high priority industries, automotive businesses, and industries permitted to discharge stormwater to the sanitary sewer.*

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Spreading the Word to Businesses

The Alameda Countywide Clean Water Program (ACCWP) began its stormwater inspection program in 1992 by conducting a survey of businesses throughout the County to determine their level of knowledge about the new stormwater requirements. Over 380 businesses responded to the survey. The ACCWP followed up by sending out a summary of the survey results, which included more information about stormwater BMPs and requirements. Then in 1993, the ACCWP conducted a series of three workshops for businesses on the municipal stormwater program and General Permit requirements, in which over 200 business representatives participated. Municipal inspectors continue this education process during facility site visits.

Acknowledging the Efforts of Business Organizations

Some business organizations and trade associations are actively educating their member businesses about stormwater requirements and providing guidance on pollution prevention measures. For example, the Western States Petroleum Association (WSPA) recently sponsored preparation of a report that summarizes and evaluates BMPs that are potentially appropriate for retail gas outlets (WSPA, 1996). Municipalities should acknowledge these efforts and work with the organizations to develop mutually acceptable pollution prevention practices.

Conflicts also occur in materials storage requirements. Constructing a cover over a materials storage area to prevent contact with stormwater can trigger expensive fire sprinkler requirements. Moving the materials indoors may conflict with hazardous materials storage requirements and conditions of occupancy for the site. These potential conflicts should be discussed with regulating agencies and resolved so that businesses can be given appropriate guidance.

In the San Francisco Bay Area, representatives of municipal stormwater programs have worked with local wastewater treatment agencies to develop disposal options for various non-stormwater discharges. Products of their efforts include "Recommended Discharge Elimination/Disposal Priorities for Wash Waters" (September 1994) developed by the Alameda Countywide Clean Water Program and "A Guideline for Prohibited Discharges to the Storm Drain System" (March 1994) developed by the Santa Clara Valley Nonpoint Source Pollution Control Program.

WORKING WITH LOCAL BUSINESSES AND BUSINESS ORGANIZATIONS

Municipalities with existing inspection programs have learned that businesses are more likely to be environmentally responsible if the municipality keeps them informed about State and local requirements and assists them in complying with those requirements. By adopting a cooperative approach, municipalities have been successful in getting businesses to take responsibility for compliance, thus reducing the need for frequent inspections.

Before implementing a new inspection program, a municipality should spread the word to businesses that are likely to be inspected by:

- Mailing out brochures or letters;
- Conducting workshops;
- Placing newspaper advertisements; and
- Other educational outreach activities.

Several municipalities, including Palo Alto, Richmond, Manhattan Beach, and Santa Rosa have worked with local businesses to develop clean business programs. These programs have successfully achieved pollutant reduction by providing education, incentives, and recognition to

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businesses that agree to implement certain BMPs and comply with local requirements. More information on clean business programs is provided in Chapter 3.

The Association of Bay Area Governments (ABAG), in cooperation with the California Department of Toxic Substances Control and EPA Region 9, is developing and planning to implement a Green Business Recognition Program in San Francisco Bay area cities and counties. This voluntary, regional program will recognize businesses that demonstrate ongoing compliance with all applicable environmental regulations, not just stormwater pollution prevention. A Green Business Advisory Board consisting of federal, state, and local government agencies, business representatives, and environmental organizations has established standards for environmental performance that will be used during facility inspections to determine the recognition status of a business.

The goal of ABAG's Green Business Recognition Program is to increase businesses' environmental compliance by providing a consistent, coordinated inspection and evaluation process and assistance on pollution prevention and resource conservation. Pilot programs in Alameda and Napa Counties will target automotive businesses and a second business category in each county. The Program is of interest to stormwater managers and inspectors since businesses will need to be in compliance with stormwater requirements to achieve recognition.

One of the best approaches to educating businesses is working with a trade organization or business association. These organizations generally want information about upcoming regulations and requirements so they can keep their members informed. Trade organizations can:

- Provide lists of member businesses and a means to communicate with them, such as a newsletter;
- Cosponsor educational workshops, giving the workshop more credibility;
- Send representatives to participate on stormwater program advisory committees;
- Assist with stormwater ordinance or BMP reviews; and
- Provide valuable input to a municipality's proposed stormwater inspection program, such as whether requirements duplicate or conflict with other agencies' requirements.

Successful Collaborations with Trade Organizations

- *An example of how municipal agencies and trade organizations can work together is the cooperative effort among the Cleaning Equipment Trade Association (CETA), the Alameda Countywide Clean Water Program, the Santa Clara Valley Nonpoint Source Pollution Control Program, three wastewater agencies in South San Francisco Bay, and the San Francisco Bay Regional Board to establish BMPs for wastewater runoff from mobile washing applications (CETA, 1994). The BMPs describe prioritized alternative methods of wastewater disposal for the most common types of cleaning operations. CETA distributed the BMPs to mobile cleaners in the San Francisco Bay Area to better educate them about stormwater and wastewater discharge requirements.*
- *A similar agreement was reached among the Southern California Professional Detail Association, the Orange County Environmental Management Agency and the Santa Ana Regional Board on acceptable BMPs for mobile detailing wastewater discharges. A brochure describing the stormwater regulations and the recommended BMPs was developed and distributed to the mobile detailers (see Appendix J).*

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MANAGING POLLUTANT SOURCES AT MUNICIPAL FACILITIES

Municipal facilities, such as corporation yards and auxiliary storage yards, are potential sources of pollutants to storm drain systems due to vehicle and equipment washing, storage of chemicals and materials, and other activities. Since municipalities have a responsibility for controlling the quality of all stormwater discharges to their storm drain systems, it is important that municipal facilities provide a good example to industrial and commercial facilities.

Municipal facilities are excluded from the requirements of the State General Permit (unless they perform the functions of a transportation or bulk fuel distribution facility). However, a memorandum prepared in September 1994 by staff of the State Board and Regional Boards to guide stormwater managers in preparing stormwater management plans strongly encourages municipalities to prepare SWPPPs for their municipal facilities.

More information on potential pollutant sources, recommended BMPs, preparation of SWPPPs, and inspection programs for municipal facilities, including a Model SWPPP, is presented in Appendix M.

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How to Develop Your Stormwater Inspection Program 3

Case Study - Part 2: Alameda Countywide Clean Water Program (ACCWP)

Participating agencies in the ACCWP conducted over 4,000 facility inspections during 1993 to 1995, including over 140 NOI facilities as well as additional follow-up inspections. With guidance from the ACCWP and the countywide performance standards, municipalities developed action plans and implemented inspection programs for priority facilities in their jurisdictions.

Municipalities use different approaches to implement their programs; some cities contract with Alameda County Department of Environmental Health or with local wastewater agencies to perform inspections, while others use their own public works, fire, or hazmat staffs. Facilities inspected include automotive businesses, NOI facilities, other heavy and light industry, food handling facilities, and other commercial businesses, depending on local priorities. Inspectors use a standardized inspection form, and results are reported to the Regional Board in the ACCWP's annual report.

In total, the municipalities conducted approximately 560 follow-up and enforcement activities during the first two years of inspections; 74% of these involved warning notices, 20% were informal violations, 6% were formal violations, and one case involved legal action.

The ACCWP, through the Subcommittee, continues to assist local efforts by:

- *Conducting annual training workshops for inspectors;*
- *Developing fact sheets and BMP flyers for targeted business activities;*
- *Evaluating and updating the performance standards annually.*

INTRODUCTION

This chapter describes the basic elements of an industrial/commercial stormwater inspection program and the process for developing such a program. The process can be used by municipalities who are working toward compliance with their stormwater permits as well as those who are not yet required to have permits but are involved in stormwater pollution prevention efforts. Use this chapter to choose the concepts and tools applicable to your municipality's characteristics, business types, and approach to inspection. Worksheets to assist you in developing a new program or improving an existing one are provided in Appendix A.

For municipalities that are just beginning to formulate an industrial/commercial stormwater inspection program, there are a number of successful models throughout the State. Information on the different approaches of existing inspection programs in California was collected for this Handbook by surveying 11 municipalities of varying sizes and locations. These included the Counties of Los Angeles and San Mateo, the large Cities of San Jose, Los Angeles, Fresno, and Modesto, and the smaller Cities of Richmond, San Leandro, Hayward, Simi Valley, and Manhattan Beach. This information is summarized in Tables 1A through 1E in Appendix E and featured as examples throughout the Handbook.

Figure 2 presents a flow chart of the essential steps for developing a successful stormwater inspection program, based on the experience of the surveyed counties and cities and other inspection programs. Figure 2 also indicates the worksheets that are available in Appendix A to assist you in applying the concepts of certain steps to your program.

Note that Steps 2 through 8 do not necessarily have to be performed in the order shown, and some steps may be performed concurrently. However, all of them should be considered (as appropriate for your municipality) before sending out your inspectors. Steps 9 through 12 represent an iterative process of program planning, implementation, and evaluation that should be conducted annually to continuously improve your program. A description of each step is presented below.

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FIGURE 2
Steps for Developing a Stormwater Inspection Program

WORKSHEET (Appendix A)

Step 1. Initiate Program Development

a. Review your local municipal stormwater program requirements.
b. Consider your approach to stormwater pollution control.
c. Consider program consistency and performance standards.

Step 2. Assess Business Types and Set Priorities for Inspection — **WS#1**

a. Collect and review information on local businesses.
b. Evaluate the potential for businesses to cause stormwater pollution.
c. Develop initial inspection priorities.

Step 3. Decide Who Should Conduct Inspections — **WS#2**

a. Identify which other agencies and internal departments are conducting inspections.
b. Evaluate who is best suited to conduct stormwater inspections.
c. Coordinate inspection responsibilities with the local Regional Board.
d. Develop any necessary agreements with the inspecting agency(s).

Step 4. Establish Enforcement Procedures — **WS#3**

a. Demonstrate and/or designate legal authority to enforce.
b. Adopt defined enforcement procedures for the inspecting agency.
c. Establish guidelines for when to involve other agencies in enforcement.

Step 5. Develop an Educational Outreach Program — **WS#4**

a. Determine appropriate methods of outreach.
b. Develop (or adapt existing) educational materials.

Step 6. Develop Methods for Collecting and Managing Inspection Information — **WS#5**

a. Develop a system for data collection.
b. Develop a system for storing, reporting, and evaluating data.

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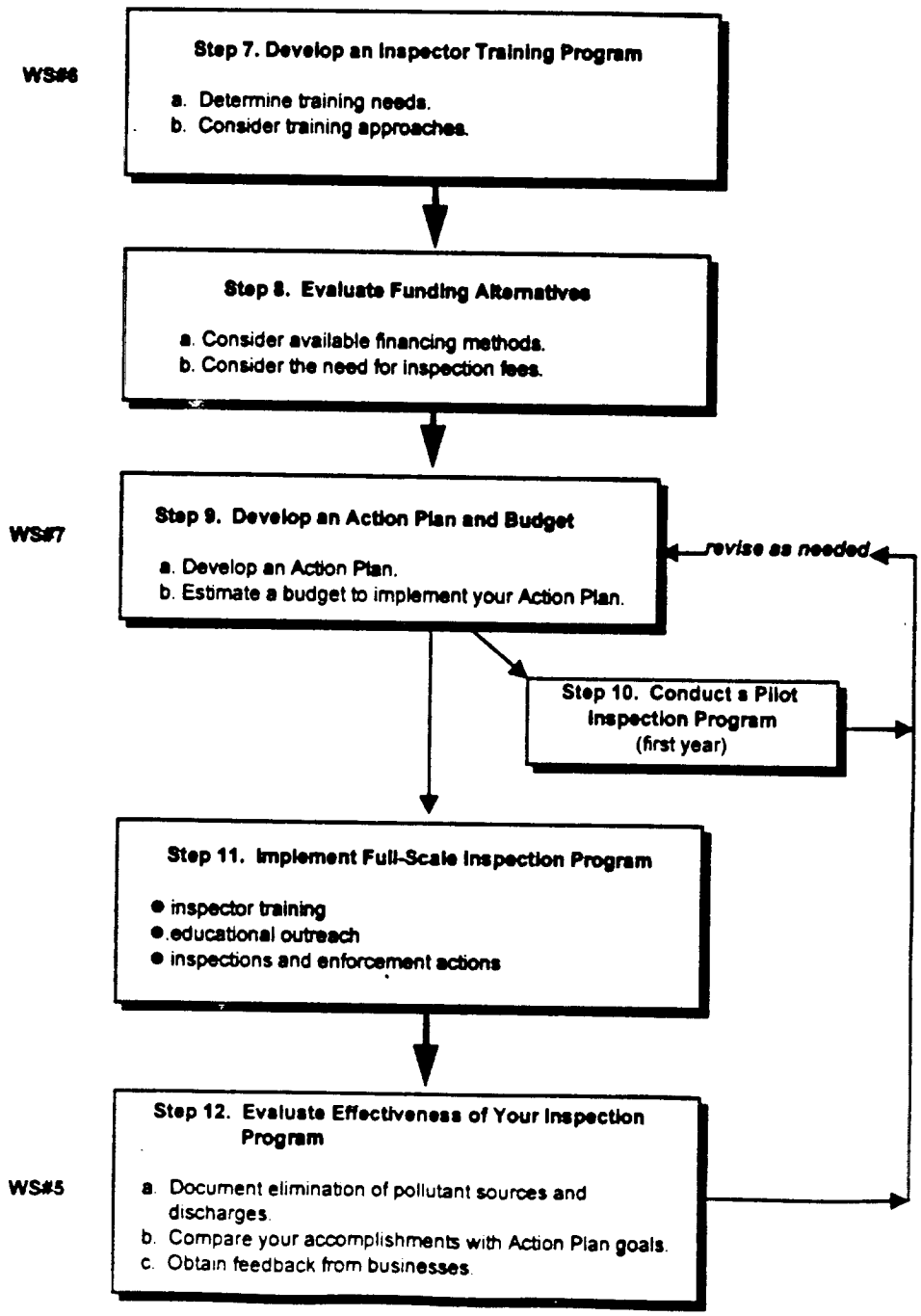
WORKSHEET (Appendix A)

FIGURE 2 (Continued)
Steps for Developing a Stormwater Inspection Program



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STEP 1. INITIATE PROGRAM DEVELOPMENT

1a. Review Your Local Municipal Stormwater Program Requirements

Your municipality may be part of an area-wide stormwater permit program, have its own stormwater permit, or be involved in an urban runoff management program which is not NPDES-permitted. Be sure to review the requirements in your permit or management plan related to control of industrial/commercial stormwater discharges, any guidance developed by your area-wide program or the State or Regional Board, and any performance standards on management measures applicable to your municipality before you begin to develop your own inspection program.

1b. Consider Your Approach to Stormwater Pollution Control

Three-Pronged Approach:

1) Education
2) Incentives
3) Enforcement

There are a number of different approaches being used by municipalities to control pollutants in stormwater discharges from industrial and commercial facilities. The approach taken depends on the size of the municipality, the types of inspections already occurring, and the types of businesses that are likely to contribute the greatest amount of pollutants in that community. Within a given municipal program, there may also be different approaches to control pollutants from large industrial businesses versus smaller commercial businesses or retail versus wholesale businesses.

In Alameda County, over half of the 380 businesses that responded to the ACCWP's 1992 survey said they were either unaware or barely aware of the new stormwater requirements.

All approaches involve some combination of the following elements: 1) education; 2) incentives; and 3) enforcement. For example, a program can be based on voluntary compliance with best management practices or the BMPs may be required by an ordinance backed by an enforcement program. The educational program can be done prior to or concurrent with enforcement. A positive incentive program may be preferable to traditional command-and-control techniques. Ultimately, the approach should address environmental concerns and match the issues, needs, and character of the business types.

Education and Outreach

Most existing inspection programs have a strong emphasis on educating business owners and operators about stormwater pollution prevention. The need for education and outreach is well placed, given the lack of

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awareness and knowledge many businesses have. Most conscientious businesses want to do the right thing environmentally, once they are made aware of what they need to do, and as long as the requirements are not too onerous or costly. An informational site visit, in which an agency representative walks the site with the facility owner/operator and provides information about stormwater requirements and BMPs, is an effective approach to outreach.

Many municipalities currently conducting inspection programs have taken an educational approach toward first-time violators (except in cases of severe violations). That is, the first time an ordinance violation or inappropriate practice is observed, the inspector informs the owner/operator of the problem and explains why it needs to be corrected. The inspector takes this opportunity to provide verbal and/or written information about stormwater requirements and proper BMPs, and allows the owner/operator a period of time to correct the problem without penalty. This approach helps to promote good will and cooperation between the municipality and business, and increases the likelihood that corrective actions will be taken.

Incentives

Many inspection programs use incentives to encourage businesses' cooperation in implementing stormwater BMPs. Incentive programs are often used to achieve better compliance among commercial businesses that may be subject to less scrutiny than NOI industries, but they can be applicable to industrial facilities as well. There are two types of incentives: those that allow a business to avoid a negative outcome (e.g., additional inspections and fees) if it complies with regulations, and those that provide a positive outcome or advantage to the business (e.g., promotion of the business in the local media, or reduced fees).

Negative Incentives. Most inspection programs inherently include negative incentives. Clean businesses will generally have fewer inspections because the municipality will focus its efforts on the bad actors. However, some programs explicitly state the cost of non-compliance by requiring businesses to pay fines for citations or subsequent inspections.

Positive Incentives. Positive incentives, such as an environmental award or recognition program, for those facilities in compliance or for those going beyond the requirements may be worth considering. Recognition for compliance or extra efforts is generally greatly

Tools for education and outreach:

- *Educational materials - provide fact sheets, brochures, posters, manuals, videos, etc.*
- *Mailings - inform businesses, in advance, of your new inspection program and requirements.*
- *Workshops - meet with businesses to distribute information, answer questions, and receive feedback.*
- *Informational site visits - evaluate a site and provide information on BMPs without threat of enforcement.*

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Types of Recognition Items:

- *award certificates*
- *public recognition*
- *display items*
- *advertising.*

Tip: The cost of these items can vary greatly, so consider the number of businesses likely to be eligible for recognition when selecting items and budgeting for recognition programs.

The ACCWP developed a sample letter of certification for its participating municipalities to use in nominating facilities for a monitoring exemption (see Appendix F).

appreciated by businesses. In addition, recognition or awards to environmentally proactive businesses not only generates favorable publicity for these facilities, but is also helps to educate the community on environmental issues as well.

If you plan to use positive incentives, make them available to all facilities within a business type during the same time period so that your municipality does not appear to favor some facilities over others. Terms such as certification and recognition have definite legal connotations, so consult with your attorneys to choose terms carefully. The coverage of the recognition must be clear and restricted to the activity or action being recognized. For example, a facility should be recognized for "preventing pollution of stormwater" as opposed to "preventing pollution", which could be interpreted as pertaining to solid waste generation, hazardous waste disposal, or other activities not covered by the municipality's stormwater inspection program.

Palo Alto's "Clean Bay Business", Manhattan Beach's "Ocean Safe Enterprise", and Santa Rosa's "Green Business" are examples of clean business programs which recognize businesses (primarily automotive and restaurant facilities) for taking actions to reduce stormwater pollution. Some clean business programs are voluntary, whereas others, like Palo Alto's, are supported by ordinance requirements specific to business types. In these programs, each participating business submits to an on-site assessment of its practices to verify compliance with specific BMPs. The business must correct any problems that are found in order to be recognized as a clean business. The cities respond by giving businesses window stickers and flyers that indicate their participation in the program and promoting them in newspapers and billboard advertisements. Palo Alto's program has demonstrated success in bringing businesses into compliance with local requirements and reducing the discharge of pollutants to storm drains (Uribe & Assoc., 1993).

Another type of incentive to businesses which have obtained General Permit coverage is to provide "local agency certification" that they are in compliance with the General Permit and do not have to monitor stormwater discharges. The State allows a local agency with responsibility for controlling stormwater discharges from industrial facilities to nominate facilities for exemption from collection and analysis of stormwater samples (they must still do visual observation of flows during dry and wet weather). The local agency must certify in writing that: 1) a particular facility has a low potential for stormwater pollution; 2) the facility has developed and

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implemented an effective SWPPP; and 3) the facility's past monitoring data do not indicate any pollution problems. Although businesses can self-certify, the requirements for exemption are less stringent if an agency certifies the business (a business must demonstrate that areas of "industrial activity" are not exposed to stormwater in order to be exempt from monitoring). Local agency certification fosters a spirit of cooperation between the business and inspection agency and encourages permit compliance.

Enforcement

Existing stormwater inspection programs employ a variety of enforcement strategies, ranging from virtually no enforcement (e.g., those in early stages) to a well-defined sequence of escalating enforcement activities (warnings, administrative actions, and legal action). Other tools include ordinances, permits, fees, and monitoring. In some programs, enforcement actions are taken only if direct or intentional non-stormwater discharges to storm drains are observed, or if violations continue to persist after repeated inspections.

The level of enforcement is dependent on the municipality's legal authority, whether the inspectors have authority to issue violation notices or citations, and whether enforcement actions need to be referred to another agency. Legal authority and enforcement strategies are discussed further under Step 4.

Enforcement needs to be balanced with the incentive and education aspects of the inspection program, in order to meet the requirements of the municipal NPDES permit to control industrial discharges to the storm drain system. For example, businesses in clean business programs need to get the message that if a cooperative approach doesn't work, they may be not only dropped from the program but subject to mandatory enforcement. Incentives for businesses to maintain clean sites will be lost if enforcement of bad actors is neglected. Businesses that continually need to be "re-educated" every time an inspector visits the site may require enforcement to obtain compliance.

1c. Consider Program Consistency and Performance Standards

Consistency among inspection programs, in terms of requirements, procedures, and enforcement, is very desirable from the standpoint of businesses that operate

Enforcement Tools:

- *Ordinance provisions - stormwater discharge ordinance and business- or activity-specific ordinances;*
- *Permits - General Industrial Permits, individual NPDES stormwater permits, local stormwater permits (uncommon), or stormwater conditions in wastewater permits;*
- *Inspection Fees - fines and recovery of abatement costs, if needed and appropriate (viewed as a negative incentive);*
- *Monitoring - by business or by municipality, to identify pollutants and activities of concern and measure*

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The ACCWP's Performance Standards

The ACCWP developed its Performance Standards for Industrial and Commercial Business Inspection Activities (see Appendix G) to achieve a county-wide consistent and effective approach to implementing inspection programs. The performance standards are divided into three tiers, depending on when the implementation of the standard will occur. Tier I represents the baseline level of effort to be implemented now. Tier II standards are to be evaluated for implementation within one year, and Tier III standards are under consideration for possible future implementation. These performance standards can serve as a model to other municipalities of baseline efforts that, if acceptable to the local Regional Board and implemented according to schedule, may be considered as the local storm water program's definition of MEP for compliance with its municipal NPDES permit.

** Use Worksheet #1 (Appendix A) to help you implement Step 2*

facilities in multiple jurisdictions and expect to be on a "level playing field" with their competitors. Businesses that do not spend money to comply with stormwater requirements have an unfair economic advantage over those that do. Municipalities and regulatory agencies have a responsibility to businesses in compliance to enforce requirements for non-compliers as well. It is also important for co-permittees in an area-wide municipal stormwater program to achieve consistency in order to demonstrate compliance with their NPDES permit.

Consistency means that municipalities are providing similar educational outreach materials, giving similar direction to businesses on improving poor practices, collecting similar information at facilities, and following upon the correction of problems and enforcement with the same level of care. This will only happen if there is coordination among municipal agencies and departments, and inspectors receive consistent and comprehensive training.

Although municipalities need the flexibility to develop inspection programs that are appropriate for local conditions, inspection programs should have similar baseline elements. To define these baseline elements, some municipal programs have developed "performance standards" for conducting inspection activities. Performance standards represent the level of implementation necessary to demonstrate that pollutants are being controlled in stormwater to the MEP, as defined through dialogue with the local Regional Board. The particular performance standards adopted by each municipality's stormwater program are part of the basis on which each municipality's compliance with its NPDES permit will be judged.

STEP 2. ASSESS BUSINESS TYPES AND SET PRIORITIES FOR INSPECTION

For municipalities beginning to develop inspection programs, the idea of having to inspect all facilities that may be contributing pollutants to stormwater may be overwhelming. A realistic approach for addressing a large number of potential inspections is phased implementation of the inspection program. Both the CWA and EPA's stormwater regulations support a phasing strategy that targets activities associated with the worst pollutant sources and/or discharges to high value waters. One advantage of phasing is that when you scope your inspection program to match available resources, your chances of success are greater than if you tried to accomplish all inspections every year. In this step, you

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will assess businesses present in your municipality and develop inspection priorities for the initial phases of your program.

2a. Collect and Review Information on Local Businesses

Lists of industries and commercial businesses that you may want to include in your inspection program are available from a number of sources, including local wastewater treatment agencies and health departments, state and local regulatory agencies, and your own departments. The information available from these sources is summarized in Table 3. Some utility companies are also willing to provide lists of their industrial customers. Other useful sources of business information include local chambers of commerce and business organizations, city business license records, Federal Census reports, business directories, surveys, telephone books and other publications. Each of these sources has its limitations, but a combination of sources can usually provide a good, overall picture of your business community. A "drive-by" survey in the commercial and industrial areas of town can also be helpful.

2b. Evaluate Potential for Businesses to Cause Stormwater Pollution

If you choose to conduct a phased stormwater inspection program, focus on the businesses that are the most likely sources of pollutants in the first phase. The EPA regulations took this approach by requiring municipalities to control stormwater from the following facilities believed to have a high potential for discharge of pollutants: municipal landfills; facilities that treat, store, or dispose of hazardous waste; facilities that handle toxic chemicals; and facilities that the municipality determines to contribute a substantial pollutant loading to the storm drain system. Another or subsequent way to prioritize is to consider facilities that are located in environmentally sensitive areas or that discharge to sensitive water bodies.

Stormwater monitoring data reported by industries as part of their stormwater permit requirements are now available from the State and Regional Boards. These data may help you to prioritize individual industries or categories of industries on the basis of the pollutants that they have been discharging in stormwater. However, keep in mind

Note On SIC Codes

Standard Industrial Classification (SIC) codes are used by the Federal stormwater regulations and the State General Permit to identify the industry types that require a permit. Knowledge of SIC codes for local businesses can help you identify priority facilities for inspection. However, be aware that SIC codes can be misleading because they may not accurately describe the primary activities that are conducted at a particular facility. The actual use of a facility may need to be confirmed during an initial site visit.

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TABLE 3
SOURCES OF INFORMATION ON INDUSTRIAL AND COMMERCIAL BUSINESSES

Source/Address	Information Available	Contact
Local business license office	Business name, address, and SIC code	Local agency
Local wastewater treatment agencies	Manufacturing and treatment processes at major industries and industries regulated by categorical pretreatment regulations; industries that store hazardous materials on-site.	Local agency
County Environmental Health Depts., Hazardous Materials Divisions; or Fire Prevention Bureau	Businesses that generate, handle, store and/or treat hazardous materials	Local agency
State Water Resources Control Board/Division of Water Quality	NOI Industries Database	(916) 657-0523
Regional Water Quality Control Boards	1) Information from State NOI Database for the region 2) NOI Industry Annual Reports 3) Waste Dischargers System Database has information on facilities with: • Individual NPDES permits; • Waste Discharge Requirements; • Site Cleanup Requirements	local Regional Board office
U.S. EPA, Region IX 75 Hawthorne Street San Francisco, CA 94105	List of Federal Superfund Sites under CERCLA (names and addresses)	Office of Public Affairs (415) 744-1500
Cal/EPA Office of Environmental Health Hazard Assessment 555 Capitol Mall, Rm 235 Sacramento, CA 95814	Lists of facilities covered by various federal, state, and local regulatory programs (per SARA Title III, Sec. 313): • hazardous waste generators • hazardous waste disposal facilities • contaminated sites • leaking underground storage tanks • dischargers to surface water • dischargers to air • hazardous materials users	(916) 327-1848
Cal/EPA Department of Toxic Substances Control, Reg. II 700 Heinz Avenue, Suite 200 Berkeley, CA 94710	List of RCRA hazardous waste treatment, storage, and disposal facilities and haulers	Public Viewing Room (510) 540-3800
Cal/EPA Integrated Waste Management Board 8800 Calcenter Dr. Sacramento, CA 95826	List of all active and closed landfills and transfer stations	(916) 255-2296
Cal/EPA Department of Toxic Substances Control Office of Pollution Prevention and Technology Development P.O. Box 806 Sacramento, CA 95812-0806	Industry Source Reduction Plans/Findings from Plans	(916) 322-2822

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that the sources of concern in your municipality may not be those industries that are regulated under permit.

A source control study conducted for the Santa Clara Valley Nonpoint Source Pollution Control Program (NPSPCP) prioritized industrial sources according to the quantities of metals that were likely to be released to the environment (Woodward-Clyde Consultants, 1992). First priority industries (i.e., those judged to be responsible for the greatest quantity of metals relative to other industrial sources) included:

- Metal plating facilities (SIC 3471)
- Boat building and repairing facilities (SIC 373)
- Industrial machinery (SICs 355, 356)
- Trucking industries (SICs 4212, 4213, 4214)
- Used vehicle parts and metal scrap yards (SIC 5015, 5093)
- Auto repair shops and auto renting (SIC 751, 7538, 7539)

Remember that these businesses are only a pollution threat if their activities are exposed to stormwater. However, you may not be able to determine this until you conduct the initial inspection of a specific facility.

2c. Develop Initial Inspection Priorities

In the first year or two of your program, set initial priorities for categories of businesses to inspect based on what you expect to be the most likely sources of pollutants. After facilities have been inspected and you have some direct experience with the conditions in your municipality, your program's priorities can be readjusted on a site-specific basis. In addition, conducting a pilot program during the first year can be useful for collecting data on local business practices so that priorities can be adjusted during the second year (see Step 10).

Suggestions for setting initial inspection priorities are as follows:

- Use information from other inspection programs, data from the Regional Board, and/or preliminary inspections of your own (such as a "windshield survey"), to get an

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Example of a Phased Inspection Approach

The San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) developed guidance for its municipal agencies to use in setting priorities for the types of businesses to inspect. The STOPPP Stormwater Management Plan requires municipalities to initiate inspections by July 1994, complete 20 percent of the priority inspections by January 1996, and complete 100 percent by June 1997. The initial 20 percent includes all NOI facilities and as many other high priority businesses as necessary to meet the requirements. The remaining 80 percent includes a number of commercial businesses that STOPPP expects to be potentially significant dischargers of pollutants to storm drains.

The priorities recommended by STOPPP are:

1. *NOI and hazardous materials business plan facilities;*
2. *Vehicle service facilities and machine shops;*
3. *Restaurants conducting outdoor washing activities and grease disposal;*
4. *Commercial printers and cleaners;*
5. *Retail stores with dumpsters and/or oil changing on-site;*
6. *Mobile washers, pool/spa maintenance, and commercial painters; and*
7. *Golf courses, nurseries, and pesticide applicators.*

idea of which businesses within your municipality are potential problem sites based on the nature of the businesses, the materials they handle, their facility management practices, and/or their proximity to environmentally sensitive areas.

- Consider including some or all of the privately-owned industries in your municipality that have obtained General Permit coverage. It is better to exercise local inspection and storm drain discharge control over these sites than to depend on Regional Board staff to enforce the General Permit requirements.

- Consider the types of facilities that could be inspected under existing inspection programs. You may be able to make significant progress toward control of industrial and commercial stormwater discharges by dovetailing your efforts with these programs. The disadvantage of only using an existing inspection program to conduct stormwater inspections is that it may not cover all of the industries that are causing the worst stormwater problems.

- Include businesses that are the focus of frequent public complaints or are known to be "hot spots". Remember that if your inspection staff is responsible for responding to complaints, these activities will generally take priority over routine inspections.

- Consider businesses in older areas of town with aging infrastructure, on areas that are unsewered, as they are more likely to have illicit discharges.

STEP 3. DECIDE WHO SHOULD CONDUCT INSPECTIONS

3a. Identify Which Other Agencies and Internal Departments are Conducting Inspections

Find out which specific agencies and/or departments are inspecting businesses within your municipality, what types of businesses they are inspecting, and how often

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they conduct inspections. A summary of different types of inspectors who could potentially perform stormwater inspections and their current inspection functions is provided in Table 4.

3b. Evaluate Who is Best Suited to Conduct Stormwater Inspections

Options for Stormwater Inspection Services

There are basically three approaches to obtaining inspection services:

1. **Use inspectors from an outside agency or internal department that are already conducting inspections of priority businesses.** This is the most popular approach because of the advantages of incorporating stormwater inspections into existing inspection programs (discussed in Chapter 2).

2. **Create a dedicated inspection staff within your own department.** Given the number of existing inspection programs, this approach is not usually chosen except by large municipalities. If you can't justify a dedicated full-time inspection staff, it may make sense to have your existing staff spend part of their time conducting inspections of facilities that are not already being inspected, or responding to public complaints or referrals from other inspectors.

3. **Hire a contractor, consultant, or temporary staff to perform the inspections.** This approach may be appropriate for conducting inspections of a particular type of business (such as one that is not part of an existing inspection program) or filling in for your own staff in Option 2. above. It allows you to meet seasonal demands for inspection services and avoid hiring permanent staff. Contractors and consultants typically do not have enforcement authority but they can perform inspections and refer follow-up and enforcement actions to your staff. The City of Palo Alto found that use of consultants was the most cost-effective

A Hybrid Approach to Inspection Services

Here's an approach proposed by the City of Palo Alto to maximize use of various inspection service options to inspect different business types for stormwater compliance [1]:

- ***Pretreatment inspectors** - inspect businesses with sanitary sewer discharge permits;*
- ***County health inspectors** - inspect restaurants and food handling facilities;*
- ***County or Fire Department hazmat inspectors** - inspect businesses that handle hazardous materials/wastes and are not subject to pretreatment inspections;*
- ***Contract inspection services** - inspect commercial businesses such as automotive shops;*
- ***Stormwater program staff** - respond to complaints regarding illicit discharges or illegal dumping.*

This approach can effectively cover priority businesses; however, it requires coordination to avoid overlap and numerous agreements for inspection services.

[1] Personal communication with Leo Sarmiento, Regional Water Quality Control Plant, Palo Alto, CA.

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TABLE 4
TYPICAL INSPECTION AGENCIES AND RESPONSIBILITIES

Agency/Department	Primary Inspection Function
County Environmental Management Hazardous materials and hazardous waste inspectors	Businesses required to have hazardous material business plans (HMBPs); hazardous waste generators; underground storage tanks (USTs)
County Health Department Health inspectors	Restaurants; food service facilities
Wastewater Treatment Agencies Pretreatment/source control inspectors	Industries which have permits to discharge industrial waste to the sanitary sewer; restaurants with grease traps
Fire Department or District Fire safety inspectors; Hazardous materials inspectors	Businesses which store and handle hazardous materials; all businesses in some locations
Public Works Department Source control inspectors	Industries which have permits to discharge industrial waste to the sanitary sewer
Building/construction inspectors	Construction activities (private and public)
Illicit discharge inspectors	Businesses found to be the source of illicit discharges to storm drains and sewers

** Use Worksheet #2 (Appendix A) to help you implement Step 3.*

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method of conducting inspections of automotive facilities. These three approaches are not mutually exclusive; they are commonly used in combination to cover inspection of different types of businesses (see sidebar). Another option is to have your stormwater inspectors conduct joint inspections with inspectors from other agencies and departments. This provides opportunities for cross-training of inspectors and is often more convenient for businesses as well.

Issues in Selecting an Outside Agency

In deciding which agency (or department) should conduct stormwater inspections and educational outreach for your municipality, consider the following questions:

- Which agency or agencies are inspecting priority businesses (related to control of stormwater discharges)?
- Is the agency willing to take on more responsibility for its inspectors?
- Does the agency have the resources to accomplish the additional inspections in the desired time frame?
- What interagency responsibility or reimbursement agreements might be needed to conduct the inspections?
- Will it be cost-effective to use the services of that agency? Will it be easier and more convenient for businesses?
- Does the approach used by the agency (i.e., use of education, incentives, and enforcement) match the approach you desire for stormwater pollution control?
- Will the agency conduct follow-up and enforcement activities and does it have sufficient legal authority to do so?
- How will information be transferred between the agency and your staff?

In reality, political or budgetary issues may ultimately drive the decision as to which agency to work with. Consideration of the above questions will then help to define what issues should be covered in interagency agreements (see Step 3d.).

Using a Bid Process to Select an Inspection Agency

The Contra Costa Clean Water Program (CCCWP) took a unique approach to selecting an agency to conduct stormwater inspections for its member agencies. The Program requested proposals and bids from various inspection agencies in the County, and invited the County Environmental Health Department and several wastewater agencies to make presentations to a selection committee. A group of three sanitary districts (Central Contra Costa, West County, and Delta Diablo) were selected to conduct inspections for a majority of the CCCWP municipalities. The districts will conduct a pilot program during the first year which will focus on vehicle service shops and some NOI industries.

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More Example Inspection Programs

- *The City of Hayward has a thoroughly integrated source control program incorporating storm water, pretreatment, and pollution prevention. Inspectors conduct site inspections for each of these issues at over 160 industrial and commercial facilities annually. The inspector can require non-stormwater discharges to be addressed by pollution prevention measures or redirected to the sanitary sewer if appropriate.*

The City of Simi Valley has a similarly integrated program in which its source control inspection staff conducts pretreatment, stormwater and hazmat inspections. Each inspector is responsible for all inspections within a geographical zone of the City. Facilities inspected include heavy and light industries (including NOIs), automotive shops, restaurants, and other commercial businesses. Inspectors use a standard inspection form with seven attachments to address specific problems under each area of concern (stormwater, waste disposal, material storage, etc.)

Typical Approaches Using Existing Inspection Programs

Based on the information collected for this Handbook, most municipalities, both large and small, have incorporated some or all of their stormwater inspections into established inspection programs. The programs that are most commonly used are pretreatment, hazmat, and health department inspection programs. Only the largest cities, San Jose and Los Angeles, are using or considering using dedicated nonpoint source inspectors to inspect industrial/commercial facilities. In the case of Los Angeles, pretreatment inspectors refer any major stormwater-related problems they observe to the nonpoint source inspectors, and the nonpoint source inspectors conduct follow-up or enforcement or respond to complaints. Other examples are presented in the sidebar and in Table 1B (Appendix E).

Impacts of CUPA Legislation

The State recently enacted legislation (Senate Bill 1082) to streamline and consolidate regulation of hazardous materials and waste facilities. Under this legislation, a county or city is required to form a "certified unified program agency" (CUPA) to administer requirements for hazardous waste generation, spill control, USTs, HMBPs, and the handling, use, and storage of hazardous materials. This single agency will be responsible for conducting all hazardous material-related inspections at regulated facilities.

The legislation does not require stormwater inspections to be performed by the CUPA; however, you may want to consider having the CUPA for your area conduct stormwater inspections with its other inspection activities at these facilities. If you choose this approach, be aware that CUPA inspectors will be focused on ensuring proper storage, handling, and disposal of hazardous materials and wastes; they may need additional guidance and training to be able to recognize potential stormwater pollution problems and suggest appropriate BMPs.

3c. Coordinate Inspection Responsibilities with the Local Regional Board

Meet with your local Regional Board staff to discuss any aspects of your inspection program that may overlap with their responsibilities. Consider developing and adopting an agreement with Regional Board staff regarding the facilities that each agency will inspect, the means of exchanging information, and coordination of enforcement

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activities. The concept of developing an MOU with the Regional Board was discussed on pages 2-4 and 2-5, and an example of an MOU is provided in Appendix C.

3d. Develop Any Necessary Agreements with the Inspecting Agency(s)

If you elect to use another agency to conduct stormwater inspections, meet with the agency to discuss any institutional arrangements or agreements that are required. These agreements may need to address issues of reimbursement, information transfer, training, enforcement authority, and liability. Also discuss your municipality's permit responsibilities and inspection standards and obtain a commitment from the inspecting agency to meet your requirements. Examples of interagency agreements are provided in Appendix D and described in the sidebar.

Remember that, when you use contract services to do your inspections, your municipality is still responsible for the results of those inspections and reporting them to the Regional Board. If the inspecting agency is not a recognized part of your municipality, it is not the NPDES permit holder so it is not legally responsible for compliance with the permit.

STEP 4. ESTABLISH ENFORCEMENT PROCEDURES

The recommended approach to conducting stormwater inspections is to educate and provide incentives to businesses to comply with stormwater requirements. Enforcement actions should be limited to businesses with repeated or flagrant violations. Your stormwater program should help businesses understand the stormwater requirements and give them a reasonable opportunity to implement appropriate BMPs, while being clear about your intentions to enforce the requirements if they do not comply. Adopting a defined enforcement procedure and training inspectors in its use will help provide a consistent, fair, and predictable approach to enforcement.

4a. Demonstrate and/or Designate Legal Authority

Assess your municipality's authority to enter and inspect a facility and take enforcement action, and which personnel have that authority. Municipalities with

Examples of Interagency Agreements

- *The City of Fremont contracts with the Union Sanitary District to conduct its stormwater inspections. The City and District have an MOU which designates District inspectors as enforcement officers, allowing them to issue warning notices and cease and desist orders, and describes the method by which the District will be compensated for its services (See Appendix D).*
- *The San Mateo County Environmental Health Division performs stormwater inspections for 12 cities in the County at no charge to the cities, because the permit fees it collects from industries with HMBPs and restaurants cover the cost of doing storm water inspections along with hazmat and UST inspections. The County has an MOU with each city which describes its responsibilities and relieves the city of liability for County staff safety.*

**** Use Worksheet #3 (Appendix A) to help you implement Step 4.***

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municipal stormwater permits are required to have or obtain the legal authority to prohibit non-stormwater discharges to storm drains and require stormwater controls to the MEP via a stormwater discharge/pollution control ordinance or other municipal code.

In order to conduct an effective inspection program, you must have sufficient legal authority to:

- regulate stormwater discharges from industrial and commercial businesses into the storm drain system;
- prohibit illicit discharges and illicit connections at these facilities;
- inspect the premises;
- require, witness, or conduct sampling and analysis of any discharges;
- require the implementation of BMPs, including installation of structural controls if necessary; and
- pursue civil and criminal penalties for violations of stormwater regulations.

Need for a Stormwater Ordinance

A review of municipal codes in Alameda County by Gorman & Waltner, Attorneys at Law, found that municipalities generally have sufficient legal authority to implement required stormwater pollution controls, but lack the actual expression of this authority in local ordinances. A stormwater discharge ordinance is the proper tool for providing municipal inspectors with general administrative authority to inspect, regulate, and enforce.

Gorman & Waltner prepared a Sample Ordinance (Appendix H) to guide municipalities in developing the means to control discharges to their storm drains. This Sample Ordinance, or a modified version of it, has been adopted by most municipalities in Alameda County and used as a model for other municipalities throughout the State. Article III of the Sample Ordinance specifically deals with the legal authority required for inspection and enforcement.

A stormwater ordinance should also include language that designates inspectors or other municipal personnel as enforcement officers. If you are using another agency to perform the inspections, you will need to either designate enforcement authority to that agency (see examples in

Use of Specific Ordinance Language

Some municipalities put business-specific or activity-specific stormwater provisions or BMP requirements into their general stormwater or sewer use ordinance, to make it more clear and enforceable for certain business types. The City of Palo Alto took this approach to regulating vehicle service shops, and designed its "Clean Bay Business" program to inform and encourage these businesses to comply. There may be opposition from the business community to this approach, so make sure the need for a specific ordinance is clear and compelling, and that businesses are given adequate information and time to comply prior to enforcement.

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Step 3d.) or set up procedures for referral of violations back to the municipality or a regulatory agency for enforcement.

Use of State and Municipal Codes

If your municipality does not have a stormwater ordinance, inspectors may have authority under existing State or municipal codes that provide environmental protection. State laws can be used by law enforcement personnel or peace officers to cite observed violations and respond to complaints. However, a search warrant may be needed to inspect a facility for a suspected problem. The Fairfield-Suisun Sewer District, lead agency for the Fairfield-Suisun Urban Runoff Management Program, compiled and distributed summaries of State environmental crime codes (see sidebar) on a two-sided laminated card to local law enforcement agencies, so they could assist the District with enforcement of stormwater pollution violations. Agencies should consult with the local District Attorney's office to determine the DA's willingness to prosecute these violations.

In order for municipal inspectors to issue citations for violations of local codes, they must receive specific training and become public officers (under Section 830.2 of the Penal Code). Some municipalities are providing their inspectors with this authority (for certain applicable codes) in order to make it easier for them to take immediate enforcement action at the time a violation is observed. Municipal inspectors need to contact the DA's office for enforcement of State codes

4b. Adopt Defined Enforcement Procedures

Once you have established enforcement authority, develop and adopt a defined enforcement procedure to guide your inspectors (or those of other agencies) in taking enforcement actions. The procedure should consist of a well-defined sequence of actions escalating from warnings to violation notices or citations and finally to legal action. Consult with your City or District Attorney for guidance in determining your enforcement approach and procedures.

An example of a typical general enforcement strategy is the minimum enforcement protocol developed by the ACCWP in 1994, which was adopted by all the municipalities in the Program that are conducting stormwater inspections (see Appendix I). The protocol describes the conditions at the facility that trigger each level of enforcement; information that should be provided in the violation notice; the response required of the

EXAMPLES OF STATE ENVIRONMENTAL CRIME CODES

Fish and Game Code

Sec. 5650 - Polluting Water (M) Prohibits depositing the following materials into or near waters of the state:

- *petroleum, acid, or related products;*
- *solid or liquid refuse from any factory;*
- *sawdust, shavings, or slabs;*
- *factory refuse, lime, or slag;*
- *any substance or material deleterious to fish, plant, or bird life.*

Sec. 5652 - Dumping Near Water (M) Unlawful to deposit, permit to pass into, or place where it can pass into water, or abandon, dispose of, or throw away, within 150 feet of high water mark, any cans, bottles, garbage, motor vehicle or parts thereof, rubbish, or animal carcass.

Health and Safety Code

Sec. 5411 - Discharge of Sewage or Other Waste (M) No person shall discharge sewage or other waste, treated or untreated, in any manner which will result in contamination, pollution, or a nuisance.

Vehicle Code

Sec. 27153 - Exhaust Products (I)No motor vehicle shall be operated in a manner resulting in the escape of excessive smoke, flame, gas, oil, or fuel residue.

M = Misdemeanor; I = Infraction

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STATE ENVIRONMENTAL CRIME CODES (continued)

Penal Code

Sec. 370 - Public Nuisance (M)
Anything which is injurious to health or indecent, or offensive to the senses or an obstruction to the free use of property, or unlawfully obstructs free passage or use of any navigable lake, or river, bay, stream, canal, or basin or any public park, square, street, or highway is a public nuisance.

Sec. 374.7 - Dumping Waste Material Into or Near Water (M)
Every person who litters or dumps any waste matter into any stream or body of water or within 150 feet of the high water mark of any stream or body of water is guilty of a misdemeanor.

Sec. 374.8 - Dumping of a Hazardous Material (M)
Knowingly depositing a hazardous substance into or upon any road, street, highway, alley, or upon the land of another, without permission of the owner is prohibited.

Business and Professions Code

Sec. 17200 - Unfair Business Practice (C)
Engaging in an unlawful or unfair business practice is a civil offense.

M = Misdemeanor; C = Civil

facility operator; the time period allowed for response; and the schedule for follow-up inspections. The San Mateo Countywide STOPPP and the Fairfield-Suisun Urban Runoff Management Program adopted similar enforcement protocols (also in Appendix I). After two years of experience with its protocol, the ACCWP revised it to define four levels of enforcement action: warnings, administrative actions, administrative actions with fines and/or cost recovery, and legal actions (Appendix I).

An alternative enforcement strategy is to give inspectors the authority to issue citations for major violations at the time they are observed. Inspectors like this approach because they can issue citations "on the spot" and do not need to collect extra documentation for enforcement at a later date. If you use this approach, your enforcement protocol should clearly specify when the issuance of a citation is appropriate.

Whatever enforcement approach you adopt, it should be well defined, consistently applied, and well publicized to the businesses being inspected.

4c. Establish Guidelines for When to Involve Other Agencies

Add guidelines to your enforcement procedures for when to draw on the legal authority of other agencies such as the Regional Board, the District Attorney, county environmental health departments, or local law enforcement agency.

Enforcement by the Regional Board

If an inspector observes a discharge from an industrial or commercial business that is a threat to water quality and cannot get the business to discontinue the discharge through local efforts, contact the local Regional Board office for direction and/or assistance. The Regional Boards have a variety of enforcement mechanisms available, including administrative civil liability (ACL) complaints, cleanup and abatement orders (CAOs), and cease and desist orders (CDOs). They also have the authority under the State Water Code (Porter-Cologne Act) to impose civil liability of up to $10,000 per day for every day that the industry is out of compliance. Keep in mind, however, that continuing referrals of problem discharges to the Regional Board may be interpreted by Board staff to mean that the municipal program is not effective.

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To encourage compliance with the General Permit, the State and Regional Boards have developed an enforcement strategy based on a cooperative approach to implementing the General Permit program. The strategy includes educational outreach, technical assistance, monitoring and inspection, and enforcement action. State and Regional Board staffs have initially focused on identifying "non-participants" and getting them involved in the program. Non-participants include industries requiring General Permit coverage that have not filed NOIs ("non-filers") and those that have filed NOIs but have done nothing else to comply with permit requirements (e.g., have not developed or implemented a SWPPP). If industries are willing to participate, Board staff will educate and assist industries in implementing their SWPPPs.

You can assist the State and Regional Boards by notifying them of industries you inspect who should have filed NOIs or implemented SWPPPs. The San Francisco Bay Regional Board's policy is to require non-participants to file an NOI within 10 days and submit and begin to implement a SWPPP within 30 days of notification. If an industry does not comply with these requirements, the Regional Board will issue a CDO or CAO and/or an ACL Complaint. If there are significant adverse impacts to beneficial uses due to stormwater runoff from a site, and a SWPPP for the site would have prevented or lessened the problem, the site owner can be fined up to $25,000 per day of discharge for non-compliance with the General Permit.

Enforcement by the District Attorney

The District Attorney's office should be contacted if the inspecting agency believes that the industry is committing a criminal offense, such as a serious hazardous material violation, e deliberate criminal act, or repeated violations and failure to respond to violation notices. In addition, it is usually desirable to allow review of this type of case by other agencies for possible additional violations of Federal, State, or local laws. For example, ignoring violations of hazardous materials and other statutes may jeopardize future enforcement. Inspectors should also be aware of any local guidelines for involving law enforcement agencies in investigation of hazardous materials incidents.

Help with Enforcement of Environmental Crimes

A number of counties in California have an Environmental Crimes Task Force which consists of representatives of local law enforcement and other public agencies that have environmental jurisdiction. These include: the Department of Fish and Game, the Department of Toxic Substance Control, the U.S. EPA, the local Air Quality Management District and Regional Board, the U.S. and District Attorneys, and other organizations. The Task Force can be very helpful in providing guidance on enforcement procedures and how and when to involve these agencies in enforcement actions. Your participation in the Task Force can help to educate these agencies about your stormwater inspection program and coordinate your enforcement activities with theirs.

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• Use Worksheet #4 (Appendix A) to help you implement Step 5.

STEP 5. DEVELOP AN EDUCATIONAL OUTREACH PROGRAM

Stormwater pollution prevention is most easily and cost-effectively achieved through education and awareness. Most businesses will do the right things if they know what the right things are. Therefore, one of the most important steps in initiating a stormwater inspection program is to communicate with the general business community about upcoming stormwater requirements and appropriate BMPs.

Experience has shown that outreach to commercial businesses is especially critical to the success of an inspection program.

Outreach to commercial and small businesses is even more critical to successful pollution prevention than it is for larger businesses and industries for several reasons:

- Commercial businesses typically operate on tighter profit margins, so they have limited resources to track and understand environmental issues and regulations.
- Lack of resources makes it difficult for small businesses to make changes, and those changes take time.
- Small businesses have a higher percentage employee turnover and one untrained employee can have a significant impact.
- Regular and frequent employee training are not as common at small businesses.
- Small businesses are not as used to being regulated as larger businesses. Outreach helps them understand the need for pollution prevention.

Consider using City staff that are not involved in inspection activities to conduct outreach to individual businesses. This approach may be appropriate if you are initiating a clean business program or if you have arranged for another agency to conduct stormwater inspections and you want to supplement their outreach efforts.

5a. Determine Appropriate Methods of Outreach

Education of individual facility owners and operators usually begins at the first site visit; in fact, this is often the main purpose of the initial visit. At a minimum, your outreach effort should include education of facility owner/operators during inspections. Inspectors should provide verbal and written information, if possible, on stormwater regulations (including General Permit and local requirements), the impacts of polluted discharges to storm drains, and the appropriate BMPs for that facility. A more comprehensive education and outreach program should also provide outreach to industrial and commercial business groups through mailings, media coverage, workshops, and incentive programs.

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The types of educational materials and activities that are being used by existing municipal inspection programs include:

- Verbal communication during site visits;
- Handouts during inspections:
  - fact sheets on stormwater regulations, General Permit requirements, local ordinances, and other local stormwater program information;
  - flyers and brochures on appropriate BMPs for specific activities;
  - comprehensive BMP handbooks or manuals;
- Pre-inspection and follow-up letters;
- Workshops or presentations for local business organizations and trade associations; and
- General mailings to the business community or specific businesses about new regulations or programs or upcoming events.

Many businesses, especially those with stormwater permits, expect to be inspected and are not used to the idea of self-regulation. Your program may lose some credibility with businesses that aren't regularly inspected if you don't keep in touch with them to remind them of the program or to recognize them for their efforts. A regular mailing or newsletter with information on the inspection program and acknowledgement of "clean" facilities is one method of continuing outreach to these businesses.

You may want to consider conducting an "informational site visit" to each facility, to briefly evaluate the site and educate the owner/operator about stormwater requirements and BMPs. If this initial visit is not for regulatory purposes, owner/operators may be more willing to discuss their processes and problems without the threat of enforcement.

Reach Out to Business Organizations

Workshops planned and conducted jointly with business organizations have been found to be effective in educating a large number of businesses about stormwater regulations and BMPs and what to expect during inspections. The ACCWP, in conjunction with the City of Oakland, Regional Board staff, and the West Oakland Commerce Association (WOCA), conducted a pilot outreach workshop for WOCA members in 1994. The workshop was very successful, attracting over 70 participants. Based on the pilot, the ACCWP developed prototype business outreach workshop materials and trained municipal staff on how to conduct similar workshops with local businesses.

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5b. Develop (or Adapt Existing) Educational Materials

A wealth of educational material has been developed by existing inspection programs that can be a resource for you in developing your own materials. It is simple and cost-effective to adapt these existing materials. Most programs will generously share their materials, but it is best to request permission first. Another approach is to work together with other stormwater or wastewater agencies to develop regional outreach pieces and share development and printing costs. For example, the Bay Area Stormwater Management Agencies Association (BASMAA) and Bay Area Dischargers Association (BADA) jointly funded development of outreach materials for mobile washers, carpet cleaners, vehicle service facilities, and pool and spa maintenance.

Appendix J provides a list of available outreach pieces for industrial and commercial businesses and contact persons, as well as some examples of inspection flyers, BMP brochures, letters and fact sheets. The ACCWP, the City of Richmond, and the City of Palo Alto have developed numerous brochures and flyers describing BMPs for specific industries. The ACCWP provided its member agencies with copies of its BMP flyers on computer disks so they could adapt the flyers to their local needs. The City of San Jose sends out a pre-inspection letter to educate businesses about nonpoint source pollution and stormwater regulations, as well as inform them about upcoming inspections of their facilities. The Santa Clara Valley NPSPCP developed a 26-page booklet of BMPs for industrial stormwater pollution control. A similar booklet on BMPs for automotive related industries was developed jointly by San Francisco Bay Area stormwater and wastewater agencies.

STEP 6. DEVELOP METHODS FOR COLLECTING AND MANAGING INSPECTION INFORMATION

** Use Worksheet #5 (Appendix A) to help you implement Step 6.*

In developing information collection and management methods for your inspection program, keep in mind the three primary purposes for collecting information during your inspection program:

1) To track the progress of inspection and follow-up activities at each facility, including documenting any observed violations for possible enforcement actions;

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2) To document inspection efforts for NPDES permit reporting to the Regional Board; and

3) To assess and improve the long-term effectiveness of your inspection activities.

6a. Develop a System for Data Collection

Data on Inspection Activities

Inspection data is usually collected by the inspector on a standardized form. Stormwater inspection data can either be collected on e separate form or added to an existing form used for hazardous material, pretreatment, or commercial business inspections. Stand-alone forms for stormwater inspections should be kept to one or two pages and be fairly simple to use.

The basic information that needs to be collected on the form during a stormwater inspection includes:

1) Background information - name and address of facility, contact person, and property owner, business type and SIC code(s), what permits the facility has, and its regulatory history;

2) Information about the facility's status for coverage under the General Permit, and whether the facility has a SWPPP and a Monitoring Plan (optional);

3) Observations regarding potential or actual discharges of pollutants to stormwater or storm drains in each area of activity at the site (e.g., outdoor material storage or manufacturing areas, waste disposal areas, rooftop equipment, vehicle and heavy equipment storage and maintenance areas, exterior wash areas, etc.), including the results of any sampling performed;

4) Directions to facility operator on corrective measures, and planned follow-up or enforcement activities, if needed; and

5) Results of any follow-up or enforcement activities.

If a violation is observed, the inspector may want to collect additional information or evidence such as samples of the discharge, statements from persons with knowledge of the violation, photographs or video tapes,

Helpful Hint

Evaluation of your program will be much easier if you can quantify the results of your activities as much as possible. Design your information collection methods with this in mind.

Important Inspection Data

- *Background information on facility;*
- *Facility's General Permit status;*
- *Observations of pollutant discharges (potential or actual);*
- *Required corrective measures;*
- *Results of follow-up activities.*

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Your Inspection Report Is An Official Record

Inspection reports can be printed on carbonless copy forms and completed on the spot during site inspections. The report can then be signed by both the inspector and the facility owner or manager, and a copy given to the owner or manager. This immediately notifies the facility of any problems or violations and provides a written record of the disclosure, eliminating later claims by the facility that staff had no knowledge of noncompliance issues.

Word of Caution on Data Management Systems:

A data management system is only as useful as the data contained in it. You must implement quality control/quality assurance and review procedures before and after entering data to ensure that data are accurate and consistent (for example, that names are spelled correctly and that street names have consistent designations).

and printed material regarding the facility's condition or operations. Forms can also be used to collect information for inspection program assessment and planning, including what outreach materials were provided by the inspector and how long it took to perform the inspection.

Some municipalities require their inspectors to review the adequacy of the SWPPP at NOI facilities and report evidence of SWPPP implementation on the form. You do not need to document separately information already provided by NOI industries to the Regional Board in their annual reports, such as the industry's facilities inspection and monitoring results. However, you should review these reports for useful information on the industry's assessment of the success of its BMPs and the types of pollutants that are being discharged in stormwater.

There are numerous examples of stormwater inspection forms available to guide you in the development of your own form. Standard inspection forms or summary forms are being used by groups of municipalities, such as those in an area-wide stormwater program, to collect and report similar inspection data and to document and follow up on violations in a consistent manner. Examples of standard forms developed by the Santa Clara Valley NPSPCP, the ACCWP, and others are provided in Appendix K.

Data for NPDES Permit Reporting

Much of the data collected on inspection activities will be useful for documenting the accomplishments of your inspection program in your report to the Regional Board. Some Regional Board staff are requiring copies of the inspection forms, while others are primarily interested in summaries of the number of inspections conducted, the number of facilities at which problems were observed, and the follow-up activities to correct the problems.

Discuss with your local Regional Board staff what information they require to document your inspection efforts. Expectations may vary among Regional Boards for different municipal programs, and may change over time. For this reason, make sure you plan to collect and store the amount of information you think is reasonable to accurately document your activities.

Data to Measure Effectiveness

Data on the history of facility inspections, follow-up, and/or enforcement activities, as well as actions taken by the industry at each stage, is also important for essessing (and demonstrating to the Regional Board) the effectiveness of the municipality's inspection program.

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This information is also useful in helping to better target inspection and educational outreach activities to address priority problems being found. Also, sufficient data should be collected and summarized so that long-term trends in the numbers of pollutant discharges encountered and corrected and the types of facilities responsible for the most discharges can be observed.

6b. Develop a System for Storing, Reporting, and Evaluating Data

Stormwater inspection information can be kept in file folders by facility name or combined with files containing other inspection or permit compliance information for businesses. However, most municipalities, especially those actively conducting large numbers of inspections each year, are using computer data bases to manage their inspection data, either on a personal computer or a mainframe. There are many simple data base programs available for this purpose. The data base fields should be set up to match the information collected on inspection forms for easy entry, and key fields for sorting and analysis should be carefully selected.

Before setting up a new data management system for your inspection data, check to see what systems may already exist for other programs within your municipality or agency. It may be possible and/or economical to add your inspection data to an existing data base or at least coordinate your data base development with other efforts. This approach can facilitate the sharing of data on businesses' activities with other programs, such as wastewater or hazardous materials permitting programs, and the reporting of combined data sets.

If possible, design your data management system to help you summarize data that have been collected, generate reports, flag problem industries or common problem areas, and/or plan future inspection efforts. This capability is also important for evaluation of the effectiveness of the inspection program at the end of the year and over the long term.

STEP 7. DEVELOP AN INSPECTOR TRAINING PROGRAM

7a. Determine Training Needs

Carefully assess the skills of your inspectors and the expected conditions at the inspection sites when planning and budgeting for inspector training. Although the

Reported Inspector Training Needs

In 1992, the Santa Clara Valley NPSPCP conducted a pilot inspection program in the City of Santa Clara which addressed requirements for inspector training. The pilot program identified the following important training needs:

- *hands-on field training by an experienced inspector;*
- *classroom training on stormwater requirements and related regulatory programs;*
- *training on communication with facility managers; and*
- *a reference manual for inspectors on regulations, legal authority, and enforcement procedures.*

The pilot program report recommended:

- *If a municipality has limited resources, a small number of people should be trained, with an intensive field training period; and*
- *Inspectors from other programs should be cross-trained about stormwater pollution prevention and referral of stormwater violations.*

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Ideas for Training Workshops

The ACCWP has been conducting annual training workshops for facility inspectors from its participating municipalities since 1994. The workshops have been well-attended, successful forums for sharing information and practicing inspection skills.

The first annual workshop (October 1994) covered:

- *Review of stormwater regulations;*
- *Review of Regional Board staff guidance for inspections;*
- *Hands-on inspection of Alameda County's municipal corporation yard; and*
- *Discussion of the inspection activity.*

The second annual workshop (September 1995) included:

- *Use of new facility inspection report forms;*
- *An exercise in selecting BMPs for different types of facilities;*
- *An exercise in conducting a follow-up visit (when a facility has not effectively implemented BMPs); and*
- *Review of General Industrial Permit requirements.*

personnel assigned to perform the inspections will likely have some background in conducting hazardous materials, pretreatment, or other types of industrial inspections, they may need specific training in identifying potential pollutant discharges to storm drains as well as education about stormwater requirements and BMPs. Added responsibilities for your inspectors may mean that you'll need to hire additional inspectors, who may need more comprehensive training.

To properly and safely conduct stormwater inspections, as well as educate facility owner/operators, inspectors will need knowledge and skills in the following minimum areas:

1. Inspection methods, including where to look, what to look for, and what questions to ask regarding activities that are performed at the site;
2. Sample collection, sample testing, and chain-of-custody procedures;
3. Types of wastes from industrial and commercial activities (including toxic constituents), sources, methods of detection, and effects on the environment;
4. Federal, state, and local stormwater regulations;
5. Good housekeeping, materials management, and other types of BMPs for stormwater pollution prevention at industrial and commercial sites;
6. Methods of presenting information and requirement clearly and diplomatically to facility operators;
7. Safety practices, procedures, and precautions; and
8. Specialized training as appropriate, including OSHA 40-hour safety training (for sites involving hazardous materials) and confined space entry training.
9. Enforcement procedures and criteria, such as how to issue citations or administrative notices.

The training needs of stormwater inspectors will depend on their existing skills and their role in implementing your program. For example, pretreatment and hazardous materials inspectors who will be looking for stormwater-related issues as part of their regular inspection duties will probably only require additional training in stormwater regulations and BMPs. If the role of municipal staff is

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primarily educating local businesses about stormwater requirements or encouraging their participation in a clean business program, they may not need training in sampling techniques or the 40-hour safety course.

Proper and consistent training of inspectors is important to the regulated business community. A well-trained inspector can conduct more efficient site inspections, taking up less of the facility operator's time, and can provide better guidance to the facility on getting into or maintaining compliance with stormwater regulations. Consistency in training also makes businesses feel that they are being treated equitably during inspections and follow-up activities. Knowledgeable businesses will lose respect for the inspection program if they perceive that their operators know more than the inspectors!

** Use Worksheet #6 (Appendix A) to help you implement Step 7.*

7b. Consider Training Approaches

Municipalities are using a number of approaches to train stormwater inspectors, depending on who is conducting the inspections and available resources. Types of training include:

- In-house training using existing staff;
- Off-site training by another agency or private firm;
- On-the-job training (i.e., "shadowing" an experienced inspector);
- Countywide stormwater program workshops; and
- Distribution of educational information to inspectors.

Among the stormwater programs surveyed for this Handbook, the most commonly used training methods are in-house training and on-the-job training. The countywide stormwater program workshops have been a cost-effective way of improving consistency among inspectors from different municipalities and agencies. Workshops in Alameda and San Mateo Counties have covered review of stormwater regulations (usually presented by Regional Board staff), discussion of typical inspection and enforcement problems encountered, distribution of educational material, and hands-on activities (see sidebar).

Approaches to Ongoing Inspector Training

1) The Santa Clara Valley Nonpoint Source Pollution Control Program and the City of San Jose hold quarterly inspector "round tables" for municipalities in the Program.

Benefits:

- *Provides valuable opportunities for inspectors to network and discuss common problems and solutions.*
- *Ensures consistency of approach and enforcement action among inspectors.*

2) Los Angeles County holds joint training sessions every two months for stormwater and hazmat inspectors.

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Funding Example: City of Hayward's Stormwater Utility Fee

The City of Hayward, like other cities in Alameda County, created a stormwater utility in 1992 to raise revenues for stormwater pollution control activities and storm drainage system improvements and repairs. Activities funded by stormwater utility fees include: public/business education, street sweeping, collection system maintenance, industrial inspections, investigation and correction of illicit discharges, new development controls, and the City's contribution to the ACCWP.

Charges are based on parcel size and the amount of runoff generated by the parcel. Each parcel is assigned a runoff factor based on land use, ranging from 0.003 for non-utilized vacant land to 0.8 for commercial/ industrial properties. All land uses are charged the same base rate per acre, except commercial/ industrial which pays a higher charge to cover inspection program costs and a portion of the illicit discharge program costs.

The annual stormwater fee is calculated by multiplying the parcel size times the runoff factor times the base rate per acre. For example, the actual charge in 1996 for a single-family residence with a 0.25 acre minimum lot size is: (0.25 acres) X (0.4) X ($285.60) = $28.56 per year.

Training by example is also a very effective method. Arrange for new inspectors to ride along with experienced inspectors to observe the proper procedures for conducting and documenting inspections and educational outreach. "Ride-alongs" are also an effective way for supervising inspectors to periodically audit the work of their inspection crews.

STEP 8. EVALUATE FUNDING ALTERNATIVES

Municipalities with inspection responsibilities under their NPDES permits cannot get those requirements waived due to lack of sufficient resources to conduct inspections and outreach. If funding is a problem in your municipality, you will need to evaluate alternative funding mechanisms to support your inspection program.

8a. Consider Available Financing Methods

There are a number of methods available for funding stormwater inspection programs (or the inspection component of a municipal stormwater management program). The most common are:

- stormwater or sewer utility fee;
- special district or benefit assessments;
- inspection and/or permit fees; and
- General Fund appropriations.

A summary of these financing methods and their advantages and disadvantages for funding inspection programs is presented in Table 5.

Selection of one or more revenue sources for inspection programs is dependent on:

- The type of organization that will perform or fund the inspections (utilities and special districts may be legally authorized to raise funds in ways that municipal governments are not);
- The amount of money that can be raised by various revenue options;
- Political feasibility; and

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TABLE 5
METHODS OF FINANCING STORM WATER INSPECTION PROGRAMS[1]

Description	Advantages	Disadvantages
User Fees Charges for services that broadly reflect distribution of benefits received. Usually held in dedicated "enterprise" funds. Requires ordinance(s) or legislation to create a utility or district and allow collection of and set fees. Types include: • Storm Water Utility Fee • Sewer Utility Fee • Special District Fee	• Equitable funding method, as costs are distributed among users who benefit from program (enjoy improved water quality). • Revenue is dependable, predictable and easily collected (via utility or property tax bills).	• Need public acceptance and approval of local government body (but does not need voter or property owner approval). • May be misperceived as a tax. • Need for fees and fee basis must be well documented and legally sound (to avoid potential lawsuits).
Special District or Benefit Assessment An annual assessment on parcels within a specified district. Requires legislative action to create district and/or allow existing district to levy assessment.	• Equitable funding method, as costs are distributed among property owners who benefit from program (enjoy improved water quality). • Revenue is dependable, predictable and easily collected (usually via property tax bills).	• Difficult to implement. • Requires state legislative action and notification and approval of property owners. • May be politically unacceptable (misperceived as a tax).
Inspection or Permit Fees Fees collected directly from businesses being inspected or regulated. A local ordinance is usually required to allow collection of and set fees.	• Allows cost recovery directly from businesses that are potential pollution sources. • If applied only to businesses in noncompliance, is equitable way to fund inspection and follow-up activities.	• Shifts financial burden to business community, including clean businesses, which discourages cooperation. • May not generate enough revenue as a sole source of funding.
General Fund Appropriation Funds allocated from municipality's General Fund. Sources of revenue are sales, property, and business taxes.	• Funding and revenue collection methods are already in place. • Traditional funding mechanism for municipal government activities.	• Must compete with other municipal programs for funds. • Need approval from local government body. • Difficult to get political backing for increased local taxes if needed.

[1]With the exception of inspection or permit fees, the methods described in this table are primarily used to finance storm water management programs (or storm water or wastewater utilities) which include storm water inspection programs.

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- The scope of activities to be funded (whether they benefit the general public or are more narrowly focused programs).

Of the eleven municipalities surveyed for this Handbook, seven of them relied on utility fees for funding their inspection programs, usually as part of their overall municipal stormwater programs. Three inspection programs (Fresno, Los Angeles County, and Simi Valley) are funded through special district assessments and two rely on inspection fees for part of their funding (Los Angeles County and San Mateo County).

8b. Consider the Need for and Appropriateness of Inspection Fees

When the State established annual fees for the General Industrial Permit of $250 for facilities in municipalities with stormwater permits end $500 for other facilities, the rationale was that facilities discharging to permitted storm drain systems would be subject to municipal inspections and thus would require less regulatory oversight by the Regional Boards. It was also thought that this would allow municipalities with stormwater permits to impose up to $250 in stormwater inspection fees on local NOI industries if necessary. However, few existing inspection programs have taken advantage of this option, primarily because they want to encourage businesses' cooperation with their programs.

Inspection programs that are funded by inspection fees or require businesses to reimburse the program for follow-up inspection are recovering costs more directly from the businesses that are sources of pollution problems. When an inspection program is funded through an allocation from the municipal stormwater program, owners of residential, commercial, and industrial properties within the municipality are helping to pay for the inspections. Utility fees or user fees are usually based on the size of the property and/or its impervious surface area. Under this system, a large, environmentally conscientious business may pay a larger stormwater fee than a small business that represents a major source of pollutants and requires numerous inspections. The use of inspection fees, at least as a partial funding source, may be more equitable in that it places more burden on potential violators.

The need for a fee should be carefully considered and should be appropriate for the size and resources of the business type. Given the negative side of fees, their use should be balanced by outreach and the offering of

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compliance assistance, regulatory relief, and positive incentives.

STEP 9. DEVELOP AN ACTION PLAN AND BUDGET

Completion of Steps 1 through 8 has laid the groundwork for the most important step, development of your Action Plan. The Action Plan is the basis for implementing and tracking an effective program, and for allocating sufficient resources each year. Development of an Action Plan is expected to be a dynamic process at first, with frequent revisions as you adjust your inspection and outreach priorities and techniques. Results of a pilot program (Step 10) and evaluations of the effectiveness of previous efforts will help you to continuously revise and improve your Action Plan for future years.

9a. Develop an Action Plan

Develop an Action Plan that describes the goals of your inspection program for the coming fiscal year and the activities that will be implemented. The Action Plan should include:

- a prioritized list of facilities to be inspected and why they were selected;
- a plan describing the target number and types of inspections to be conducted, which agency(ies) will conduct them, in what time period, and with what level of effort (i.e., informational visit or full inspection);
- related activities to be performed, such as follow-up procedures and development of interagency agreements;
- a plan to collect and manage inspection information;
- a plan for providing inspector training; and
- a list of educational outreach materials to be developed and activities to be conducted (based on what inspectors are finding to be major problems).

** Use Worksheet #7 (Appendix A) to help you implement Step 9.*

Example of An Action Plan

The City of Oakland's action plan for FY 1995/96 includes the following elements:

1. Description of business types and pollution potential:

The City has a mix of commercial and industrial businesses. A facilities list with over 3000 records was compiled from several databases and reviewed for applicability to storm water inspections. A table lists business types (by SIC code), relative pollution potential and suspected causes.

2. Agency selected to conduct inspections:

The City will transfer stormwater inspections to the Oakland Fire Department, which will conduct them during inspections of HMBP facilities. City will revise internal documents to reflect this agreement and each City department's responsibilities.

3. Targeted businesses:

The City plans to inspect 90% of list of 119 priority HMBP facilities; 35% of another 749 facilities needing hazmat inspections; and 10% of 1600 potential facilities for first time stormwater inspections, for a total of approximately 500 facilities. The City expects 50% of these to require follow-up inspections, of which half may be allowed to use a self-certification process.

4. Expanded outreach:

The Fire Department will inform the business community about their inspection program through workshops and other outreach materials.

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Major Budget Items

- *Staff*
- *Equipment*
- *Sample Collection and Analysis*
- *Database Development and Maintenance*
- *Educational Outreach*

Inspection Times

Alameda County Department of Environmental Health, in agreements to conduct stormwater inspections for several cities within the county, uses the following assumptions for inspection times in its cost projections:

- *Inspection of new hazmat facilities: 2.5 hours/site*
- *Hazmat reinspections: 2.0 hours/site*
- *Follow-up visits: 1.5 hours/site*
- *Inspection of food facilities: 2.0 hours/site*

These projected times do not include data input, reporting and business outreach, which can add 50% more to the inspection cost.

9b. Estimate a Budget to Implement Your Action Plan

Develop a budget to support the activities and goals outlined in your Action Plan. Consider all costs, including the following major budget elements:

Staff

Staff salaries and benefits are typically the largest cost components in an inspection program, which is why it is often cost-effective to incorporate stormwater inspections into existing inspection programs. The additional time required for an inspector to conduct a stormwater inspection concurrent with other duties should be relatively short. But follow-up activities by your agency may take a significant amount of time.

A rough initial estimate of the average time to complete all activities associated a comprehensive facility inspection is four to eight hours. An analysis of inspection reports from the ACCWP indicates that the average actual on-site inspection time for each facility is about two hours. However, you also need to budget time for preparing for the inspection, preparing an inspection report, and conducting a minimum amount of follow-up activities. The average inspection time will vary with the size and types of facilities inspected, but will generally decrease over the years as inspectors gain experience and businesses are educated. If your agency is conducting informational site visits, these can usually be completed in less than an hour per visit.

Data collected during a pilot inspection program can provide more accurate estimates of staffing requirements in your municipality. Note that the required number of inspectors for a program will depend on whether they are also expected to respond to complaints about industries or illicit discharges.

Equipment

Equipment needed for inspections includes vehicles, safety equipment, sampling equipment, tools, and supplies. Equipment costs are highly variable and depend on what resources are already available to the inspectors. Many municipalities and inspecting agencies already have vehicles, sampling equipment, and safety equipment that may be available on a part-time basis for stormwater inspections. However, if additional staff are being hired for stormwater inspections, they may need to be outfitted with their own equipment. Other than sampling and safety equipment, the tools and supplies required to

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actually conduct the inspections are not significant cost items. Some of the budget should be reserved for conducting laboratory analyses of any samples that are collected to document illicit discharges.

Sample Collection and Analysis

Some of your budget should be reserved for conducting laboratory analyses of any samples that are collected to document illicit discharges or characterize pollutants in runoff. Analysis costs vary tremendously, depending on what chemical constituents are analyzed for and whether analyses are conducted at inhouse or contract laboratories. Use of field test kits to characterize a discharge first can help save money by reducing the list of laboratory analyses required to the most important constituents.

Database Development and Maintenance

The cost of developing and maintaining a database for inspection data also varies with the size of the program and the municipality's existing resources. The computer hardware and software represent a small fraction of the cost; the biggest expense will be staff time to set up the data files and to enter, update, and report the data.

Educational Outreach

This budget, which may include development, printing and distribution of educational materials, workshops, and other activities, will depend on your inspection program approach. A program that is based on incentives, such as a clean business program, will spend a larger portion of its total budget on outreach than a program focused on frequent inspection and enforcement. Also, a larger portion of the budget will go toward education and outreach in the initial stages of a program than in later years, because the municipality will need to develop educational materials and bring businesses "up to speed" with program objectives and requirements.

The costs of industrial/commercial inspection programs vary widely, depending on the size and type of program. Table 1D in Appendix E lists the 1994/95 budgets and number of full-time equivalent staff for each of the existing programs surveyed for this Handbook. Note that some of the budgets include illicit discharge control activities (e.g., those for the Cities of Los Angeles and San Jose) and some represent only the incremental cost of conducting stormwater inspections in conjunction with other types of industrial inspections (e.g. Counties of Los Angeles and San Mateo). Therefore, it is difficult to derive any guidance on unit inspection costs from these

Examples of Inspection Program Costs

The Union Sanitary District, which conducts stormwater inspections for the City of Fremont, tracks its inspectors' hours and costs so it can bill the City for its services. In 1994/95, the District's costs averaged $325 to $350 per inspection, including overhead, administration, program management, facility inspections and follow-up activities, reporting, and data management costs.

The Regional Water Quality Control Plant in Palo Alto has been conducting vehicle service facility inspections (within its service area) since 1992. The first year of the program, inspection costs were averaging approximately $300 per facility. Costs include developing a mailing list and database, developing outreach materials, conducting a workshop, performing facility inspections and follow-up activities, and coordinating with other agencies. In subsequent years of the program, the inspection cost dropped to about half the initial cost.

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Case Study of a Pilot Program

The Fairfield-Suisun Sewer District, which administers the Urban Runoff Management Program for the Cities of Fairfield and Suisun City, conducted an industrial inspection and educational outreach pilot program during FY 1993-94. The pilot program included a survey of the local fire and building departments and the Solano County Department of Environmental Management (DEM) to determine their views on potential industrial pollutant problems and how to incorporate stormwater inspections into their existing activities. Based on the survey, it was determined that the inspections should be primarily conducted by the District, as part of its pretreatment inspections, and the County DEM, as part of its hazardous materials inspections. During the pilot program, the District and County inspected and provided educational information to thirteen facilities. The County referred three facilities to the District for follow-up inspections and assistance.

Pilot program results included:

- *Practical experience on how to proceed with full-scale implementation;*
- *Observation that facility operators were willing to correct stormwater pollution problems that could be easily corrected using good housekeeping measures or other simple changes;*
- *Identification of the need for educational brochures and training for inspectors on alternatives to resolve more difficult pollution problems;*
- *Agreement on a short, simple checklist which could be integrated into existing inspections.*

figures. However, unit cost data reported by two wastewater treatment agencies in the San Francisco Bay Area indicate an average inspection of $300 to $350 per facility (see sidebar on page 3-35).

STEP 10. CONDUCT A PILOT INSPECTION PROGRAM

If appropriate for your inspection program, conduct a pilot program during the first year to test inspection procedures, outreach materials, and the use of your staff or another agency to conduct inspections. It may be easier for your municipality to begin its inspection program on a smaller scale, approach the program with an experimental attitude, and build on your success. A pilot program also provides you opportunities to conduct trial or joint inspections and receive feedback from the business community about the process.

A pilot program can be a useful way of collecting valuable information about:

- predominant types of pollution problems;
- the staff time required to complete an inspection;
- the percentage of facilities that require follow-up inspections;
- the existing level of knowledge of businesses about stormwater requirements; and
- other factors specific to your municipality.

The results of the pilot program can help improve estimates of budget, staffing, and other resource requirements to implement the full-scale program.

STEP 11. IMPLEMENT THE FULL-SCALE INSPECTION PROGRAM

After significant up-front planning, and based on the experience of your pilot program, update your Action Plan as needed and conduct the full-scale stormwater inspection program. Detailed information on conducting the inspections is provided in Chapter 4.

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STEP 12. EVALUATE THE EFFECTIVENESS OF YOUR INSPECTION PROGRAM

Review your inspection program's effectiveness annually to assess how it can be improved in the future. If your municipality is part of an NPDES-permitted stormwater program, you will have to report on your program's effectiveness in your municipality's annual report to the Regional Board. Use the results of your review to develop your Action Plan and budget for the following year. Steps for evaluating effectiveness are presented below.

** Use Worksheet #5 (Appendix A) to help you implement Step 12*

12a. Document Elimination of Pollutant Sources and Discharges

Document how many actual or potential pollutant discharges observed during inspections were eliminated, or in other words, how effectively follow-up and enforcement activities were conducted once a violation or possible violation was identified. To do this, review the results of inspections and documentation of follow-up actions, and summarize the number of problems identified and successfully eliminated. If the inspection and follow-up activities have been well documented in a data management system, you can use that system to help generate the summaries.

You should be able to gauge the long-term effectiveness of the inspection program by the overall decline in the number of pollution problems found at businesses over time. Again, a well-maintained data management system is the best means of tracking and summarizing the necessary information on violations found and eliminated, so that long term trends can be observed.

12b. Compare Your Accomplishments with Action Plan Goals

Review your Action Plan at the end of the year and assess whether the goals of the Action Plan were met. (If the Action Plan was ill conceived, there may be good reasons why the goals were not met.) If your stormwater program has performance standards for industrial/commercial inspections, compare your accomplishments with these standards as well. Consider these questions:

- Was the planned number of inspections completed?

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- Were the needed educational materials developed and distributed?
- Did all of the inspectors receive the necessary training?
- Has all documentation been completed and/or entered into the database?

Other measures of effectiveness include the number of businesses participating in clean business programs or contacted through outreach efforts, and the increase in the number of businesses who obtained coverage under the General Permit.

12c. Obtain Feedback from Businesses

Consistent with the philosophy of thinking of businesses as customers, it is also appropriate to solicit feedback from businesses whose facilities are inspected. This feedback could take the form of a periodic survey, informal interviews during an inspection, or giving business owners an opportunity to review and comment on annual inspection plans or changes to the inspection program. The latter can be accomplished through a business advisory committee that meets periodically to discuss the inspection program. A report back to businesses on any changes that were made as a result of their input helps to promote the spirit of cooperation between the municipality and the business community and provides another opportunity for outreach and education.

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How To Conduct Stormwater Inspections 4

Case Study - Los Angeles County's Inspection Program

The unincorporated portion of Los Angeles County contains almost one million people and an estimated 22,000 industrial and commercial facilities, of which more than 3,600 are potential NOI facilities (only 427 have filed to date).

The County conducts stormwater inspections as part of industrial waste inspections at facilities regulated by its Industrial Waste Control program (IWCP) in unincorporated areas. Sixteen inspectors in the Public Works Department's Environmental Programs Division conduct approximately 10,000 IWCP scheduled and follow-up inspections annually, including inspections within 40 cities that contract with the County for IWCP services. Facilities inspected include heavy industries (up to four times a year), light industries, automotive businesses, restaurants, and other commercial businesses required to provide wastewater pretreatment. Since the contract cities have adopted IWCP ordinances essentially the same as the County's, stormwater elements are incorporated into the routine IWCP inspections.

The County has initiated an additional stormwater inspection program for businesses not subject to the IWCP in unincorporated areas, at present limited to non-NOI facilities. The non-NOI facilities alone will add over 2,000 inspections per year to the program. The future inspection program remains subject to negotiations over the County's reissued stormwater NPDES permit.

The IWCP's $2.2 million annual budget, of which approximately $500,000 is allocated for stormwater inspection activities, is funded through benefit assessments and inspection fees from IWCP-permitted facilities.

This chapter provides information for the stormwater inspector on the basic elements of conducting a facility inspection for stormwater pollution prevention. To be an effective inspector you will need a good understanding of:

1) relevant background information (e.g., how information described in Chapters 2 and 3 of this handbook applies to your day to day activities),

2) procedures and steps of a facility inspection, and

3) methods to reduce or eliminate stormwater pollution.

For the purposes of this chapter, it is assumed that your municipal stormwater program has already selected the agency(ies) that will be conducting the facility inspections (see Chapter 3, Step 3) and obtained adequate legal authority (see Chapter 3, Step 4).

BACKGROUND INFORMATION INSPECTORS SHOULD KNOW

A stormwater inspector needs a basic understanding of the background and requirements of municipal and industrial stormwater programs to conduct an effective facility inspection. Facility owners/operators will question the need for the inspection and will ask about the specific requirements of the stormwater program. It is essential that you be prepared to clearly communicate this information, to help develop a rapport with the owner/operator and help the facility come into compliance. You will likely be the first person to inform the facility owner/operator about the stormwater program; therefore, you play an essential role in promoting the credibility of the program.

Questions you should be prepared to answer include general stormwater questions as well as questions specific to the municipal program. Common general questions include:

- what is "stormwater" and "non-stormwater"?
- what is the difference between storm drains and sanitary sewers?
- why is stormwater pollution a problem?
- why do we need a stormwater program?

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You [the inspector] will likely be the first person to inform the facility owner/operator about the stormwater program; therefore, you play an important role in promoting the credibility of the program.

There have been several regional efforts throughout California to develop general public information pieces to answer these types of questions. The California Stormwater Quality Task Force maintains a list of this information, which can be obtained through the Task Force's Public Information/Participation Committee. (A portion of the Task Force list of available pieces for commercial/business outreach is included in Appendix J.)

The facility owner/operator will also be interested in how the stormwater program specifically applies to his or her business. Chapter 1 of this handbook provides an overview of stormwater regulations and Chapter 5 contains a list of references for specific information. You should also become very familiar with the municipality's inspection program elements described in Chapter 3 of this handbook, particularly the following:

Step 1 - What is your municipality's approach to education and outreach, incentives, and enforcement? (e.g., will your first stormwater site visit be an informational meeting or a full, facility inspection?) What performance standards and baseline practices has your municipality adopted to help ensure businesses are treated consistently?

Step 2 - What are your municipality's priorities for inspection?

Step 4 - What are your municipality's established enforcement procedures? What is your legal authority to inspect, require a business to implement BMPs, and conduct enforcement? What are your municipality's enforcement protocols? When do other agencies nead to be involved in the enforcement activities?

Step 5 - What is your municipality's educational outreach program? What methods has your municipality selected to implement? What outreach and informational materials are available for you to distribute?

It is important that you understand the answers to these questions concerning the municipality specific program prior to the site visit since it is likely they will be asked by the facility owner/operator. Inform the facility owner/operator that the program is being implemented region-wide and nation-wide and that all businesses are, or will be, required to comply with similar stormwater requirements. You should also be prepared to respond to questions that concern other components of your municipality's overall stormwater program (e.g. Municipal

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Maintenance, Public Information and Participation, or New Development and Construction Activities Controls).

STORMWATER INSPECTION PROCEDURES

The role of the stormwater inspector includes both evaluating the facility's activities that impact stormwater quality and requiring the facility to come into compliance with the municipality's stormwater program. The first three sections of this chapter discuss the steps for evaluating the facility. The last section of this chapter describes the inspector's role in requiring BMPs at facilities that impact stormwater quality.

WHAT Should You Look For?

Evidence of Past and/or Continuing Non-stormwater Discharges

One of your objectives is to effectively eliminate non-stormwater discharges to storm drains. This includes accidental spills, intentional dumping, and discharges from illegal connections to storm drains. During dry weather, there should generally be no flow in the storm drains (except for certain natural or allowable discharges discussed in the next paragraph). Look for evidence of flows during dry weather. It is more difficult to observe non-stormwater discharges during wet weather since rain is likely to dilute or wash away any evidence of the discharge. However, you should still observe the runoff to look for anything it might have picked up as it flowed through the site. Typical observations for dry and wet weather flows are described in Table 6. Table 7 also includes a section on typical observations for non-stormwater discharges during inspection of facility activities and practices.

Note that a non-stormwater discharge might be exempt from discharge prohibitions if it is regulated under an NPDES permit. In this case, you should document this in your inspection report and ask for a copy of the facility's discharge permit. The 1990 EPA NPDES stormwater permit regulations allow municipalities to exempt the following discharges in their municipal permit program:

- flows from springs, riparian habitats, and wetlands;
- diverted stream flows, rising ground waters, uncontaminated ground water infiltration, and uncontaminated pumped ground water;

Tips on Finding Illicit Connections

- *Screen the facility for indications of possible illicit connections. Review general facility and location maps. (SWPPPs require site maps, topographic maps that indicate drainage patterns on-site, and sanitary sewer and storm drain maps.) Consider:*
  - *the density, type, and age of industrial activity in the area and*
  - *the proximity of the facility to the storm drain outfall.*
- *Inspect the facility for evidence of non-stormwater discharges (See Tables 6 and 7).*
- *Examine past records or previously-issued permits that may have authorized connections to storm drains before the stormwater regulations defined them as illicit.*
- *If appropriate, consider performing field analytical testing on the discharge at the site's outfall; decide whether it is also appropriate to sample the first upstream and/or downstream manhole. Indicator tests for conductivity and pH are inexpensive and relatively simple to perform. Field test kits are also available for metals, chlorine, ammonia nitrogen, glycols, and other chemicals. The objectives of the analyses are to identify the possibility of a non-stormwater discharge and to obtain clues for its sources.*

Decide whether it is appropriate to split the sample with the facility owner/operator; consider whether or not you plan to use the sample in future follow-up/enforcement activities.

(continued on page 4-5)

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TABLE 6
TYPICAL OBSERVATIONS DURING DRY AND WET WEATHER

Description	Observations
DRY WEATHER Evidence of Any Flow	When inspecting the storm drain conveyance system: • Is there flow in the storm drains? • Are there any wet areas, pools of water/liquid, or sludges? • Are there any stains on the ground, inlets, and/or channels? • Is there an odor coming from the inlet or outfall? • Is there lush vegetation or algal growth in a relatively dry area? When inspecting the facility site: • Is the ground (dirt, asphalt or concrete) worn from where a spill or discharge has occurred repeatedly? • Is the pevement surface etched away (possibly from flowing water)?
WET WEATHER Evidence of Pollutants in the Flow	When observing runoff discharging from the site: • Is there anything being discharged with the runoff? • Does the runoff have a smell? • Is anything floating in the runoff? • Does the runoff have a color? an oily sheen? suds?

TABLE 7
TYPICAL OBSERVATIONS FOR FACILITY ACTIVITIES AND PRACTICES

Description	Observations
NON-STORMWATER DISCHARGES	Are spills from fueling or vehicle/equipment maintenance areas prevented from entering storm drains?
	Are all washwater and/or process wastewater discharged to the sanitary sewer or recycled instead of discharged directly or indirectly to storm drains?
POLLUTANT EXPOSURE TO RUNOFF	Are storage containers including drums, waste dumpsters, and/or trash compactors: • free from cracks/leaks? • have lids or covers that are kept closed? • not exposed to rain water?
	Are material and equipment storage areas enclosed or covered from the rain?
	Are material processing or handling areas enclosed or covered?
	Are parking areas or access roads free from signs of excessive oil and/or motor fluids, leaks, stains, litter, and sediment?
	Are vehicle repair and maintenance areas covered or out of the rain?
	Are dry cleaning methods used to clean: • shop floors? • waste disposal areas? • material processing areas? • access roads? • material storage areas? • parking lots?
	Are storm drain inlets and catch basins inspected and mechanically cleaned on a regular schedule?
	Are waste products from rooftop equipment exposed to runoff?

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- water line flushing and other discharges from potable sources;
- landscape irrigation water;
- water from foundation and footing drains, and crawl space pumps;
- air conditioning condensation;
- individual residential car washing;
- dechlorinated swimming pool discharges; and
- flows from fire fighting and street wash waters.

EPA regulations state that municipalities should address these discharges "...where such discharges are identified by the municipality as sources of pollutants..." (40 CFR Section 122.26(d)(2)(iv)(B)(1)). Many municipalities exempt these discharges (i.e., the discharge is allowed to go to the storm drain) if they are properly managed or when BMPs are effectively applied to minimize or eliminate the pollutants in the discharge. Be aware of your municipality's policy on these discharges and get a list of the allowable discharges that might be described in the municipality's ordinance, if any.

Pollutants Exposed to Rain

Another objective is to minimize the amount of pollutants in runoff discharged to storm drains. This means removing pollutants from surfaces so that pollutants are not exposed to rain and picked up by runoff. Table 7 includes a section on typical observations for pollutant exposure to runoff. Note that although exposure of pollutants to rain occurs outdoors, the source of the pollutant may be from indoor activities or areas. For example, an indoor marble cutting operation might allow its slurry to flow outdoors. Another example is when indoor areas are kept clean by sweeping or pressure washing materials outdoors. The following section provides more ideas on looking indoors for impacts to stormwater.

Tips on Finding Illicit Connections (continued)

- *It is difficult to identify underground connections. Refer to your municipality's maintenance staff for their knowledge and experience with the storm drain. As appropriate, coordinate with other agencies when your investigation extends to other jurisdictions.*
- *If you suspect that a drain discharges to the storm drain system, consider conducting a tracer test using non-toxic dye. If the dye is observed in the storm drain, the illicit connection is confirmed. However, if the dye is not detected in the storm drain, an illicit connection might still exist, particularly in older facilities where the sanitary sewer and/or storm drain systems may be in disrepair, or the connection may only occur under certain flow conditions.*

Allowable Non-Stormwater Discharges

The ACCWP model ordinance (Appendix H) includes most of the non-stormwater discharges allowed by the EPA regulations. Other stormwater programs have more restrictive requirements. For example, the Marin County Stormwater Pollution Prevention Program, with its extensive natural creeks and other waterways, has elected to prohibit all swimming pool discharges, de-chlorinated or otherwise, to storm drains.

Check your municipality's NPDES stormwater permit and local ordinances to find out what discharges are allowed to go to the storm drains in your area.

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Even though air conditioning condensate may be allowed to discharge to the storm drain, discharges from cleaning air conditioning equipment should not go to the storm drain. Some facilities annually clean their HVAC units or chillers, and this sometimes includes power washing the unit or cleaning the tubing with acid.

Sampling Considerations

If you decide to collect a sample for laboratory analysis,

- ✓ *have a clear idea what purpose or use the analytical results would have if used in enforcement activities,*
- ✓ *take special care to protect the integrity of the sample, and*
- ✓ *provide the facility operator/owner the option of collecting a split of any sample.*

See Appendix L for more guidance on sample collection.

WHERE Should You Look for Impacts to Stormwater Quality?

Inspect outdoor areas of activity.

Walk through all outdoor areas and observe activities, wherever it is safe to do so. Typical areas of activity that might impact stormwater quality include:

- wash and rinsing areas;
- process/manufacturing areas;
- material storage areas;
- loading, unloading and transfer areas
- waste storage/disposal areas;
- vehicle and heavy equipment storage and maintenance areas;
- parking areas and access roads; and
- rooftop equipment areas.

Inspect all portions of the stormwater conveyance system, where possible and safe. This includes inlets, open channels, ditches, and roof leaders.

Inspect indoor areas of activity.

Review indoor activities and areas to ensure that pollutants are not spilled, dumped, or allowed to flow outdoors. Walk through the process area, as is safe, to ensure wastewaters are discharged to the sanitary sewer, as appropriate. Inquire where floor, wall or any other suspect drains discharge. Also review the facility's indoor housekeeping procedures. For example, is the workshop area hosed down with water at the end of the day and allowed to drain outdoors? Review material handling areas (loading docks, storage areas, etc.) to identify if there is a pathway to the storm drain. Inquire about a spill prevention plan and the facility's cleanup procedure if a spill does occur. Your objective is to ensure that pollutants are properly disposed of so that they do not end up in the storm drain.

HOW Should You Conduct Facility Inspections and Outreach?

This section describes a three phase approach to inspecting a facility:

I) preparation,
II) field inspection, and
III) follow-up and/or enforcement, as necessary.

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The phases and the steps within each phase are summarized in Figure 3.

Phase I. Prepare for the inspection.

The objective of this phase is to optimize the use of your time on-site. You can also identify any gaps of information that need to be obtained and filled in at the time of the inspection.

Step I-1. Review existing information and prepare for the site visit.
Little information on stormwater issues may be available for facilities during the initial years of a municipal stormwater inspection program. Some information may be available if the facility is already regulated under another inspection program (e.g. pretreatment, source control, hazmat, etc.). Review whatever information is available and note what is missing.

Plan ahead of time which facilities you will visit. If you have a scheduled facility inspection, consider what other facilities in the area you might inspect if time allows. Prioritize which facilities to visit first if your time becomes limited.

Step I-2. Notify the facility or conduct an informational site visit. *(Optional)*
Your municipality should decide whether or not to notify the facility of an upcoming inspection by letter and/or by phone, or to conduct an informational site visit. This decision should be consistent with the inspection approach the municipality adopts. Prior notification gives you an opportunity to describe the program requirements and inspection goals to the facility owner/operator. It also allows you to request that background information (site plans, business plan, spill prevention countermeasure plan, etc.) be available for the visit. It is particularly important to schedule an appointment if you plan to conduct a full site inspection at a large facility. Request that a responsible facility official be available to accompany you during the entire inspection.

If you do decide to send a notification letter prior to the inspection, make the letter brief and highlight the key points. (See sample notification letters developed by the ACCWP and the City of San Jose in Appendix J.) Consider sending a copy of your inspection checklist with the notification letter so that the facility owner/operator knows what to expect. The ACCWP also developed a self-inspection checklist (included in

Stormwater Inspection Equipment Checklist

Before you leave the office for the facility, remember to include the following with the rest of your equipment:

Program Literature
- ✓ *public information outreach pieces*
- ✓ *stormwater ordinance*
- ✓ *BMP brochures and flyers*
- ✓ *copies of the General Permit*

Field Equipment
- ✓ *inspection report form*
- ✓ *previous inspection report, when available*
- ✓ *area-wide storm drain and/or topographic map(s)*
- ✓ *Thomas Guide*
- ✓ *flashlight or mirror*
- ✓ *rain gear (pants, jacket, rain boots)*
- ✓ *instant camera and film*
- ✓ *personal safety equipment*

Chemical Analysis Equipment
(if your program includes sampling)
- ✓ *field test kits*
- ✓ *equipment for laboratory analysis (sample bottles, large ice chest with ice, container with lid for wastes, etc.)*
- ✓ *chain of custody forms*

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FIGURE 3
Phases and Steps of a Facility Inspection

Phase I. Prepare for the Inspection

Step I-1. Review existing information and prepare for the site visit.

Step I-2. Notify the facility or conduct an informational site visit. (Optional)

↓

Phase II. Conduct the Inspection and Collect Facility Information

Step II-1. Inspect the facility's stormwater conveyance system to understand how stormwater runoff discharges from the site.

Step II-2. Determine the facility's impact on stormwater quality.

i. What is the facility's potential to impact stormwater quality from pollutant exposure and non-stormwater discharges?

ii. Are BMPs effectively applied so that pollutant exposure is minimized and non-stormwater discharges are eliminated?

iii. What type(s) of impact does or could the facility have on stormwater quality?

Step II-3. Determine what follow-up actions are required of the facility owner/operator and include a time schedule.

Step II-4. Document the inspection.

Step II-5. Communicate expectations/requirements to the facility owner/operator.

↓

Phase III. Conduct Follow-up and/or Enforcement.

Step III-1. Conduct a follow-up inspection or receive certification that requirements from the initial inspection were completed.

Step III-2. Conduct enforcement, as necessary.

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Appendix K) to help facility owner/operators prepare for a stormwater inspection.

Another approach is to conduct an informational site visit in place of or in addition to a notification letter. The visit is conducted to inform the facility owner/operator about the stormwater program without any threat of enforcement, and to allow the owner/operator time to comply with stormwater requirements before a full inspection is conducted.

Phase II. Conduct the inspection and collect facility information.

This phase is where you perform your evaluation of the facility's impact on stormwater quality. The objective of the following sections is to describe information relevant to conducting a *stormwater* inspection but is not intended to describe how to be an inspector. Specific inspection protocols or procedures will also vary among municipalities and agencies.

Step II-1. Inspect the facility's stormwater conveyance system to understand how stormwater runoff discharges from the site.
Gain a clear understanding of how runoff leaves the site by examining the facility's stormwater conveyance system (as much as is safe and possible to inspect) and the site grading. This will help you determine what pollutants might be exposed to runoff. Although you will be limited to plans and diagrams for examining underground piping, visually inspect parts of the conveyance system above ground, such as gutters, ditches, drop inlets, and drains, and look for any signs of past and/or continuing discharges (See the section **What Should You Look For?**). Consider conducting facility inspections during rainy weather; this is a good way to observe runoff patterns on the site.

Step II-2. Determine the facility's impact on stormwater quality.
Walk through all outdoor and indoor areas of activity. (see the section on **Where Should You Look for Impacts to Stormwater Quality?**) Determine the facility's impact on stormwater quality at two levels: the facility's *potential* to discharge and the facility's *actual* discharge. The difference between potential and actual is determined by whether BMPs are effectively applied. For example, a facility that stores all its machinery and heavy equipment outdoors has a high *potential* to impact storm drains from any oil and grease that might be exposed to runoff. However, if the equipment is well maintained and always covered

TIP: Not quite sure how the site is graded? Which way is downhill? Place a golf ball on the ground and see where it rolls.

Inspection Entry Procedures

- *Present your credentials to a responsible facility owner/operator, whether or not identification is requested.*
- *The facility owner/operator must consent to the inspection.*
  - *If the inspector is allowed to enter, entry is considered voluntary and consentual.*
  - *The absence of an expressed denial can be considered authorization to continue the inspection.*
- *Do not sign any type of "waiver", "visitor release" or document with restrictive conditions that would relieve the facility owner/operator of responsibility for injury or limit your rights to use information obtained during the inspection. Explain that you cannot sign the form and request a blank sign-in sheet.*

(continued on page 4-10)

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Inspection Entry Procedures (continued)

- *If the owner/operator denies entry, ask why. Tactfully probe the reason(s) for denial. In some cases, diplomacy and discussion may be sufficient to overcome the owner/operator's reluctance. Be careful to avoid saying something that can be misconstrued as a threat such as discussing potential penalties. Avoid inflammatory discussions and/or deepening of misunderstandings.*

  If entry is still denied, withdraw from the premises and contact your supervisor. Confer with your municipality's attorneys.

  Document all conditions and circumstances surrounding the denial for entry. At a minimum, collect:
  - *facility name and exact address,*
  - *name and title of person(s) you spoke with,*
  - *authority of person(s) who refused entry,*
  - *date, time, and detailed reason for the denial of entry.*

- *Follow the same procedures if consent is withdrawn during the inspection. Information obtained prior to the withdrawal of consent is valid.*

- *If access is denied to some parts of the facility, document the portion of the inspection that could not be performed, the reason for the denial of access, and proceed with the inspection of other areas.*

by a tarp when not in use, the level of pollutant exposure is minimized and the *actual* impact of the facility is small. You should note three things on your inspection report:

i. **What is the facility's potential to impact stormwater quality from pollutant exposure and non-stormwater discharges?** Identify areas or activities that require BMPs be applied to reduce or eliminate potential pollutant discharges to storm drains. For example, is the answer to any of the questions listed in Table 7 "no"? If BMPs are in place, determine what the impact would be if BMPs failed or were no longer applied. Rating the facility's *potential* to discharge pollutants to storm drains can help you prioritize facilities for reinspection.

ii. **Are BMPs effectively applied so that pollutant exposure is minimized and non-stormwater discharges are eliminated?** For each of the facility's areas of activity, observe whether BMPs are *in place* and *effective*. You will most likely encounter situations where a BMP is in place but is not effectively applied. For example, an outdoor drum storage area might be bermed but the berm leaks or is already full of rainwater so that a spill would overflow the contained area. The inspector needs to make a professional judgement on the imminent impact of the facility and decide how much time to allow the owner/operator to correct the problem.

iii. **What type(s) of impact does or could the facility have on stormwater quality?** Clearly describe on the inspection report whether the impact is from: 1) pollutant exposure to runoff; and/or 2) non-stormwater intentionally or accidentally discharged to the storm drains (e.g., illicit connections, process wastewater, spills, illegal dumping, etc.).

The facility's potential to impact stormwater quality and the effectiveness of BMPs can be more easily evaluated with the help of the facility's SWPPP, if one is available. The SWPPP should indicate what BMPs should be in place to minimize stormwater pollution. (See page 4-18 for more information on using the SWPPP to aid your inspection.)

Figure 4 presents an example of how inspectors for municipalities in the ACCWP record their evaluation of a facility's potential and actual impact on stormwater quality.

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Figure 4. How ACCWP Inspectors Evaluate a Facility's Impact on Stormwater Quality

The following table is an excerpt from the ACCWP facility inspection report:

AREAS OF ACTIVITY	N/A	PTNL	ACTUAL Type of Discharge		
			BMP	PEX	NSW
A. Outdoor Process/Manufacturing Areas					
B. Outdoor Material Storage Areas					
C. Outdoor Waste Storage/Disposal Areas					
D. Outdoor Vehicle and Heavy Equipment Storage, Maintenance Areas					
E. Outdoor Parking Areas end Access Roads					
F. Outdoor Wash Areas					
G. Rooftop Equipment					
H. Outdoor Drainage from Indoor Areas					
I. Other (describe):					

Directions for completing the table:

N/A = Not Applicable: Check when the facility does not include the activity area.

PTNL = POTENTIAL for Pollutant Discharge: 1 = little/low potential, 2 = medium potential, or 3 = high. (There is no potential only if the facility does not have the activity, in which case, "not applicable" was checked.)

ACTUAL Type of Discharge

BMP = For each area of activity, note whether BMPs are in place and how effectively the facility applies BMPs using the following system:

- 0 - BMPs are applied and effective at minimizing pollutant discharge;
- 1 - BMPs are applied and are fairly effective but may need more effort to be completely effective;
- 2 - BMPs are applied but are not effective; or
- 3 - No BMPs are implemented.

Record the type of pollutant discharge in each area of activity by checking one or both:

PEX = Pollutant Exposure
NSW = Non-Stormwater Discharge

The ACCWP inspection report also includes sections for describing these discharges in more detail. See Appendix K for a copy of the ACCWP inspection report.

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Professional Judgement

Making a "professional judgement" is the toughest part of the inspection. Where one inspector might require a corrective action, another inspector might not require anything given the same scenario. This type of inconsistency is inevitable but should be minimized. Inspectors can talk to other inspectors within their own agency. Regional programs can develop guidelines or criteria for certain levels of enforcement actions.

TIP: Self Certification

In situations where the facility's impact on stormwater quality is minor, consider allowing the facility owner/operator to mail you a letter certifying that your requirements have been met in the specified time schedule. This will save you and the owner/operator from having to make time for a second site visit.

Step II-3. Determine what follow-up actions are required of the facility owner/operator and include a time schedule.
Consider your municipal program goals and requirements: minimize the pollutants exposed to runoff and effectively eliminate non-stormwater discharges. Where does the facility fail to meet these requirements and what must facility operators do to come into compliance? You will have to give owner/operators this information, along with a compliance schedule.

Compliance is accomplished through effective application of BMPs, but be careful when making specific BMPs a *requirement*. Make clear to the facility owner/operator that he or she is still responsible for pollutant discharges even if the BMPs you suggest are not effective. Your job is to point out which sources of pollutants or discharges must be eliminated - the manner in which this is accomplished should be left to the facility owner/operator.

Beware of making requirements that could conflict with the Uniform Building, Fire, or Plumbing Codes. For example, before requiring that a drain be plugged, be sure the drain is not required by the Building or Plumbing Code. In such cases, answer questions from the facility owner/operator as best you can but refer difficult questions to the appropriate agency or department.

Step II-4. Document the inspection.
Record your observations, evaluation of the facility, and all follow-up requirements on your inspection report. Obtain any background information you are missing (e.g., owner of property if different from occupant, facility contact phone number, SIC number, etc.). Although your initial inspection approach will probably be more outreach than enforcement oriented, remember that your inspection report may be used for future enforcement activities. You should contact your local District Attorney's office for guidance on collecting additional evidence. An example of guidance on evidence collection and sampling from an Alameda County hazardous materials incident investigation document is included in Appendix L.

The inspection report can also be a useful tool for prioritizing future inspections. At the end of your evaluation, rate the facility as to the need for future, routine inspections. For example, rate facilities with a high potential to impact stormwater as a first priority; a possible goal would be to re-inspect these facilities within the next year or two. You might also

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want to note on the inspection report if future inspections would be more effective when conducted during a certain time of day or year. For example, restaurant inspections might be more effective when conducted later in the day when mats are being washed. Another example might be sites with diversion facilities where inspections would be more effective if conducted before the wet season.

Step II-5. Communicate expectations/requirements to the facility owner/operator.
Clearly explain to the owner/operator the deficiencies you observed, the stormwater regulations or local codes that have been violated, and the requirements for compliance. Make sure the owner/operator understands your expectations. If there are follow-up actions and a compliance schedule, explain what the owner/operator must do to complete your inspection. *Document* in your inspection report that you have notified the owner/operator of the inspection results. (Provide a copy of your report, if possible.)

Conduct a post-inspection conference to allow the owner/operator an opportunity to ask questions and minimize confusion. It is important that you be available to answer the owner/operators' questions to help them achieve compliance, particularly if your municipality is emphasizing an educational approach to stormwater inspections. A discussion of appropriate BMPs to recommend begins on page 4-14 of this chapter.

Phase III. Conduct follow-up and/or enforcement, as necessary.

Step III-1. Conduct a follow-up inspection or receive certification that requirements from the initial inspection were completed.
If certification is received, include it in your facility file to complete your routine inspection. If a follow-up inspection is necessary, document the date of the initial inspection, the date of the follow-up inspection, and the facility's progress in implementing the requirements from your initial inspection. You will need to decide whether the owner/operator has made his or her best effort to complete your requirements. Be aware of your legal authority to impose and enforce such requirements. If pollutant discharges to storm drains are not abated, decide whether the facility warrants a second follow-up inspection or whether to allow the owner/operator more time to meet your requirements. If the impact to water quality is significant, you might decide to proceed with enforcement actions instead.

Recommendation vs. Requirement

It is important to differentiate in your documentation between a recommendation and a requirement. Recommendations are suggested actions that cannot be enforced. Requirements must be met within a prescribed time schedule and are subject to enforcement action if not completed. In order to be enforceable, requirements must be documented in the inspection report, warning notice, violation notice, order, or other official document.

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Step III-2. Conduct enforcement, as necessary. Enforcement might be necessary for continued non-compliance or for discharges that impact water quality significantly. Enforcement activities include warning notices, administrative actions, citations and other legal actions. Follow your municipality's specific protocols for these activities (see Step 4, Chapter 3 - Establish Enforcement Procedures). Contact your local District Attorney's office to find out what information they require to conduct legal action.

What Can the Facility Owner/Operator Do to Reduce or Eliminate Impacts On Stormwater?

Your job is to point out which sources of pollutants or discharges must be eliminated - the manner in which this is accomplished should be left to the facility owner/operator.

It is the facility owner/operator's responsibility to achieve compliance through the effective implementation of best management practices, or BMPs. Your specific role in educating owners/operators on stormwater BMPs and helping them achieve compliance depends on your municipality's inspection approach, which will include some combination of education, incentives, and enforcement. Although you will want to be helpful, beware of recommending specific BMPs. Stormwater BMPs may not be effective under circumstances at the facility that you have limited knowledge of and no control over. The owner/operator should clearly understand that he or she is responsible for the effectiveness of BMPs and the facility's discharges to the storm drains.

During the first few years of your stormwater inspection program, become familiar with the businesses in your community to get an understanding of their overall impact on stormwater quality. This will help you more effectively prioritize future inspections and give businesses time to achieve compliance with a new stormwater program.

Employee Training

To help ensure BMPs are effective, employees must be trained on a regular basis on how to implement them correctly. Facility owners/operators must also notify contractors and service companies (such as mobile washers) of appropriate BMPs while the contractors are on site.

The following sections provide a general description of how facilities owners/operators can achieve compliance through the use of BMPs. Sources of information on specific BMPs are provided in Chapter 5.

BMPs for Effectively Eliminating Non-stormwater Discharges

The only non-stormwater discharges allowed to storm drains are permitted discharges and exempt discharges within municipality-specific programs (see discussion under **Evidence of Past and/or Continuing Non-stormwater Discharges**). All BMPs to effectively eliminate

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non-stormwater discharges include one or more of the following:

Eliminate the Discharge: An example of this BMP is a closed loop system where the discharge is recycled back into the system. However, this BMP may not be possible for certain continuous discharges depending on the specific business and/or operations of the facility. BMPs to eliminate discharges to the storm drain from spills should include a plan for preventing spills *and* measures for containing and cleaning up a spill if one occurs.

Reroute the Discharge (e.g., illicit connections, washwaters and other wastewaters) to the Sanitary Sewer System: Wastewaters, such as washwaters and process waters, should be discharged to the sanitary sewer. Before beginning any inspections, find out the requirements for hooking up to the sanitary sewer system and discharging to the wastewater treatment plant. These can include permit fees, requirements for pretreatment, monitoring, and discharge limits on certain parameters. Note that in some cases, the sewer systems and treatment plant are owned and/or operated by different agencies. There are also cases where local ordinances do not allow rain into the sanitary sewer system. This makes plumbing outdoor operations to the sanitary system very difficult and could involve costly modifications. Discharge to the sanitary system might not even be feasible where it is prohibited by zoning, building and fire codes.

Permit the Discharge to Storm Drains: The permitting agency would be the local Regional Board. The permit could also include requirements for reporting, treatment, and monitoring, and discharge limits.

In most cases, the facility owner/operator will need time to research alternatives for modifying the facility's systems and/or operations and will need to implement interim measures to minimize the immediate impact on stormwater. To promote the cooperation of businesses in achieving compliance, your municipality's policy should be flexible enough to allow businesses time to make the necessary modifications. However, you should be clear that temporary measures are required to control the discharge in the mean time.

An example of how a municipal program has implemented this approach is described in the ACCWP's guidance document on "Recommended Discharge Elimination/ Disposal Priorities for Wash Waters". The guidance document includes recommended disposal options for

From "Recommended Discharge Elimination/Disposal Priorities for Wash Waters"

"... [Businesses' and the ACCWP's] shared goal is to work toward only uncontaminated rainwater entering storm drain systems. However, many customary operations cannot simply eliminate their discharges or transfer discharges to the sanitary sewer without significant capital investment. We recommend an incremental approach that would give these operations a window to comply and develop technologies to remove pollutants or to eliminate the discharge. In our inspection programs we will continue to stress Best Management Practices to aid in this goal in this order:

1) *Eliminate discharge completely; or*
2) *Minimize pollutant generation through effective BMPs; or*
3) *Examine if discharge can be feasibly transferred to the sanitary sewer, with approval of POTW; or*
4) *If discharge cannot be feasibly transferred, implement an immediate BMP program as a temporary measure and plan for structural or treatment controls that would treat stormwater before it is released to the storm drain."*

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BMPs Described in the "California Storm Water Industrial/Commercial Best Management Practice Handbook"

Source Control BMPs
(by activity)

- *vehicle and equipment fueling*
- *vehicle and equipment washing and steam cleaning*
- *vehicle and equipment maintenance and repair*
- *outdoor loading/ unloading of materials*
- *outdoor process equipment operations and maintenance*
- *outdoor storage of raw materials, products, and by-products*
- *waste handling and disposal*
- *contaminated or erodible surfaces*
- *building and grounds maintenance*
- *building repair, re-modeling, and con-struction*
- *over-water activities*
- *employee training*

Treatment Control BMPs
(for stormwater)

- *infiltration*
- *wet ponds*
- *constructed wetlands*
- *biofilters*
- *extended detention basins*
- *media filtration*
- *oil/water separators and water quality inlets*
- *multiple systems*

typical wash water concerns found during stormwater inspections and was developed with input and approval from San Francisco Bay Regional Water Quality Control Board staff (see sidebar, page 4-15). The California Storm Water Industrial/Commercial Best Management Practice Handbook (1993) also includes a discussion on eliminating non-stormwater discharges and provides guidance on disposal alternatives for wastewaters and waste products that are prohibited from discharge to storm drains.

BMPs for Minimizing Pollutant Exposure and Discharge of Pollutants with Runoff

This group of BMPs focuses on source control. Basic practices include keeping outdoor areas clean, moving materials indoors, or covering and grading an outdoor area to prevent run-on and runoff. Effectively applying these types of BMPs generally means implementing some combination of housekeeping, material management, operational practices, and preventive measures.

There is a wide variety of BMP material available that addresses source control practices to eliminate pollutant exposure to runoff. Appendix J includes examples of BMP flyers developed by the ACCWP for good housekeeping practices, outdoor liquid storage, outdoor storage of dry materials, and parking lots. Appendix J also includes an example of a BMP booklet for vehicle service shops called "Your Shop Can Make a Difference" developed through a regional effort by Bay Area Wastewater Treatment Plants and Stormwater Management Agencies.

There are certain operations for which pollutant exposure cannot be sufficiently minimized and stormwater should be treated prior to discharge to storm drains. Stormwater treatment systems are expensive to install and maintain for effective operation and should be a last resort after all other options have been attempted. Treatment facilities vary in size, cost, and effectiveness depending on the application and treatment requirements. The facility operator/owner should carefully consider all of his or her options when selecting a treatment system appropriate for the facility's operations; certain treatment controls might not be effective for the specific discharges.

The facility owner/operator should also take into careful consideration the design limitations and operations and maintenance demands of the treatment system. Further discussion of the application of treatment control BMPs is provided in the California Storm Water Industrial/Commercial BMP Handbook.

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USING GENERAL PERMIT INFORMATION IN YOUR INSPECTION OF INDUSTRIAL FACILITIES

Your municipality is required to control discharges from commercial and industrial facilities to the municipal storm drain system. This includes industrial facilities that are covered by the State General Permit (see Chapter 1, **Overview of Stormwater Regulations**).

It is important for you to know at least the basics of the General Permit requirements since it is likely that the industrial facility owner/operator will ask you questions concerning the permit. However, answer only the questions you feel comfortable answering and defer others to Regional Board staff. Your level of involvement in evaluating permitted facilities will depend on your municipality's agreement, if any, with the Regional Board to share inspection information from these facilities. Regardless of the specifics of this agreement, it is useful for you to be aware of the components of the General Permit that can help you conduct your facility inspection.

This section describes what information is required by the General Permit and how you can use this information to help you conduct your inspections.

The annual report is due to the Regional Board July 1 for the previous wet season. The State Board will generally mail the facility owner/operator a reporting form a few months prior to the due date.

Certification of Elimination of Non-stormwater Discharges

The owner/operator of a facility covered by the General Permit must certify that there are no non-stormwater discharges from their facility to storm drains. The owner/operator is required to conduct tests similar to those you might conduct to identify non-stormwater discharges during an inspection (see previous section on **Evidence of Past and/or Continuing Non-stormwater Discharges**). You should obtain a copy of this certification, if it is available, and include it in your inspection report.

Stormwater Pollution Prevention Plan

The facility owner/operator is required to develop and implement a SWPPP that includes the following information:

To comply with the General Permit, the facility owner/operator must:

1) *certify that there are no non-stormwater discharges;*

2) *develop and implement a SWPPP;*

3) *develop and implement a stormwater monitoring program; and*

4) *submit annual reports that evaluate the facility's stormwater pollution prevention program.*

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- Site information, such as types of activities conducted on site, facility layout, locations of the storm drainage system and outfalls, drainage areas, presence of surface water bodies or wells, materials inventory, etc.;

- Description of potential sources of stormwater pollutants; and

- Description of BMPs to address pollution sources including 1) a description of what BMPs are being implemented to reduce or eliminate pollutant discharges to storm drains and 2) a description of how the facility is ensuring that these BMPs are effective (i.e., evaluating the BMPs).

The General Permit basically requires the owner/operator to evaluate the facility's impact on stormwater in a manner similar to how you would evaluate the facility in your inspection. This information should be described in the SWPPP and be used as a tool for your inspection. Refer to Section A of the General Permit (included in Appendix C) which describes the specific requirements for a SWPPP.

Stormwater Monitoring Program

The primary objective of the General Permit's stormwater monitoring requirements is to evaluate effectiveness of the facility's BMPs described in the SWPPP. The spacific components include:

- dry weather visual inspections of all stormwater outfalls;

- wet weather visual inspections of all stormwater outfalls;

- stormwater sampling and analysis; and

- an annual site inspection.

A sampling and analysis exemption is a real cost savings to the facility owner/operator and is a positive incentive to encourage compliance with your municipal stormwater requirements.

Table 8 summarizes the frequency, objectives, and key points for each of the monitoring requirements.

The General Permit allows municipalities to exempt a facility from stormwater sampling and analysis if the facility has developed and implemented an effective SWPPP. The ACCWP has developed a sample exemption letter (included in Appendix C) for inspectors to certify a facility. The General Permit exemptions apply only to sampling and analysis. The operator/owner must continue to conduct wet and dry weather visual inspections and the annual site inspection.

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TABLE 8
GENERAL PERMIT MONITORING REQUIREMENTS FOR INDUSTRIAL FACILITY OWNERS/OPERATORS

Requirement	Frequency	Objective	Comments
Dry Weather Visual Inspections of All Stormwater Outfalls	once per month for two months during the dry season	Inspect for any non-stormwater discharges.	Facility owner/operator observations for dry weather inspections are similar to your inspection observations. (See Table 6 and 7)
Wet Weather Visual Inspections of All Stormwater Outfalls	once per month for every month during the wet season that there is significant stormwater discharge	Look for the presence of pollutants discharged with stormwater.	Facility owner/operator observations for wet weather inspections are similar to your inspection observations. (See Table 6)
Stormwater Sampling and Analysis	two storm events during the wet season which produce significant stormwater discharge	Sample for the presence of pollutants discharged with stormwater.	Required parameters include: • pH; total suspended solids; specific conductance; and total organic carbon or oil and grease. * • toxic chemicals and other pollutants that are likely to be present in stormwater discharge in significant quantities (these are operation-specific).
Annual Site Inspection	once per year	Evaluate implementation and effectiveness of facility's BMPs.	Based on the annual inspection, the facility operator/owner must certify the facility is in compliance with the General Permit. This is similar to your evaluation of the facility's compliance with your municipality's program.

* Guidance developed by the State Board on interpreting analytical data is distributed to General Permit facilities with their Annual Report forms. This guidance is included in Appendix C.

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You should also become familiar with the forms developed by the State Board for facilities to terminate coverage under the General Permit and for facility owner/operators to apply for an exemption from sampling and analysis. These forms are included in Appendix C. To obtain a sampling exemption in this way, a facility must self-certify that all areas of industrial activities are not exposed to stormwater. The requirements for self-certification are more difficult than if an inspector recommends a facility to the Regional Board for monitoring exemption.

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Stormwater Inspection Program Contacts

Alameda Countywide Clean Water Program
Robert Hale or James Scanlin
510-670-5543

Contra Costa Clean Water Program
Ephraim Leon-Guerrero
510-313-2364

Fairfield-Suisun Sewer District
Larry Bahr
707-429-8930

City of Hayward
Gayle Gundell
510-881-7993

Los Angeles County Department of Public Works
Environmental Programs Division
Carl Sjoberg
818-458-3539

City of Oakland
Ana Ward
510-238-7116

City of Palo Alto
Leo Sarmiento
415-329-2292

Santa Clara Valley Nonpoint Source Pollution Control Program
David Drury
408-927-0710

City of Simi Valley
Larry Whitney or Robert Zumwalt
805-583-6420

San Mateo Countywide Stormwater Pollution Prevention Program
Duane O'Donnell (County Environmental Health)
415-363-4708

Union Sanitary District
Donna Wies
510-790-0100, Ext. 275

For additional municipal inspection program contacts, see Table 1A in Appendix E.

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Cleaning Equipment Trade Association
San Francisco Bay Area Branch - David Wyett
408-452-0727
CETA Headquarters (St. Paul, MN)
800-441-0111

West Oakland Commerce Association
George Burtt
510-839-6999

Western States Petroleum Association
Ron Wilkniss
818-543-5324

Business Organization Contacts

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Notes:

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Appendix A

Worksheets For Inspection Program Development

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APPENDIX A

WORKSHEETS FOR INSPECTION PROGRAM DEVELOPMENT

The following worksheets are provided to assist you in developing a plan for your stormwater inspection program:

Worksheet #1: Assessing Business Types and Setting Priorities for Inspection

Worksheet #2: Deciding Who Should Conduct Inspections

Worksheet #3: Defining Enforcement Authority and Procedures

Worksheet #4: Developing Your Educational Outreach Strategy

Worksheet #5: Data Collection for Evaluating Program Effectiveness

Worksheet #6: Developing an Inspector Training Program

Worksheet #7: Developing Your Action Plan

The worksheets are not meant to be (or to advocate) a particular program design; they are intended to facilitate program development using an outlining-type process.

To get a broad perspective on program design and to help reach consensus, make copies of the worksheets and consider asking several people from your department or other departments to use the worksheets to outline a program design. Keep the outlining process as simple as possible and use best professional judgement. There are no right or wrong responses, and it is important to identify where information may be incomplete.

The exercise of using the worksheets to think through the program outline can help provide the necessary documentation to promote the program to other departments, elected officials, regulatory agencies, businesses, and the general public. It will also help define what your program is and, just as importantly, what it is not, and why.

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INDUSTRIAL/COMMERCIAL STORM WATER INSPECTION PROGRAM HANDBOOK
WORKSHEET FOR INSPECTION PROGRAM DEVELOPMENT

Preparer: Date:

Worksheet #1: Assessing Business Types and Setting Priorities for Inspection

Collect information about local businesses from the sources listed in Table 2, as well as local business directories, business license records, Census reports, surveys, and other publications. Use this information to estimate the number of different types of businesses in your municipality, their potential to cause storm water pollution, and their priority for inspection.

Type of Business (Check categories that apply)	Estimated Number	Potential to Impact Storm Water: High	Medium	Low	Inspection By Other Agency?	Inspection Priority (1,2,3; 1 = High)
☐ NOI facilities (all)	_____	☐	☐	☐	☐ yes ☐ no	___
By Category:						
☐ 1. Facilities with pollutant effluent standards (Subchapter N)	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 2. Manufacturing facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 3. Mining/oil and gas facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 4. Hazardous waste treatment, storage, and disposal facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 5. Landfills, land application sites, and open dumps	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 6. Recycling facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 7. Steam electric power generation	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 8. Transportation facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ 11. Manufacturing facilities with exposure to storm water	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Vehicle service facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Restaurants/food handling facilities	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Commercial printers and cleaners	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Retail stores (with dumpsters or oil changing facilities)	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Mobile washers, pool maintenance and commercial painters	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Golf courses, nurseries, and pesticide applicators	_____	☐	☐	☐	☐ yes ☐ no	___
☐ Other: _____	_____	☐	☐	☐	☐ yes ☐ no	___
_____	_____	☐	☐	☐	☐ yes ☐ no	___

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Worksheet #2: Deciding Who Should Conduct Inspections

Identify which agencies are inspecting businesses in your municipality, what types of businesses they are inspecting, and how often they conduct inspections. Use the checklist below to assess which agency is best suited to conduct storm water inspections, or whether you should create (or contract with) a special staff.

Check each agency for which the desired charateristic is true:	County Hazwaste	County Health	WWTreat Agency	Fire Dept	Public Works Source/Bldg/Illicit			Special Staff*
• Agency is inspecting local businesses on a regular basis	☐	☐	☐	☐	☐	☐	☐	N/A
• Agency is inspecting priority businesses for storm water (Step 2)	☐	☐	☐	☐	☐	☐	☐	N/A
• Agency is willing to take on more responsibility (or hire more staff)	☐	☐	☐	☐	☐	☐	☐	☐
• Agency has resources to complete inspections within desired time frame	☐	☐	☐	☐	☐	☐	☐	☐
• Agency's services will be cost-effective (lowest cost per facility)	☐	☐	☐	☐	☐	☐	☐	☐
• Agency approach matches desired approach for storm water inspections	☐	☐	☐	☐	☐	☐	☐	☐
• Agency has authority to conduct follow-up and enforcement actions	☐	☐	☐	☐	☐	☐	☐	☐

*Key: County Hazwaste = county hazardous materials/waste inspectors
County Health = county health inspectors
WWTreat Agency = wastewater treatment agency pretreatment or source control inspectors
Fire Dept = fire department or district safety/hazardous materials inspectors
Public Works = public works department source control, building, or illicit discharge inspectors
Special staff = designated storm water program inspectors (in-house, contractors, or consultants)

Once You Select One or More Agencies to Do Storm Water Inspections, Consider These Issues:

• What interagency agreements will be needed? _____

_____

• Who will conduct follow-up/enforcement and how will this be coordinated? _____

_____

• How will information be transferred between the agency and your staff? _____

_____

• How will inspections be coordinated with the Regional Board? _____

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WORKSHEET FOR INSPECTION PROGRAM DEVELOPMENT

Preparer: Date:

Worksheet #3: Defining Enforcement Authority and Procedures

Assess your municipality's legal authority to take enforcement action:

- *What legal tools are available for enforcement?*

☐ storm water discharge ordinance
☐ business- or activity-specific ordinance(s)
☐ Municipal Code, Sections _____
_____
☐ State environmental crime codes
☐ storm water or wastewater permits
☐ inspection fees
☐ other _____

- *Do these tools (alone or in combination) provide you with authority to:*

	Yes	No
1. regulate discharges from industrial and commercial businesses into storm drain systems?	☐	☐
2. prohibit illicit discharges and illicit connections at these facilities?	☐	☐
3. enter and inspect the premises without a search warrant?	☐	☐
4. require, witness or conduct sampling and analysis of any discharges?	☐	☐
5. require implementation of BMPs, including installation of structural controls if necessary?	☐	☐
6. pursue civil and criminal penalties for violations of the ordinance?	☐	☐
7. designate inspectors or other municipal personnel as enforcement officers?	☐	☐

If you answered no to any of the above questions, list the steps required to obtain sufficient authority:

_____

_____

_____

- *What will be your enforcement protocol?*

	Criteria for Issuance	Enforcement Tools	Follow-up Action/Schedule
☐ Warning Notice			
☐ Violation Notice			
☐ Administrative order ☐ without fines ☐ with fines			
☐ Legal action			

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Preparer: Date:

Worksheet #4: Developing Your Educational Outreach Strategy

Use this worksheet to select and prioritize the initial elements of your educational outreach program:

Target Audience (Check those that apply)	Educational Material: Fact Sheet	Program Brochure	BMP Brochure	Info. Letter	How-To Manual	Form of Outreach: Handout	General Mailing	Workshop	Action Priority
☐ General business outreach	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Management	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Facility operators	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ NOI industries	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Targeted large businesses:									
_____	☐	☐	☐	☐	☐	☐	☐	☐	___
_____	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Targeted small businesses:									
_____	☐	☐	☐	☐	☐	☐	☐	☐	___
_____	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Facility inspectors	☐	☐	☐	☐	☐	☐	☐	☐	___
☐ Other insp. agency staff	☐	☐	☐	☐	☐	☐	☐	☐	___

Use your selections above to prepare a prioritized list of the educational materials you need and a schedule for developing them. See Appendix J for lists and samples of existing outreach materials that could be adapted for your program and information on obtaining these materials.

Priority	Type of Material	Existing Resources	Schedule
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
7.	_____	_____	_____
8.	_____	_____	_____

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Worksheet #5: Data Collection for Evaluating Program Effectiveness

One of the main purposes of inspection data collection is to measure program effectiveness. This worksheet presents a method for evaluating your program's effectiveness, and illustrates what information you need to collect during the implementation of the program to perform the evaluation.

I. *Results of Inspection and Follow-up Efforts:*

- Number of initial storm water inspections: Planned _____ Completed _____
- Number of actual/potential pollutant discharges: Identified _____ Eliminated _____
  - ★ Most common types of discharges: _____
- Number of facilities with actual/potential violations: Identified _____ Corrected _____
  - ★ Types of facilities with the most problems: _____
- Number of follow-up inspections: Needed _____ Completed _____
- Number of cases involving enforcement action: Needed _____ Completed _____
  - ★ Results of significant enforcement actions: _____
- Number of NOI facilities inspected: With General Permit coverage _____ Without coverage _____
  - ★ Facilities that filed NOIs after inspection: _____

II. *Completion of Other Action Plan Goals:*

Action Plan Goal	Met	Partially Met	Not Met	Comments/ Plan for Improvement
Outreach materials developed/used	☐	☐	☐	
Annual training of all inspectors	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	

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WORKSHEET FOR INSPECTION PROGRAM DEVELOPMENT

Preparer: **Date:**

Worksheet #6: Developing an Inspector Training Program

Use this worksheet to evaluate the training needs of the personnel that will be performing storm water inspections and to select the method(s) and topics for a complete training program. Complete one sheet for each agency involved with the inspection program.

Inspecting Agency: _____

Business Type(s) Inspected: _____

_____

_____

I. *Inspector Training Needs*

Skill or Knowledge Required (Check all those that apply)	Have Rec'd Training	Training Method: In-house	Off-site	On-job	Workshop	Handout	Resources[1]
☐ Inspection methods	☐	☐	☐	☐	☐	☐	Chapter 4
☐ Sampling methods	☐	☐	☐	☐	☐	☐	U.S. EPA, 1992
☐ Pollutant sources/effects	☐	☐	☐	☐	☐	☐	Chapter 1; BMP Handbook, 1993
☐ Storm water regulations	☐	☐	☐	☐	☐	☐	Chapter 1; BMP Handbook, 1993
☐ Storm water BMPs	☐	☐	☐	☐	☐	☐	Appendix J; BMP Handbook, 1993
☐ Communications with facility owner/operators	☐	☐	☐	☐	☐	☐	Chapters 2 & 4; _____
☐ Safety procedures	☐	☐	☐	☐	☐	☐	_____
☐ Specialized safety training (OSHA, confined space)	☐	☐	☐	☐	☐	☐	_____
☐ Enforcement procedures	☐	☐	☐	☐	☐	☐	_____

[1]References: U.S. EPA, 1992. *NPDES Storm Water Sampling Guidance Document*. Office of Water. EPA 833-B-92-001. July.

Storm Water Quality Task Force, 1993. *California Storm Water Industrial/Commercial Best Management Practice Handbook*. March.

Chapters 1, 2, and 4, and Appendix J refer to this *California Industrial/Commercial Storm Water Inspection Program Handbook*, 1996.

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Worksheet #6, continued: Developing an Inspector Training Program

II. Specific Storm Water Training Topics

Rate the inspectors' knowledge on the following storm water-related topics, and use the results to determine the topics to include in your training program. (It is assumed that these topics would be added to the inspection agency's standard inspector training program, as needed.)

Knowledge of Storm Water Programs: ☐ Adequate ☐ Some ☐ None

Do inspectors know enough about the following topics to effectively explain them to a facility owner/operator?

- Why is it important to protect storm water quality?
- What is the municipal storm water permit?
- What are the components of the storm water program?
- What is the storm water inspection program's approach?
- What is storm water agency's enforcement policy?
- Who needs coverage under a storm water permit?
- Who should be covered by the General Permit?
- What does the General Permit require?

Knowledge of Storm Water Inspection Procedures: ☐ Adequate ☐ Some ☐ None

Do inspectors know the procedures for reporting and coordinating inspections and taking enforcement action?

- How do you use the inspection report form?
- What information is reported to the Regional Board?
- How are activities coordinated with the storm water staff?
- How are inspections coordinated with Regional Board staff?
- What enforcement tools are available to the inspector?
- What are the policies and procedures for enforcing storm water requirements?

Knowledge of Storm Water BMPs: ☐ Adequate ☐ Some ☐ None

Do inspectors know how to effectively eliminate non-storm water discharges?
Do they know how owner/operators can minimize pollutant discharges to storm drains?

- What non-storm water discharges can be discharged to the storm drain?
  (e.g., what is the policy on swimming pool water or certain washwaters?)
- What non-storm water discharges must go to the sanitary sewer?
  How does the owner/operator obtain approval for sanitary sewer discharge?
- What alternatives to discharging to storm drains are available at the facility?
- What alternatives are available for minimizing pollutant exposure?

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INDUSTRIAL/COMMERCIAL STORM WATER INSPECTION PROGRAM HANDBOOK
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Preparer: Date:

Worksheet #7: Developing Your Action Plan

Use this final worksheet to pull together the elements from previous steps into a coordinated Action Plan. Summarize your plan for each element here or refer to the appropriate worksheet(s).

I. Inspection Plan

Priority	Business Type	Inspecting Agency (Indicate (A) if necessary*)	Target No. of Inspections (Indicate I,L,F*)	Estimated No. of Follow-ups (Indicate L or F*)	Time Period for Completion

* *Key: A = Interagency agreement needed; I = Informational site visit; L = Limited inspection; F = Full (comprehensive) inspection.*

II. Plan for Establishing Enforcement Authority and Procedures

III. Educational Outreach Plan

IV. Data Collection and Management Plan

V. Inspector Training Plan

Inspection Agency	Training Method and Topics

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Appendix B

Dischargers Of Stormwater Associated With Industrial Activities (As Defined By EPA)

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Table B-1.
Dischargers of Storm Water Associated with Industrial Activities (as defined by EPA)

i. Facilities listed under 40 CFR Subchapter N. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards which are also identified under category xi).

ii. Manufacturing Facilities. Facilities classified as Standard Industrial Classifications (SIC):

24	Lumber and Wood Products (except 2434)	32	Stone, Clay, and Glass Products (except 323)
26	Paper and Allied Products (except 265 & 267)	33	Primary Metal Industries
28	Chemicals and Allied Products (except 283 & 285)	3441	Fabricated Structural Metal
29	Petroleum and Coal Products	373	Ship and Boat Building and Repairing

iii. Oil and Gas/Mining Facilities. Facilities classified as SIC 10 through 14 (mineral industry including active or inactive mining operations, oil and gas exploration, production, processing, or treatment operations or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations.

10 Metal Mining	13 Oil and Gas Extraction
12 Coal Mining	14 Non Metallic Minerals except Fuels

iv. Hazardous Waste Treatment, Storage, or Disposal Facilities. Hazardous waste treatment, storage, or disposal facilities that are operating under interim status or a permit under Subtitle C or the Resource, Conservation and Recovery Act.

v. Landfills, Land Application Sites, and Open Dumps. Landfills, land application sites, and open dumps that receive or have received industrial wastes and that are subject to regulation under subtitle D of RCRA.

vi. Recycling Facilities. Facilities involved in the recycling of materials, including metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as SIC:

5015 Motor Vehicle Parts, Used
5093 Scrap and Waste Materials

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Table B-1.
Discharges of Storm Water Associated with Industrial Activities (continued)

vii. Steam Electric Power Generating Facilities. Steam electric power generating facilities, including coal handling sites, and onsite and offsite ancillary transformer storage areas.

viii. Transportation Facilities. Transportation facilities classified as SIC:

40	Railroad Transportation	44	Water Transportation
41	Local and Interurban Passenger Transit	45	Transportation by Air
42	Trucking and Warehousing (except 4221-25)	5171	Petroleum Bulk Stations and Terminals
43	U.S. Postal Service		

which have vehicle maintenance shops, material handling facilities, equipment cleaning operations or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling and lubrication), equipment cleaning operations or which are identified in another subcategory of facilities under EPA's definition of storm water discharges associated with industrial activity.

ix. Sewage or Wastewater Treatment Works. POTW lands used for land application treatment technology/sludge disposal, handling or processing areas, and chemical handling and storage areas.

x. Construction Activities. Activities include clearing, grading and excavation activities except operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale.

xi. Manufacturing Facilities. Facilities where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. These facilities are under SIC:

20	Food and Kindred Products	323	Products of Purchased Glass
21	Tobacco Products	34	Fabricated Metal Products (except 3441)
22	Textile Mill Products	35	Industrial Machinery and Equipment
23	Apparel and other Textile Products	36	Electronic and Other Electrical Equipment
2434	Wood Kitchen Cabinets	37	Transportation Equipment (except 373)
25	Furniture and Fixtures	39	Miscellaneous Manufacturing Industries
265	Paperboard Containers and Boxes	4221	Farm Product Warehousing and Storage
267	Misc. Converted Paper Products	4222	Refrigerated Warehousing and Storage
38	Instruments and Related Products	4225	General Warehousingand Storage
27	Printing and Publishing		
283	Drugs		
285	Paints and Allied Products		
30	Rubber and Misc. Plastics Products		
31	Leather and Leather Products (except 311)		

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Appendix C

State General Industrial Activities Storm Water Permit and Associated Documents

1) Cover Letter from State Water Resources Control Board - October 15, 1992

2) Fact Sheet for General Permit - September 17, 1992

3) General Permit No. CAS000001 - Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities, Excluding Construction Activities

4) General Instructions and Form for Notice of Intent

5) San Francisco Bay Regional Board Storm Water Program Fact Sheets - August 1994:

   - Industrial Storm Water General Permit
   - Industrial Storm Water Monitoring

6) Overview of the General Permit - APWA Storm Water Task Force

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STATE OF CALIFORNIA - CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

STATE WATER RESOURCES CONTROL BOARD

PAUL R. BONDERSON BUILDING
901 P STREET
P.O. BOX 1977
SACRAMENTO, CALIFORNIA 95812-01977
(916) 657-0757
(916) 657-1011

PETE WILSON Governor

TO: STORM WATER DISCHARGER

SUBJECT: CHECK LIST FOR SUBMITTING A NOTICE OF INTENT

In order for the State Water Resources Control Board to expeditiously process your Notice of Intent (NOI), the following items must be submitted:

1. _____ NOI with all applicable sections filled out and signed by the owner/operator;

2. _____ Check made out to the "State Water Resources Control Board" with the appropriate fee; and

   - County Fees: $250.00 OR $500.00
   - Dairy Farms: $2,000.00

3. _____ Site map displaying the layout of premises.

Please return the above items to the address below. If you have any questions regarding this matter, please contact us at (916) 657-0757.

State Water Resources Control Board
Division of Water Quality
Attn: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

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STATE OF CALIFORNIA CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

STATE WATER RESOURCES CONTROL BOARD
PAUL R. BONDERSON BUILDING
901 P STREET
P.O. BOX 100
SACRAMENTO, CALIFORNIA 95812-0100
(916) 657-0941
FAX: (916) 657-0932

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OCT 15, 1992

TO: INTERESTED PARTIES

AMENDED GENERAL INDUSTRIAL ACTIVITIES STORM WATER PERMIT

Enclosed is an updated copy of the General Industrial Activities Storm Water Permit (General Permit) adopted by the State Water Resources Control Board (State Water Board) on November 19, 1991 and amended on September 17, 1992. Dischargers who have not already filed their Notice of Intent (NOI) to comply with the terms of the General Permit and the first annual fee must submit a NOI accompanied by the first annual fee to the State Water Board in order to be covered by this General Permit. The NOI and fee must be sent to the following address:

State Water Resources Control Board
Division of Water quality
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

The NOI will only be processed if accompanied by the appropriate fee. The fee will be either $250.00 or $500.00. Enclosure 1 describes those areas in which the $250.00 annual fee applies. Dischargers in all other areas of the State must pay the $500.00 annual fee.

Attachment 2 to the Permit lists the nine California Regional Water Quality Control Boards' (Regional Water Boards) addresses and telephone numbers. You should discuss any questions or issues which relate to the implementation of the General Permit with Regional Water Board staff.

The updated General Permit contains amended monitoring and reporting requirements (Section B of the General Permit) that replace the original monitoring and reporting requirements. The new monitoring and reporting requirements have been simplified and now offer several sampling and analysis exemption options. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers (those beginning industrial activity after January 1, 1993) must develop and implement a monitoring program prior to the commencement of industrial activity.

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The amended monitoring and reporting provisions require that group monitoring proposals be submitted to the appropriate Regional Water Board(s) by December 1, 1992 and in subsequent years by August 1. Groups with participants within the boundaries of more than one Regional Water Board must send their group monitoring proposal to the State Water Board's Executive Director for approval to the above address.

Also, we would appreciate it if you would inform other industries similar to your own of the need to obtain a storm water permit. If you know of industries that need to obtain a permit but may be unaware of the State's program, please ask them to call Division of Water Quality staff at the telephone number shown below.

If you have any questions regarding this General Permit, please telephone the industrial activities storm water permit information line at
(916) 657-0919.

Sincerely,

/s/

Walt Pettit
Executive Director

Enclosures (2)

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January 31, 1995

Enclosure 1

AREAS OF THE STATE IN WHICH THE $250.00 ANNUAL FEE APPLIES

Municipality	Permitted Area
1. Alameda County	The permitted area consists of the westerly side of the county which drains to San Francisco Bay.
2. Bakersfield	The permitted area consists of the city of Bakersfield and the unincorporated portions of Kern County within the city limits.
3. Contra Costa County	The permitted area consists of the entire county except for the community of Brentwood.
4. El Dorado County	The permitted area consists of the easterly side of the county which drains into Lake Tahoe.
5. Fresno County	The permitted area consists of the cities of Fresno and Clovis, and the California State University of Fresno.
6. Los Angeles County	The permitted area consists of the five hydrologic subbasins which drain into the Pacific Ocean as follows: Santa Monica Bay, Upper Los Angeles River--including Sycamore Channel, Upper San Gabriel River, Lower Los Angeles River, and Lower San Gabriel River--including Santa Clarita Valley. The permit does not cover the cities of Avalon, Lancaster, and Palmdale.
7. Orange County	The permitted area consists of the entire county.
8. Placer Counties	The permitted area consists of the easterly side of the county which drains into Lake Tahoe.
9. Riverside County	The permitted area is delineated by the San Bernardino County line on the north and northwest, the Orange County line on the west, the San Diego County line on the south, and the Santa Ana/Colorado River Basin Regional Board's boundary line on the east (mountain crest).

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10. Sacramento County	The permitted area consists of the entire county except for the incorporated city of Isleton.
11. San Bernardino County	The permitted area is delineated by the Santa Ana/Lahontan Regional Board's boundary line on the north and northeast, the Santa Ana/Colorado River Basin Regional Board's boundary line on the east, the San Bernardino/Riverside County boundary line on the south and southeast, the San-Bernardino/ Orange County boundary line on the southwest, and the San Bernardino/Los Angeles County boundary line on the west.
12. San Diego County	The permitted area is delineated by the San Diego County lines on the north and south, the Pacific Ocean on the west, and the San Diego/Colorado River Basin Regional Board's boundary on the east (mountain crest).
13. San Joaquin	The permitted area consists of the city of Stockton and the unincorporated portions of the county within the city limits.
14. San Mateo County	The permitted area consists of the entire county.
15. Santa Clara County	The permitted area consists of the Santa Clara Valley Basin portion of the county containing eleven hydrologic subbasins which discharge into watercourses, which in turn flow into South San Francisco Bay.
16. Stanislaus	The permitted area consists of the city of Modesto and the unincorporated portions of the county within the city limits.
17. Ventura County	The permitted area consists of the cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks, as well as the unincorporated areas of Ventura County--defined as urban by the U.S. Census Bureau.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
901 P STREET
SACRAMENTO, CA 95814

FACT SHEET
FOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT (NPDES)
GENERAL PERMIT (AS AMENDED SEPTEMBER 17, 1992) FOR
STORM WATER DISCHARGES ASSOCIATED WITH INDUSTRIAL ACTIVITIES
EXCLUDING CONSTRUCTION ACTIVITIES

BACKGROUND

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, the U.S. Environmental Protection Agency (USEPA) published final regulations that establish application requirements for storm water permits. The regulations require that storm water associated with industrial activity (industrial storm water) that discharges either directly to surface waters or indirectly, through municipal separate storm sewers, must be regulated by a NPDES permit. This includes the discharge of "sheet flow" through a drainage system or other conveyance.

The federal regulations allow authorized states to issue general permits or individual permits to regulate industrial storm water discharges. The State Water Board has elected to issue a statewide general permit that will apply to all industrial storm water discharges requiring a permit except construction activity. A separate statewide general permit has been issued for construction activity. To obtain authorization for continued and future industrial storm water discharge, owners, or operators when the owners do not operate the facility (dischargers), must submit a Notice of Intent (NOI) to be covered by this general permit. This approach is consistent with the four-tier permitting strategy described in federal regulations, i.e., Tier 1, Baseline Permitting. Tier 1, Baseline Permitting, enables the State to begin reducing pollutants in industrial storm water in the most efficient manner possible. Thus, as soon as possible, all dischargers will be required by this general permit to begin implementing practices to prevent storm water pollution. Time will not be lost preparing detailed individual and general permit applications before implementing practices to prevent storm water pollution.

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The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for specific industrial groups at this time. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual permit by October 1, 1992. The State Water Board bases this decision on the following factors:

1. USEPA does not allow the states to review and approve the group applications.

2. Review of hundreds of USEPA model permits and preparation of hundreds of group-specific general permits is administratively burdensome and is inconsistent with the State Water Board's long-term permitting strategy.

3. Allowing the group application action in California would result in an inequitable and ineffective storm water permitting program. While group applicants would not be required to implement best management practices (BMPs) to reduce pollutants in storm water discharge until they receive a permit (probably several years), dischargers under the State Water Board's general permit will be required to implement BMPs on October 1, 1992.

4. The State Water Board is providing a group monitoring alternative, somewhat similar to the group application monitoring requirements, that should provide reduced monitoring costs to the dischargers.

When USEPA issues model permits for any groups, the Regional Water Boards may consider, as appropriate, adopting group permits based upon the USEPA model permits.

The general permit accompanying this fact sheet is intended to regulate industrial storm water discharges. The consolidation of many discharges under one general permit will greatly reduce the otherwise overwhelming administrative burden associated with start up of a new program to regulate industrial storm water discharges. It is also the least costly way for a discharger to obtain a permit and comply with USEPA's regulations. It is expected that as the storm water program develops, the Regional Water Boards will issue individual and general permits which regulate discharges specific either to industrial categories or to watersheds. As new permits are adopted, dischargers subject to those permits will no longer be regulated by this general permit. As permits are reissued for discharges of treated wastewater that are currently regulated by a NPDES permit, Regional Water Boards may include storm water provisions in the revised permit.

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This general permit generally requires dischargers to:

1. Eliminate most non-storm water discharges (including illicit connections) to storm water sewer systems;
2. Develop and implement a storm water pollution prevention plan; and
3. Perform monitoring of discharges to storm water sewer systems.

TYPES OF STORM WATER DISCHARGES COVERED BY THIS GENERAL PERMIT

This general permit is intended to cover all new or existing discharges composed entirely of industrial storm water from facilities required by federal regulations to obtain a permit. This includes all facilities that are participating in a group application. The State Water Board notes that officials from USEPA have stated that the regulations include only those facilities which are operated by industries whose primary function is described in the categories listed below. The State Water Board does not agree with this interpretation of the regulations, as the regulations are based on the primary activity at each industrial facility, and not the primary business of the owner or operator of the facility. The State Water Board concludes that, based on its interpretation of the federal regulations, and its duty and authority to protect water quality within California, the general permit must extend to all facilities which are described in the categories below, whether the activity is primary or is auxiliary to the owner or operator of the facility. For example, even though a school district's primary function is education, a facility which it operates for vehicle maintenance of school buses is a transportation facility which is covered by this general permit.

Discharges from facilities and commercial enterprises which are not required by federal regulations to obtain a permit will not be covered by this general permit unless designated by the Regional Water Board.

Discharges requiring a permit are listed by category in 40 Code of Federal Regulations (CFR) Section 122.26(b)(14) (Federal Register, Volume 55 at Pages 48065-66). The facilities can be publicly or privately owned. A general description of these categories are:

1. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR Subchapter N);
2. Manufacturing facilities;
3. Mining and Oil and Gas facilities;
4. Hazardous waste treatment, storage, or disposal facilities;

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5. Landfills, land application sites, and open dumps that receive industrial waste;
6. Recycling facilities such as metal scrap yards, battery reclaimers, salvage yards, automobile yards;
7. Steam electric generating facilities;
8. Transportation facilities;
9. Sewage treatment plants;
10. Construction activity (covered by a separate general permit); and
11. Certain facilities if materials are exposed to storm water.

For the most part, these facilities are identified in the federal regulations by Standard Industrial Classification (SIC). Attachment 1 to the general permit contains a more detailed description including SIC codes of industries to be regulated.

Category 1 Dischargers

The following categories of facilities currently have storm water effluent limitations guidelines for at least one of their subcategories. They are cement manufacturing (40 CFR Part 411); feedlots (40 CFR Part 412); fertilizer manufacturing (40 CFR Part 418); petroleum refining (40 CFR Part 419); phosphate manufacturing (40 CFR Part 422); steam electric power generation (40 CFR Part 423); coal mining (40 CFR Part 434); mineral mining and processing (40 CFR Part 436); ore mining and dressing (40 CFR Part 440); and asphalt emulsion (40 CFR Part 443). A facility that falls into one of these general categories should examine the effluent guidelines to determine if it is categorized in one of the subcategories that have storm water effluent guidelines. If a facility is classified as one of those subcategories, that facility is subject to the standards listed in the CFR for that category, and is subject to this general permit. This general permit contains additional requirements (see Section B.7) for facilities with storm water effluent limitations guidelines.

Category 5 Dischargers

Inactive or closed landfills, land application sites, and open dumps that have received industrial wastes (Category 5) may be subject to this general permit unless the storm water discharges from the sites are already regulated by a NPDES permit issued by the appropriate Regional Water Board. Owners or operators of closed landfills that are regulated by waste discharge requirements (WDRs) may be required to comply with this general permit. In some cases, it may be appropriate for closed landfills to be covered by the State Water Board's General Construction Activity Storm Water Permit during closure activities. The appropriate Regional Water Board should be contacted for this determination.

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Category 11 Dischargers

Dischargers in Category 11 that believe they are not subject to this general permit because of no exposure should conduct a facility inspection and document that the following minimum conditions have been met:

1. All illicit connections to the storm drainage system have been eliminated;

2. All materials are completely contained at all times;

3. All unhoused equipment associated with industrial activity is not exposed to storm water; and

4. All emissions from stacks or exhaust systems and emissions of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

Dischargers should evaluate all direct and indirect pathways of exposure. Dischargers are not required to submit this documentation but are advised to keep the above documentation on site.

In a recent ruling, the Ninth Circuit Court of Appeals invalidated the exemption granted by USEPA for storm water discharges from facilities in Category 11 that do not have exposure and remanded the regulation to USEPA for further action. The State Water Board, at this time, is not requiring storm water discharges from facilities in Category 11 that do not have exposure to be covered by this general permit. Instead, the State Water Board will await future USEPA or court action clarifying the types of storm water discharges that must be permitted. If necessary, the State Water Board will reopen the general permit to accommodate such a clarification.

TYPES OF DISCHARGES NOT COVERED BY THIS GENERAL PERMIT

- CONSTRUCTION ACTIVITY: Discharges from construction activity of five acres or more, including clearing, grading and excavation. A separate general permit was adopted on August 20, 1992 for this industrial category.

- FACILITIES LOCATED IN SANTA CLARA COUNTY WHICH DRAIN TO SAN FRANCISCO BAY: The San Francisco Bay Regional Water Board has adopted a general permit for discharges from facilities located in Santa Clara County which drain to San Francisco Bay.

- FACILITIES COVERED BY INDIVIDUAL PERMITS: While it is the intent of the State Water Board, in order to reduce

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administrative burden, to regulate most discharges of industrial storm water by this general permit, dischargers may choose to apply for an individual NPDES Permit. Permit application requirements are set forth in the USEPA regulations at 40 CFR Section 122.21.

- FACILITIES WHICH HAVE NPDES PERMITS CONTAINING STORM WATER PROVISIONS: The NPDES permits for some industrial waste water discharges already contain requirements regulating storm water. These discharges are in compliance with storm water regulations and will not be regulated by this general permit. When the existing permit for such discharges expires, a Regional Water Board may authorize coverage under this permit, or another general permit, or issue a new permit consistent with the new federal and State storm water requirements.

- FACILITIES DETERMINED INELIGIBLE BY REGIONAL WATER BOARDS: Regional Water Boards may determine that discharges from a facility or groups of facilities, otherwise eligible for coverage under this general permit, have potential water quality impacts that may not be addressed by this general permit. In such cases, a Regional Water Board may require such dischargers to apply for and obtain an individual permit or a different general permit. Interested persons may petition the appropriate Regional Water Board to issue individual permits. The applicability of this general permit to such discharges will be terminated upon adoption of an individual permit or a different general permit.

- FACILITIES WHICH DO NOT DISCHARGE STORM WATER TO WATERS OF THE UNITED STATES: The discharges from the following facilities are not required to obtain a permit:

  1. FACILITIES THAT DISCHARGE STORM WATER TO MUNICIPAL SANITARY SEWER SYSTEMS: Facilities that discharge storm water to municipal sanitary sewer systems or combined sewer systems are not required by federal regulations to obtain a storm water permit or to submit a NOI to comply with this general permit. (It should be noted that many municipalities have sewer use ordinances that prohibit storm drain connections to their sanitary sewers.)

  2. FACILITIES THAT DO NOT DISCHARGE STORM WATER TO SURFACE WATERS OR SEPARATE STORM SEWERS: Dischargers that capture all industrial storm water runoff from their facilities and treat and/or dispose of it with their process waste water, and dischargers that dispose of their industrial storm water to evaporation ponds, percolation ponds, or combined sewer systems, are not required to obtain a storm water permit. To avoid liability, the discharger should

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be certain that a discharge of industrial storm water to surface waters will not occur under any circumstances.

- LOGGING ACTIVITIES: Logging activities described under SIC 2411.

- MINING AND OIL AND GAS FACILITIES: Oil and gas facilities that have not released storm water resulting in a discharge of a reportable quantity (RQ) for which notification is or was required pursuant to 40 CFR Parts 110, 117, and 302 at any time after November 19, 1988 are not required to be permitted unless the industrial storm water discharge contributed to a violation of a water quality standard. Mining facilities that discharge storm water that does not come into contact with any overburden, raw materials, intermediate product, finished product, by-product, or waste product located at the facility are not required to be permitted. These facilities must obtain a storm water permit if they have a new release of storm water resulting in a discharge of a RQ.

- FACILITIES ON INDIAN LANDS: Discharges from facilities on Indian lands will be regulated by the USEPA.

NOTIFICATION REQUIREMENTS

Dischargers of facilities described in the section entitled "Types of Storm Water Discharges Covered by This General Permit", must obtain a permit to discharge storm water. A NOI must be submitted for each individual facility to obtain coverage. Certification of the NOI signifies that the discharger intends to comply with the provisions of the general permit.

Dischargers that do not submit a NOI for facilities must submit an application for an individual permit. USEPA's regulations (40 CFR 122.21 [a]) exclude dischargers covered by a general permit from requirements to submit permit applications. The NOI requirements of this general permit are intended to establish a mechanism which can be used to establish a clear accounting of the number of dischargers complying with the general permit, their identities, the nature of operations at the facilities, and location.

Dischargers of existing facilities in California were required to obtain coverage by submitting a completed NOI no later than March 30, 1992. Dischargers of new facilities (those beginning operations after March 30, 1992) must submit a NOI 30 days prior to the beginning of operations. The NOI must be sent to the

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following address:

California State Water Resources Control Board
Division of Water Quality
P. O. Box 1977
Sacramento, CA 95812-1977
Attention: Storm Water Permitting Unit

Facilities that do not obtain coverage under this general permit or by an individual NPDES permit for a discharge of industrial storm water, by the appropriate deadlines, will be in violation of the Clean Water Act and the California Water Code. There are substantial penalties which can be pursued by the State or Regional Water Boards, USEPA, or by private citizens for violation of these laws. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late. In general, late filers should develop and implement their SWPPP and Monitoring Plan no more than 30 days following submittal of their late NOI. Dischargers that cannot develop and implement these plans within 30 days should notify the appropriate Regional Water Board.

DESCRIPTION OF GENERAL PERMIT CONDITIONS

Prohibitions

This general permit authorizes the discharge of industrial storm water from industrial facilities that are required to obtain industrial storm water permits. This general permit prohibits most non-storm water discharges (including illicit connections) and discharges containing hazardous substances in storm water in excess of reportable quantities established at 40 CFR 117.3 and 40 CFR 302.4. Allowable non-storm water discharges are discussed below under the heading Storm Water Pollution Prevention Plan (SWPPP).

Effluent Limitations

Permits for discharges of industrial storm water must meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require control of pollutant discharges that use best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to reduce pollutants, and any more stringent controls necessary to meet water quality standards.

USEPA regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories. For these facilities, the numeric

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effluent limitations constitute BAT and BCT for the specified pollutants, and must be met to comply with this general permit.

For storm water discharges from facilities not among the ten industrial categories listed in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. The reasons why establishment of numeric effluent limitations is not feasible are discussed in detail in State Water Board Orders No. WQ 91-03 and WQ 91-04. Therefore, the effluent limitations contained in this general permit are narrative and include best management practices (BMPs).

These effluent limitations constitute compliance with the requirements of the Clean Water Act.

The narrative effluent limitations in this general permit include prohibitions against most discharges of non-storm water. They require dischargers to control and eliminate the sources of pollutants in storm water through the development and implementation of storm water pollution prevention plans. The plans must include best management practices, which may include treatment of storm water discharges along with source reduction, which will constitute BAT and BCT and will achieve compliance with water quality standards. If water quality standards are not met, the appropriate Regional Water Board may specify any additional effluent limitations necessary to meet the specific standards.

Storm Water Pollution Prevention Plans (SWPPP)

This general permit requires development and implementation of SWPPP emphasizing storm water BMPs. This approach provides the flexibility necessary to establish controls which can appropriately address different sources of pollutants at different facilities. Existing dischargers must develop and implement a SWPPP by October 1, 1992. New dischargers must submit a NOI, and develop and implement a SWPPP prior to commencement of operations.

All dischargers must prepare, retain on site, and implement a SWPPP. The SWPPP has two major objectives: (1) to help identify the sources of pollution that affect the quality of industrial storm water discharges; and (2) to describe and ensure the implementation of practices to reduce pollutants in industrial storm water discharges.

The SWPPPs are considered reports available to the public under Section 308(b) of the Clean Water Act. Required elements of a SWPPP are: (1) source identification, (2) practices to reduce pollutants, (3) an assessment of potential pollution sources, (4) a materials inventory, (5) a preventive maintenance program,

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(6) spill prevention and response procedures, (7) general storm water management practices, (8) employee training, (9) recordkeeping, and (10) elimination of unpermitted non-storm water discharges to the industrial storm water system. Elimination of non-storm water discharges is a major element of the SWPPP. Non-storm water discharges include a wide variety of sources including illicit connections (i.e., floor drains), improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges can contribute a significant pollutant load to receiving waters. Measures to control spills, leakage, and dumping can often be addressed through BMPs. Non-storm water discharges and industrial storm water mixed with non-storm water prior to discharge should be covered by a separate NPDES Permit.

There are many discharges that may occur at a facility that are not related to industrial activity (i.e., air conditioning condensate, fire control water line testing, landscaping overflow, etc.). It is not the intent of this Permit to prohibit all non-industrial-related discharges. Non-industrial-related discharges may be appropriate if they:

1. Are not subject to local Regional Water Board permitting requirements.
2. Do not contain significant quantities of industrial-related pollutants.
3. Are infeasible to eliminate.
4. Are identified and addressed in the SWPPP and monitoring program.
5. Are in compliance with local municipal storm water permittee requirements.

Monitoring Program

The general permit requires development and implementation of a monitoring program. Existing dischargers must develop and implement a monitoring program by January 1, 1993. New dischargers must develop and implement a monitoring program prior to commencement of operations, but no earlier than January 1, 1993. The objectives of the monitoring program are to (1) demonstrate compliance with the permit, (2) aid in the implementation of the SWPPP, and (3) measure the effectiveness of the BMPs in removing pollutants in industrial storm water discharge.

All dischargers (with the exception of inactive mining operations) are required to:

1. Perform visual observations during the dry and wet seasons. Dry season observations are required to verify that non-storm water discharges have been eliminated. Wet season

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observations are required to aid dischargers in evaluating the effectiveness of the SWPPP.

2. Conduct an annual inspection to determine compliance with this general permit.

3. Perform or participate in a sampling and analysis program. Analysis must include pH, total suspended solids (TSS), total organic carbon (TOC), specific conductance, toxic substances, and other pollutants which are likely to be present in storm water discharges in significant quantities. Dischargers subject to federal storm water effluent limitations guidelines in 40 CFR Subchapter N must also sample and analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N.

Dischargers are not required to collect samples or perform visual observations during adverse climatic conditions. Sample collection and visual observations are required only during scheduled facility operating hours or within two hours after scheduled facility operating hours. Visual observations are required only during daylight hours. Dischargers that are unable to collect any of the required samples or visual observations because of the above circumstances must provide documentation to the Regional Water Board in their annual report.

Dischargers may be exempt from performing sampling and analysis if they: (1) do not have areas of industrial activity exposed to storm water, (2) receive certification from a local agency which has jurisdiction over the storm sewer system that the discharger has developed and implemented an effective SWPPP and should not be required to sample, or (3) receive an exemption from the appropriate Regional Water Board. Dischargers must always perform sampling and analysis for any pollutant specified in storm water effluent limitations guidelines.

Local agencies that wish to provide certifications to dischargers within their jurisdiction should develop a certification program that clearly indicates the certification procedures and criteria used by the local agency. At a minimum, these programs should include site inspections, a review of the dischargers' SWPPP, and a review of other records such as monitoring data, receiving water data, etc. It is recommended that the certification program be sent to the local Regional Water Board for review and comment prior to implementation.

Group Monitoring

Each discharger may either perform sampling and analysis individually or participate in a group sampling program. A group monitoring program may be developed either by an entity

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representing a group of similar facilities or by a local agency which holds a storm water permit for a municipal separate storm sewer system, for industrial facilities within its jurisdiction. The entity or local agency responsible for the group monitoring program must perform sampling at a minimum of 20 percent of the facilities within the group (and at least four dischargers in a group of less than 20 dischargers). The facilities selected for sampling must be representative of all the facilities in the group. Dischargers subject to federal effluent limitations guidelines in 40 CFR Subchapter N must individually sample and analyze for pollutants listed in the appropriate federal regulations.

Facilities within a group may be located within the jurisdiction of more than one Regional Water Board. Multi-Regional Water Board groups must receive the approval of the State Water Board Executive Director (with the concurrence of the appropriate Regional Water Boards). Groups may request variance from the minimum 20 percent (and a minimum of four facilities for groups of less than 20 dischargers) with adequate justification. As a minimum, the justification should: (1) explain the need for the variance, and (2) show that the variance, if approved, will result in representative monitoring data.

Each entity or local agency responsible for group sampling must: (1) ensure that the monitoring is done correctly, (2) recommend appropriate BMPs to reduce pollutants in storm water discharges from group participants, and (3) evaluate and report the monitoring data to the appropriate Regional Water Board(s).

All group monitoring plans are subject to Regional Water Board(s) review. Consistent with the four-tier permitting strategy described in the federal regulations, the Regional Water Board(s) will evaluate the data and results from group monitoring to establish future permitting decisions. As appropriate, Regional Water Board(s) may terminate or require substantial amendment to the group monitoring plans, dependent, in part, on the group's overall success in meeting the objectives of the Permit.

The State Water Board recognizes that the group monitoring option will result in fewer facilities monitored. The State Water Board believes that this is a desirable trade-off for the following reasons:

1. Review of monitoring data from all individual facilities is administratively burdensome.

2. Monitoring of fewer facilities, but with more parameters and better quality control, will result in more accurate and meaningful monitoring data.

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3. Group monitoring is consistent with USEPA's four-tier permitting strategy.

4. As no numeric limits are specified in the Permit (with the exception of 40 CFR Subchapter N facilities), implementation of a SWPPP, performance of visual monitoring, and performance of an annual inspection are consistent with the minimum monitoring requirements of the CWA.

5. Data from group monitoring programs will be indicative of the effectiveness of BMPs to control pollution in storm water discharge. Additional BMPs, useful to the entire group, may be developed from the monitoring data.

6. A large percentage of dischargers are small businesses which do not have the regulatory sophistication, organizational structure, or resources to conduct an adequate individual monitoring program.

Retention of Records

The discharger is required to retain records of all monitoring information, copies of all reports required by this permit, and records of all data used to complete the NOI, for a period of five years from the date of measurement, report, or application. This period may be extended by the State and/or Regional Water Boards. All records are public documents.

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STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD)
WATER QUALITY ORDER NO. 91-13-DWQ
(AS AMENDED BY WATER QUALITY ORDER NO. 92-12-DWQ)
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT NO. CAS000001

WASTE DISCHARGE REQUIREMENTS (WDRS)
FOR
DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES
EXCLUDING CONSTRUCTION ACTIVITIES

The State Water Board finds that:

1. Federal regulations for storm water discharges were issued by the U.S. Environmental Protection Agency on November 16, 1990 (40 Code of Federal Regulations (CFR) Parts 122, 123, and 124). The regulations require specific categories of facilities, which discharge storm water associated with industrial activity (storm water), to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate industrial storm water pollution.

2. This general permit shall regulate discharges of storm water from specific categories of industrial facilities identified in Attachment 1, excluding discharges covered by existing NPDES permits which already include provisions regulating discharges of storm water, discharges from construction activities, or discharges determined ineligible for coverage by this general permit by the California Regional Water Quality Control Boards (Regional Water Boards). Attachment 2 contains the addresses and telephone numbers of each Regional Water Board office.

3. All dischargers participating in group applications must either obtain coverage under this general permit or apply for an individual general permit by October 1, 1992. The State Water Board has elected not to accept USEPA's group application approach or to adopt general permits for industrial groups at this time.

4. This general permit does not preempt or supersede the authority of local agencies to prohibit, restrict, or control discharges of storm water to storm drain systems or other watercourses within their jurisdictions, as allowed by State and federal law.

5. To obtain authorization for continued and future storm water discharge pursuant to this general permit, owners, or operators when the owners does not operate the facility (dischargers), must submit a Notice of Intent (NOI) and appropriate fee to the State Water Board. Dischargers who

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submit a NOI and appropriate fee are authorized to discharge storm water under the terms and conditions of this general permit.

6. If an individual NPDES general permit is issued to a discharger otherwise subject to this general permit, or an alternative general permit is subsequently adopted which covers storm water discharges regulated by this general permit, the applicability of this general permit to such discharges is automatically terminated on the effective date of the individual general permit or the date of approval for coverage under the subsequent general permit.

7. Effluent limitations, and toxic and effluent standards established in Sections 208(b), 301, 302, 303(d), 304, 306, 307, and 403 of the Federal Clean Water Act (CWA), as amended, are applicable to storm water discharges regulated by this general permit.

8. This action to adopt a NPDES general permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

9. The State Water Board adopted the California Ocean Plan on March 22, 1990, and the California Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan on April 11, 1991. In addition, the Regional Water Boards have adopted and the State Water Board has approved Water Quality Control Plans (Basin Plans).

   Discharges regulated by this general permit must be in compliance with the water quality standards in these Plans, and subsequent amendments thereto. The State Water Board shall, by April 1996, determine what further actions are appropriate to ensure that discharges subject to this general permit are in compliance with the numerical objectives in the Inland Surface Waters Plan and the Enclosed Bays and Estuaries Plan.

10. Federal regulations (40 CFR Subchapter N) establish numeric effluent limitations for storm water discharges from facilities in ten industrial categories.

11. For facilities which do not have established numeric effluent limitations for storm water discharges in 40 CFR Subchapter N, it is not feasible at this time to establish numeric effluent limitations. This is due to the large number of discharges and the complex nature of storm water discharges.

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12. Implementation of the provisions of this general permit constitutes compliance with BAT/BCT requirements, and with requirements to achieve water quality standards.

13. Best Management Practices (BMPs) to control and abate the discharge of pollutants in storm water discharges are authorized where numeric effluent limits are infeasible and the BMPs are reasonably necessary to achieve compliance with effluent limitations or water quality standards.

14. Following adoption of this general permit, the Regional Water Boards shall enforce the provisions of this general permit including the monitoring and reporting requirements.

15. Following public notice in accordance with State and Federal law and regulations, the State Water Board, in a public hearing held September 3, 1991, heard, considered, and responded to all comments pertaining to this general permit.

16. This Order is a NPDES general permit in compliance with Section 402 of the Clean Water Act and shall take effect upon adoption by the State Water Board.

IT IS HEREBY ORDERED that all dischargers that file a NOI indicating their intention to be regulated under the provisions of this general permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of material other than storm water, which are not otherwise regulated by a NPDES permit, to a storm sewer system or waters of the nation are prohibited.

2. Storm water discharges for those facilities listed in Category I of Attachment 1 of this general permit shall not exceed the numeric effluent limitations as specified in Federal Regulations (40 CFR Subchapter N). Dischargers subject to those regulations who do not have or are unable to obtain copies of the pertinent regulations from other sources (e.g., Government Printing Office) should contact the:

   State Water Resources Control Board
   Division of Water Quality
   P.O. Box 1977
   Sacramento, CA 95812-1977
   Attn: Storm Water Permitting Unit

3. Storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

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4. Storm water discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

B. RECEIVING WATER LIMITATIONS:

1. Storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. Storm water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters Plan, Enclosed Bays and Estuaries Plan, or the applicable Regional Water Boards' Basin Plan.

C. PROVISIONS

1. All dischargers must submit an NOI and appropriate fee for each facility covered by this general permit in accordance with Attachment 3: Notice of Intent--General Instructions.

2. All dischargers must develop and implement a Storm Water Pollution Prevention Plan for each facility covered by this general permit in accordance with Section A: Storm Water Pollution Prevention Plan.

3. All dischargers must develop and implement a Monitoring and Reporting Progra Plan for each facility covered by this general permit ... accordance with Section B: Monitoring Program and Reporting Requirements.

4. Feedlots as defined in 40 CFR Part 412 that are in full compliance with Section 2560 to Section 2565, Title 23, California Code of Regulations (Chapter 15) will be in compliance with all effluent limitations and prohibitions contained in this general permit. Feedlots must comply with any Regional Water Board WDRs or NPDES general permit regulating their storm water discharge. Feedlots that comply with Chapter 15, however, must perform monitoring in compliance with the requirements of Provisions 5(c) and 16 of Section B: Monitoring Program and Reporting Requirements.

5. All dischargers must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or other water courses under their jurisdiction, including applicable requirements in

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municipal storm water management programs developed to comply with NPDES general permits issued by the Regional Water Boards to local agencies.

6. All dischargers must comply with the standard provisions and reporting requirements for each facility covered by this general permit contained in Section C: Standard Provisions.

7. This general permit will expire on November 19, 1996. Upon reissuance of the NPDES general permit by the State Water Board, the facilities subject to this reissued general permit are required to file a revised NOI.

D. REGIONAL WATER BOARD AUTHORITIES

1. Following adoption of this general permit, Regional Water Boards shall:

   (a) Implement the provisions of this general permit, including, but not limited to, reviewing storm water pollution prevention plans, reviewing group monitoring plans, reviewing monitoring reports, conducting compliance inspections, and taking enforcement actions.

   (b) Issue general permits as they deem appropriate to individual dischargers, categories of dischargers, or dischargers in a geographic area. Upon issuance of such general permits by a Regional Water Board, the affected dischargers shall no longer be regulated by this general permit. The new general permits may address additional storm water pollution prevention plan requirements, more stringent effluent limitations, or additional monitoring and reporting program requirements.

2. Regional Water Boards may provide guidance to dischargers on Storm Water Pollution Prevention Plan and Monitoring Program implementation.

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CERTIFICATION

The undersigned, Administrative Assistant to the State Water Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 19, 1991 (as amended by Water Quality Order No. 92-12-DWQ).

AYE: W. Don Maughan
Edwin H. Finster
Eliseo M. Samaniego
John P. Caffrey

NO: None

ABSENT: None

ABSTAIN: None

/s/
Maureen Marché
Administrative Assistant to the Board

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Section A: STORM WATER POLLUTION PREVENTION PLAN

1. A storm water pollution prevention plan (SWPPP) shall be developed and implemented for each facility covered by this general permit. The SWPPP shall be designed to comply with BAT/BCT and be certified in accordance with the signatory requirements of Standard Provision C.9. For existing facilities (and new facilities beginning operations before October 1, 1992), a SWPPP shall be developed and implemented no later than October 1, 1992. For facilities beginning operations after October 1, 1992, a SWPPP shall be developed prior to submitting a NOI and implemented when the facility begins operations. The SWPPP shall be retained onsite and made available upon request of a representative of the Regional Water Board and/or local storm water management agency (local agency) which receives the storm water discharge.

2. The Regional Water Board and/or local agency may notify the discharger when the SWPPP does not meet one or more of the minimum requirements of this Section. Within 30 days of notice, the discharger shall submit a time schedule that meets the minimum requirements of this section to the Regional Water Board and/or local agency that requested the changes. After making the required changes, the discharger shall provide written certification that the changes have been made.

3. The discharger shall amend the SWPPP whenever there is a change in construction, operation, or maintenance which may effect the discharge of significant quantities of pollutants to surface water, ground waters, or the local agency's storm drain system. The SWPPP should also be amended if it is in violation of any conditions of this general permit, or has not achieved the general objectives of controlling pollutants in storm water discharges.

4. The SWPPP shall provide a description of potential sources which may be expected to add significant quantities of pollutants to storm water discharges, or which may result in non-storm water discharges from the facility. The SWPPP shall include, at a minimum, the following items:

   a. A map extending approximately one-quarter mile beyond the property boundaries of the facility, showing: the facility, general topography surface water bodies (including known springs and wells), and the discharge point where the facility's storm water discharges to a municipal storm drain system or other water body. The

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requirements of this paragraph may be included in the site map required under the following paragraph if appropriate.

b. A site map showing:

i. The storm water conveyance and discharge structures;

ii. An outline of the storm water drainage areas for each storm water discharge point;

iii. Paved areas and buildings;

iv. Areas of pollutant contact, actual or potential;

v. Location of existing storm water structural control measures (i.e., berms, coverings, etc.);

vi. Surface water locations;

vii. Areas of existing and potential soil erosion; and

viii. Vehicle service areas.

c. A narrative description of the following:

i. Significant materials that have been treated, stored, disposed, spilled, or leaked in significant quantities in storm water discharge after November 19, 1988;

ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharge;

iii. Material loading, unloading, and access areas;

iv. Existing structural and non-structural control measures (if any) to reduce pollutants in storm water discharge;

v. Industrial storm water discharge treatment facilities (if any);

vi. Methods of on-site storage and disposal of significant materials; and

vii. Outdoor storage, manufacturing, and processing activities including activities that generate significant quantities of dust or particulates.

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d. A list of pollutants that are likely to be present in storm water discharge in significant quantities, and an estimate of the annual quantities of these pollutants in storm water discharge.

e. An estimate of the size of the facility (in acres or square feet), and the percent of the facility that has impervious areas (i.e., pavement, buildings, etc.).

f. A list of significant spills or leaks of toxic or hazardous pollutants to storm water that have occurred after November 19, 1988. This shall include:

   i. Toxic chemicals (listed in 40 CFR Part 372) that have been discharged to storm water as reported on USEPA Form R.

   ii. Oil or hazardous substances in excess of reportable quantities (see 40 CFR Part 110, 117 or 302).

g. A summary of existing sampling data (if any) describing pollutants in storm water discharge.

5. The SWPPP shall describe the storm water management controls appropriate for the facility. The appropriate controls shall reflect identified potential sources of pollutants at the facility. The description of the storm water management controls shall include:

a. Storm Water Pollution Prevention Personnel. Identify specific individuals (and job titles) who are responsible for developing, implementing, and revising the SWPPP.

b. Preventive Maintenance. Preventive maintenance involves inspection and maintenance of storm water conveyance system devices (i.e., oil/water separators, catch basins, etc.) and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.

c. Good Housekeeping. Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

d. Spill Prevention and Response. Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, and clean-up equipment

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and procedures should be identified, as appropriate. Internal reporting procedures for spills of significant materials shall be established.

e. Storm Water Management Practices. Storm water management practices are practices other than those which control the source of pollutants. They include measures such as installing oil and grit separators, diverting storm water into retention basins, etc. Based on assessment of the potential of various sources to contribute pollutants to storm water discharges in significant quantities, additional storm water management practices to remove pollutants from storm water discharge shall be implemented.

f. Erosion and Sediment Controls. The SWPPP shall identify measures to reduce sediment in storm water discharges.

g. Employee Training. Employee training programs shall inform all personnel responsible for implementing the SWPPP. Training should address spill response, good housekeeping, and material management practices. Periodic dates for training should be identified.

h. Inspections. All inspections, visual observations and sampling as required by Section B, shall be done by trained personnel. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to these activities.

6. Non-storm water discharges to storm water conveyance systems shall be eliminated prior to implementation of this SWPPP. The SWPPP shall include a certification that non-storm water discharges have been eliminated and a description of any tests for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Such certification may not always be feasible if the discharger (a) must make significant structural changes to eliminate the discharge of non-storm water discharges to the industrial storm water conveyance system, or (b) has applied for, but not yet received, an NPDES general permit for the non-storm water discharges. In such cases, the discharger must notify the appropriate Regional Water Board prior to implementation of the SWPPP that non-storm water discharges cannot be eliminated. The notification shall include justification for a time extension and a schedule, subject to modification by the Regional Water Board, indicating when non-storm water discharges will be eliminated. In no case shall the elimination of non-storm water discharges exceed three years from the NOI submittal date.

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7. The SWPPP may incorporate, by reference, the appropriate elements of other program requirements (i.e., Spill Prevention Control and Countermeasures (SPCC) plans under Section 311 of the CWA, Best Management Programs under 40 CFR 125.100, etc.).

8. The SWPPP is considered a report that shall be available to the public under Section 308(b) of the CWA.

9. The SWPPP shall include the signature and title of the person responsible for preparation of the SWPPP and include the date of initial preparation and each amendment, thereto.

Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

[Note: This Section was modified by Order No. 92-12-DWQ adopted by the State Water Board on September 17, 1992.]

1. Implementation

A monitoring program shall be developed and implemented for each facility covered by this general permit. It shall be certified in accordance with the signatory requirements contained in Standard Provision C.9. A description of the monitoring program shall be retained on site and made available upon request of a representative of the Regional Water Board and/or local agency which receives the storm water discharge.

2. Schedule

For existing facilities (and new facilities beginning operations before January 1, 1993), a monitoring program must be developed and implemented no later than January 1, 1993. For facilities beginning operations after January 1, 1993, a monitoring program shall be developed and implemented concurrent with commencement of industrial activities.

3. Objectives

The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

a. Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in this general permit.

b. Ensure practices at the facility to control pollutants in storm water discharges are evaluated and revised to meet changing conditions.

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c. Aid in the implementation of the Storm Water Pollution Prevention Plan required by Section A of this general permit.

d. Measure the effectiveness of best management practices (BMPs) in removing pollutants in storm water discharge.

4. General Requirements for Monitoring Programs

The monitoring program shall contain:

a. Rationale for selection of monitoring methods.

b. Identification of the analytical methods to detect pollutants in storm water discharge.

c. Description of the sampling methods, sampling locations, and frequency of monitoring.

d. A quality assurance/quality control program to assure that:

i. All elements of the monitoring program are conducted; and

ii. All monitoring is conducted by trained personnel.

e. Procedures and schedules by which the effectiveness of the monitoring program in achieving the objectives above can be evaluated.

5. Specific Requirements for Monitoring Programs

The monitoring program shall document the elimination or reduction of specific pollutants, resulting from the implementation of the SWPPP required by Section A of this general permit.

a. Annual Site Inspection

Except for certain inactive mining operations (See Section B.8), all dischargers shall:

i. Conduct a minimum annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity and to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the general permit or whether additional control measures are needed. A record of the annual

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inspection must include the date of the inspection, the individual(s) who performed the inspection, and the observations.

ii. Certify, based on the annual site inspection, that the facility is in compliance with the requirements of this general permit and its SWPPP. The certification and inspection records must be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. Any noncompliance shall be reported in accordance with Section B.17.

b. Dry Season Observations

No less than twice during the dry season (May through September), all dischargers shall observe and/or test for the presence of non-storm water discharges at all storm water discharge locations. At minimum, all dischargers shall conduct visual observations of flows to determine the presence of stains, sludges, odors, and other abnormal conditions. Dye tests, TV line surveys, and/or analysis and validation of accurate piping schematics may be conducted if appropriate. Records shall be maintained of the description of the method used, date of testing, locations observed, and test results.

c. Wet Season Visual Observations

During the wet season (October through April), all dischargers shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharge[1] to observe the presence of floating and suspended materials, oil and grease, discolorations, turbidity, and odor, etc. Feedlots (subject to federal effluent limitations guidelines in 40 CFR Part 412) that are in compliance with Sections 2560 to 2565, Article 6, Chapter 15, Title 23, California Code of Regulations, shall, instead, conduct monthly inspections of their containment facilities to detect leaks and ensure maintenance of adequate freeboard.

[1] "Significant storm water discharge" is a continuous discharge of storm water for approximately one hour or more.

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d. Sampling and Analysis

During the wet season (October through April), dischargers (unless exempted per Section B.9 below) shall collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge. The samples should be analyzed for:

i. pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC). Oil and grease (O&G) may be substituted for TOC; and

ii. Toxic chemicals and other pollutants that are likely to be present in storm water discharge in significant quantities.

6. Toxic Pollutant Analysis Reduction

Samples shall be analyzed for toxic chemicals and other pollutants as identified in Sections B.5.d.ii for at least two consecutive sampling events. If toxic chemicals or other pollutants are not detected in significant quantities after two consecutive sampling events, the facility may eliminate that toxic chemical or pollutant from future sampling events. A discharger may analyze for alternative representative parameters (e.g., whole effluent toxicity) as a substitute for the toxic chemicals and other pollutants identified in Section B.5.d.ii as long as the discharger submits the alternative monitoring procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

7. Facilities Subject to Federal Storm Water Effluent Limitations Guidelines

Facilities subject to federal storm water effluent limitations guidelines are defined in Attachment 1 of the general permit. In addition to the requirements in Section B.5 above, these facilities must collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge.

a. Analyze for any pollutant specified in the appropriate category of 40 CFR Subchapter N;

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b. Estimate or calculate the volume of effluent discharged from each outfall;

c. Estimate or calculate the mass of each regulated pollutant as defined in the appropriate category of 40 CFR Subchapter N; and

d. Identify the individual(s) performing the estimates or calculations in accordance with Subsections b and c above.

8. Inactive Mining Operations

Inactive mining operations are defined in Attachment 1 of this general permit. Where annual facility inspections, wet season visual observations, dry season observations, and sampling as required by Section B.5 are impracticable, inactive mining operations may instead obtain certification once every three years by a Registered Professional Engineer that a SWPPP has been prepared for the facility and is being implemented in accordance with the requirements of this general permit. By means of these certifications, the engineer, having examined the facility and being familiar with the provisions of this general permit, shall attest to the SWPPP which has been prepared in accordance with good engineering practices. Dischargers which cannot obtain a certification because of noncompliance must notify the appropriate Regional Water Board and, upon request, the local agency which receives the storm water discharge in accordance with Section B.17.

9. Sampling and Analysis Exemptions

A discharger is not required to collect and analyze samples in accordance with Section B.5.d if the discharger certifies that the facility meets all of the conditions set forth below in Section B.9.a, if the discharger obtains the local agency certification described in Section B.9.b, or if the discharger obtains a Regional Water Board exemption as described in Section B.9.d. A discharger who is not required to comply with Section B.5.d monitoring requirements is still required to comply with all other monitoring program and reporting requirements. If exempted from Section B.5.d monitoring requirements, dischargers subject to federal storm water effluent guidelines in 40 CFR Subchapter N must still comply with the provisions of Section B.7 above.

a. Self-Certification

The certification must state that areas of industrial

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activity are not exposed to storm water, including manufacturing, processing, and material handling areas and areas where material handling equipment, raw materials, intermediate products, final products, waste materials, byproducts, and industrial machinery are stored. (See definition of "storm water associated with industrial activity" in Attachment 4 to this general permit.) Exposure includes both direct contact with storm water and the possible release of industrial pollutants into storm water (e.g., spills or leaks). In order to demonstrate that these areas are not exposed to storm water, the following minimum conditions must be met:

i. All illicit (unpermitted) connections to the storm drainage system are eliminated;

ii. All materials must be completely contained at all times;

iii. All unhoused equipment associated with industrial activity is not exposed to storm water; and

iv. All emissions from stacks or air exhaust systems and emission of dust or particulates do not contribute significant quantities of pollutants to storm water discharge.

b. Certification by Local Agency

A local agency which has jurisdiction over the storm sewer system or other water course which receives storm water discharge from the discharger's facility has certified in writing that the discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

c. Submittal of Sampling Exemption Certifications

Dischargers must submit sampling exemption certifications to the appropriate Regional Water Board by December 1, 1992 for the 1992-93 wet season and by August 1 for subsequent years. Unless otherwise instructed by the Regional Water Boards, dischargers who file a sampling exemption certification are exempt from Section B.5.d.

d. Exemptions by Regional Water Board

A Regional Water Board may grant an exemption to Section B.5.d monitoring requirements if it determines that a

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discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

10. Group Monitoring

Group monitoring may be done in accordance with the following requirements:

a. A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers (entity) regulated by this general permit or by a local agency which holds a NPDES general permit (local agency permittee) for a municipal separate storm sewer system. Participants in a group monitoring plan may discharge storm water within the boundaries of a single Regional Water Board or within the boundaries of multiple Regional Water Boards (with State Water Board approval).

b. At least 20 percent of the dischargers who are members of a group (and at least 4 dischargers in a group of less than 20 dischargers) must collect and analyze samples in accordance with Section B.5.d. The entity or local agency permittee may request that fewer member dischargers be allowed to collect and analyze, but reasons for this exception must be stated in the group monitoring plan (Section B.10.e.v.). The entity or the local agency permittee shall select facilities from which samples are collected and analyzed which best represent the overall quality of the group members' storm water discharges.

c. The entity or the local agency permittee must have the authority to levy fees against the participating dischargers in the group or be able to otherwise pay for the implementation of the group monitoring plan.

d. The entity or the local agency permittee is responsible for:

   i. Developing and implementing the group monitoring plan;

   ii. Evaluating and reporting group monitoring data;

   iii. Recommending appropriate BMPs to reduce pollutants in storm water discharges;

   iv. Submitting a group monitoring plan to the

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appropriate Regional Water Board(s) and State Water Board, no later than December 1, 1992 and August 1 in subsequent years; and

v. Revising the group monitoring plan as instructed by the Regional Water Board or the State Water Board Executive Director.

e. The group monitoring plan shall:

i. Identify the participants of the group by name and location;

ii. Include a narrative description summarizing the industrial activities of participants of the group and explain why the participants, as a whole, are sufficiently similar to be covered by a group monitoring plan;

iii. Include a list of significant materials stored or exposed to storm water and material management practices currently employed to diminish contact of these materials with storm water discharge;

iv. Identify and describe why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of processes used or materials managed. To the extent possible, representative facilities with the most extended scheduled facility operating hours should be selected;

v. If an exception to the requirement that at least 20 percent of the dischargers in a group (and at least 4 dischargers in a group of less than 20 dischargers) is requested, explain why such an exception is necessary, and how the proposed monitoring will be representative of the entire group; and

vi. Contain all items specified in Section B.4 above.

f. Sampling and analysis must comply with the applicable requirements, including Sections B.5.d, B.6, B.7, and B.11 through 17.

h. Unless otherwise instructed by the Regional Water Board or the State Water Board Executive Director, the group monitoring plan shall be implemented by January 1, 1993 and, in subsequent years, at the beginning of the wet season.

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i. Upon approval of the State Water Board Executive Director, a group may perform representative monitoring which includes dischargers within the boundaries of more than one Regional Water Board area.

j. Upon approval by the appropriate Regional Water Board, a group within a single Regional Water Board area may perform representative monitoring.

k. All dischargers participating in an approved group monitoring plan that have not been selected to perform sampling are required to comply with all other monitoring program and reporting requirements in Sections B.5.a, b, and c.

l. If any group includes members which are subject to federal storm water effluent limitations guidelines, each of those members must perform the monitoring described in Section B.7, and submit the results of the monitoring to the appropriate Regional Water Board in the discharger's annual monitoring report.

11. Sample Locations

Samples shall be collected from all locations where storm water is discharged. Samples must represent the quality and quantity of storm water discharged from the facility. If a facility discharges storm water at multiple locations, the discharger may sample a reduced number of locations if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

12. Sampling Procedure

Sampling shall consist of a grab sample from a storm event that produces significant storm water discharge that is preceded by at least three (3) working days of dry weather. The grab sample should be taken during the first thirty minutes of the discharge. If collection of the grab sample during the first 30 minutes is impracticable, the grab sample can be taken as soon as practicable thereafter, and the discharger shall explain in the annual monitoring report why the grab sample could not be taken in the first 30 minutes. A discharger may select alternative monitoring procedures (e.g., composite sampling) as long as the discharger has submitted the proposed procedures and justification to the appropriate Regional Water Board prior to use. Unless otherwise instructed by the Regional Water Board, dischargers may use the alternative monitoring procedures submitted.

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13. Visual Observation and Sample Collection Exceptions

a. When a discharger is unable to collect any of the required samples or perform visual observations due to adverse climatic conditions (drought, extended freeze, dangerous weather conditions, etc.), a description of why the sampling or visual observations could not be conducted, including documentation of all significant storm water discharge events, must be submitted along with the annual monitoring report.

b. Dischargers are required to collect samples and perform visual observations only if significant storm water discharges commence during scheduled facility operating hours[2], or within two hours following scheduled facility operating hours. Dischargers are required to perform visual observations only within daylight hours. If dischargers do not collect samples or perform visual observations during a significant storm water discharge due to these exceptions, the discharger shall include documentation in the annual monitoring report.

14. Standard Methods

All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this general permit or by the Regional Water Board. All metals shall be reported as total metals. All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Dischargers may conduct their own laboratory analyses only if the discharger has sufficient capability (qualified employees, laboratory equipment, etc.) to adequately perform the test procedures.

[2] "Scheduled facility operating hours" are the time periods when the facility is staffed to conduct any function related to industrial activity, including routine maintenance, but excluding time periods where only emergency response, security, and/or janitorial services are performed.

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15. Records

Records of all storm water monitoring information and copies of all reports required by this general permit shall be retained for a period of at least five years from the date of the sample, observation, measurement, or report.

These records shall include:

a. The date, place, and time of site inspections, sampling, visual observations, and/or measurements;

b. The individual(s) who performed the site inspections, sampling, visual observations, and/or measurements;

c. Flow measurements or estimates (if required);

d. The date and time of analyses;

e. The individual(s) who performed the analyses;

f. The analytical techniques or methods used and the results of such analyses;

g. Quality assurance/quality control results;

h. Dry season observations and wet season visual observation records (see Sections B.5.b & c);

i. Visual observation and sample collection exception records (see Section B.13);

j. All calibration and maintenance records of on-site instruments used; and

k. All original strip chart recordings for continuous monitoring instrumentation.

16. Annual Report

All dischargers shall submit an annual report by July 1 of each year to the Executive Officer of the Regional Water Board responsible for the area in which the facility is located and to the local agency (if requested).

The report shall include a summary of visual observations and sampling results, the certification required in Section B.5.a.ii, and information as required in Section B.13. The

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report shall be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this general permit. The first report will be due July 1, 1993.

17. Noncompliance Reporting

Dischargers who cannot certify compliance in accordance with Section B.16 above and/or who have had other instances of noncompliance must notify the appropriate Regional Water Board and/or, upon request, the local agency that receives the storm water drainage. The notifications shall identify the type(s) of noncompliance, describe the actions necessary to achieve compliance, and include a time schedule, subject to the modifications by the Regional Water Board, indicating when compliance will be achieved. Noncompliance notifications must be submitted within 30 days of identification of noncompliance.

Section C: STANDARD PROVISIONS

1. Duty to Comply

The discharger must comply with all of the conditions of this general permit. Any general permit noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action; for general permit termination, revocation and reissuance, or modification; or denial of a general permit renewal application.

The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this general permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

This general permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a general permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any general permit condition.

If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more

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stringent than any limitation on the pollutant in this general permit, this general permit shall be modified, or revoked and reissued to conform to the toxic effluent standard or prohibition, and the discharger so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the general permitted activity in order to maintain compliance with the conditions of this general permit.

4. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this general permit which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this general permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems, installed by a discharger when necessary to achieve compliance with the conditions of this general permit.

6. Property Rights

This general permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

7. Duty to Provide Information

The discharger shall furnish the Regional Water Board, State Water Board, USEPA, or local storm water management agency within a reasonable time specified by the agencies, any requested information to determine compliance with this general permit. The discharger shall also furnish, upon request, copies of records required to be kept by this general permit.

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8. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, USEPA, and local storm water management agency upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this general permit;

b. Have access to and copy at reasonable times, any records that must be kept under the conditions of this general permit;

c. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment) that are related to or may impact storm water discharge; and

d. Sample or monitor at reasonable times for the purpose of ensuring general permit compliance.

9. Signatory Requirements

a. All Notices of Intent submitted to the State Water Board shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of the facility if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. The principal executive officer of a Federal agency includes the chief executive officer of the agency, or the senior executive officer having responsibility for the overall operations of a

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principal geographic unit of the agency (e.g. Regional Administrators of USEPA).

b. All reports, certification, or other information required by the general permit or requested by the Regional Water Board, State Water Board, USEPA, or local storm water management agency shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above and retained as part of the Storm Water Pollution Prevention Plan.

(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

(3) If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization must be attached to the Storm Water Pollution Prevention Plan prior to submittal of any reports, certifications, or information signed by the authorized representative.

10. Certification

Any person signing documents under Provision 9 shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information,

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including the possibility of fine and imprisonment for knowing violations."

11. Reporting Requirements

a. Planned changes: The discharger shall give notice to the Regional Water Board and local storm water management agency as soon as possible of any planned physical alteration or additions to the general permitted facility. Notice is required under this provision only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged.

b. Anticipated noncompliance: The discharger will give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the permitted facility or activity which may result in noncompliance with general permit requirements.

c. Compliance schedules: Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this general permit shall be submitted no later than 14 days following each schedule date.

d. Noncompliance reporting: The discharger shall report any noncompliance at the time monitoring reports are submitted. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

12. Oil and Hazardous Substance Liability

Nothing in this general permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject under Section 311 of the CWA.

13. Severability

The provisions of this general permit are severable, and if any provision of this general permit, or the application of any provision of this general permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this general permit

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shall not be affected thereby.

14. Reopener Clause [modified by Order No. 92-12-DWQ, September 1992]

This general permit may be modified, revoked, and reissued, or terminated for cause due to promulgation of amended regulations, receipt of USEPA guidance concerning regulated activities, judicial decision, or in accordance with 40 CFR 122.62, 122.63, 122.64, and 124.5.

15. Penalties for Violations of General Permit Conditions.

a. Section 309 of the CWA provides significant penalties for any person who violates a general permit condition implementing Sections 301, 302, 306, 307 308, 318, or 405 of the CWA, or any general permit condition or limitation implementing any such section in a general permit issued under Section 402. Any person who violates any general permit condition of this general permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, in some cases greater than those under the CWA.

16. Availability

A copy of this general permit shall be maintained at the discharge facility and be available at all times to operating personnel.

17. Transfers

This general permit is not transferable to any person. A new owner or operator of an existing facility must submit a NOI in accordance with the requirements of this general permit to be authorized to discharge under this general permit.

18. Continuation of Expired General Permit

This general permit continues in force and effect until a new general permit is issued or the State Water Board rescinds the general permit. Only those dischargers authorized to discharge under the expiring general permit are covered by the continued general permit.

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19. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this general permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or by both.

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ATTACHMENT 1

FACILITIES COVERED BY THIS GENERAL PERMIT

Industrial facilities include Federal, State, municipally owned, and private facilities from the following categories:

1. FACILITIES SUBJECT TO STORM WATER EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS, OR TOXIC POLLUTANT EFFLUENT STANDARDS (40 CFR SUBCHAPTER N). Currently, categories of facilities subject to storm water effluent limitations guidelines are Cement Manufacturing (40 CFR Part 411), Feedlots (40 CFR Part 412), Fertilizer Manufacturing (40 CFR Part 418), Petroleum Refining (40 CFR Part 419), Phosphate Manufacturing (40 CFR Part 422), Steam Electric (40 CFR Part 423), Coal Mining (40 CFR Part 434), Mineral Mining and Processing (40 CFR Part 436), Ore Mining and Dressing (40 CFR Part 440), and Asphalt Emulsion (40 CFR Part 443).

2. MANUFACTURING FACILITIES: Standard Industrial Classifications (SICs) 24 (except 2411 and 2434), 26 (except 265 and 267), 28 (except 283 and 285) 29, 311, 32 (except 323), 33, 3441, and 373.

3. OIL AND GAS/MINING FACILITIES: SICs 10 through 14 including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l) because of performance bond issued to the facility by the appropriate Surface Mining Control and Reclamation Act (SMCRA) authority has been released, or except for area of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge stormwater contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products, or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined material, or sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim.

4. HAZARDOUS WASTE TREATMENT, STORAGE, OR DISPOSAL FACILITIES: Includes those operating under interim status or a general permit under Subtitle C of the federal Resource Conservation and Recovery Act (RCRA).

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5. LANDFILLS, LAND APPLICATION SITES, AND OPEN DUMPS: Sites that receive or have received industrial waste from any of the facilities covered by this general permit, sites subject to regulation under Subtitle D of RCRA, and sites that have accepted wastes from construction activities (construction activities include any clearing, grading, or excavation that results in disturbance of five acres or more).

6. RECYCLING FACILITIES: SICs 5015 and 5093. These codes include metal scrapyards, battery reclaimers, salvage yards, motor vehicle dismantlers and wreckers, and recycling facilities that are engaged in assembling, breaking up, sorting, and wholesale distribution of scrap and waste material such as bottles, wastepaper, textile wastes, oil waste, etc.

7. STEAM ELECTRIC POWER GENERATING FACILITIES: Includes any facility that generates steam for electric power through the combustion of coal, oil, wood, etc.

8. TRANSPORTATION FACILITIES: SICs 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication) or other operations identified herein that are associated with industrial activity.

9. SEWAGE OR WASTEWATER TREATMENT WORKS: Facilities used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day or more, or required to have an approved pretreatment program under 40 CFR Part 403. Not included are farm lands, domestic gardens, or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with Section 405 of the CWA.

11. MANUFACTURING FACILITIES WHERE MATERIALS ARE <u>EXPOSED</u> TO STORM WATER: SICs 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, and 4221-4225.

Note: Category 10, Construction activity, is covered by a separate general permit.

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Storm Water Contacts for the State and Regional Boards

STATE WATER RESOURCES CONTROL BOARD
Division of Water Quality Regional Water
Attention: Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977
(916) 657-0919 FAX: (916) 657-2388
Contact: Bruce Fujimoto

1) NORTH COAST REGION
Mr. Benjamin D. Kor, Executive Officer
5550 Skyline Boulevard, Suite A
Santa Rosa, CA 94503
(707) 576-2220 FAX: (707) 523-0135
Contact: Nathan Quarles

2) SAN FRANCISCO BAY REGION
Mr. Steven R. Ritchie, Executive Officer
2101 Webster Street, Suite 500
Oakland, CA 94612
(510) 286-1255 FAX: (510) 286-1380
Contact: Tom Mumley

3) CENTRAL COAST REGION
Mr. Roger W. Briggs, Executive Officer
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5427
(805) 549-3147 FAX: (805) 543-0397
Contact: Adam White

4) LOS ANGELES REGION
Mr. Robert P. Ghirelli, Executive Officer
101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213) 266-7596 FAX: (213) 266-7600
Contact: Mark Pumford

5R) CENTRAL VALLEY REGION
Redding Branch Office
Mr. James C. Pedri, Supervising Engineer
415 Knollcrest Drive, Redding, CA 96002
(916) 224-4849 FAX: (916) 224-4857
Contact: Carole Crowe

5S) CENTRAL VALLEY REGION
Sacramento Office
Mr. William H. Crooks, Executive Officer
3443 Routier Road
Sacramento, CA 95827-3098
(916) 255-3000 FAX: (916) 255-3015
Contact: Pamela Barksdale

5F) CENTRAL VALLEY REGION
Fresno Branch Office
Mr. Loren J. Harlow, Principal Engineer
3614 East Ashlan Avenue
Fresno, CA 93726
(209) 445-5116 FAX: (209) 445-5910
Contact: Darrel Evensen

6SLT) LAHONTAN REGION
South Lake Tahoe Office
Mr. Harold J. Singer, Executive Officer
2092 Lake Tahoe Boulevard, Suite 2
South Lake Tahoe, CA 96150
(916) 542-5400 FAX: (916) 544-2271
Contact: John Short

6V) LAHONTAN REGION
Victorville Office
Mr. Hisam Bagai, Supervising Engineer
15428 Civic Drive, Suite 100
Victorville, CA 92392
(619) 241-6583 FAX: (619) 241-7308
Contact: Tom Rheiner

7) COLORADO RIVER BASIN REGION
Mr. Philip Gruenberg, Executive Officer
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
(619) 346-7491 FAX: (619) 341-6820
Contact: Orlando Gonzalez

8) SANTA ANA REGION
Mr. Gerard J. Thibeault, Executive Officer
2010 Iowa Avenue, Suite 100
Riverside, CA 92507-2409
(909) 782-4130 FAX: (909) 781-6288
Contact: Pervieve Vitale

9) SAN DIEGO REGION
Mr. Arthur L. Coe, Executive Officer
9771 Clairemont Mesa Boulevard, Suite B
San Diego, CA 92124
(619) 467-2952 FAX: (619) 571-6972
Contact: Deborah Jayne

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ATTACHMENT 3

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

NOTICE OF INTENT (NOI) TO COMPLY WITH THE TERMS OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES EXCLUDING CONSTRUCTION ACTIVITIES

GENERAL INSTRUCTIONS

Updated October 15, 1992

Who Must Submit

Facilities which have been defined by the USEPA regulations as having "storm water discharges associated with industrial activity" must obtain coverage under an NPDES permit for their storm water discharges. Facilities requiring coverage are defined in 40 CFR Section 122.26(b)(14). All facilities in California except those listed below, may seek coverage under the State Water Board's NPDES general permit.

Facilities Not Covered By This General Permit

Storm water discharges from the following facilities may not obtain coverage by this general permit:

a. Facilities in Santa Clara County which drain to San Francisco Bay must seek coverage under a separate general permit issued by the San Francisco Bay Regional Water Board.

b. Facilities with an existing NPDES permit that specifically limits and regulates storm water discharges.

c. Construction activities greater than five acres must obtain coverage under the NPDES construction activity storm water general permit.

d. Facilities on Indian lands will be regulated by the USEPA.

e. Logging Activities.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
P.O. Box 1977
Sacramento, CA 95812-1977
Attn: Storm Water Permitting Unit

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When to Apply

Owners/operators of existing facilities must file a NOI, along with the appropriate annual fee, prior to March 30, 1992. Owners/operators of new facilities (those beginning operations after March 30, 1992) must file a NOI at least 30 days prior to the beginning of operations. Facilities that miss the appropriate deadlines for filing their NOIs may file their NOIs late but will be in violation for the period they were late.

Fees

The annual fee is $250.00 for each facility which discharges into a municipal separate storm sewer system regulated by an areawide urban storm water general permit and $500.00 for all other facilities.

Facilities that have either a NPDES permit or waste discharge requirements (WDRs) and already pay an annual fee are not subject to an additional fee for the storm water general permit. Feedlots subject to this general permit will pay a one-time only fee of $2,000. Feedlots that already have a NPDES general permit or WDRs and have paid the $2,000 fee do not have to pay an additional fee for the storm water general permit.

Completing the NOI

Completion and submittal of the attached NOI (Form NOI-1) is required to gain coverage under the general permit. It must be completely and accurately filled out. A facility will be considered to be covered by the general permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. Each discharger will be given a distinct identification number. Upon receipt of the NOI and fee, each discharger will be sent a letter containing the discharger's identification number.

Questions?

If you have any questions completing the NOI after reading the following line-by-line instructions, please call the appropriate Regional Water Board or the State Water Board at (916) 657-0919.

NOI--LINE-BY LINE INSTRUCTIONS

The NOI consists of two parts--a NOI Form (Form NOI-1) and a site map. Please type or letter when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for an existing facility, box 2 if the facility is new (has not started operations), and box 3

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if the NOI is being submitted to report changes to a facility already covered by the general permit. An example of a change that warrants a resubmittal of the NOI would be a change of owner/operator of a facility. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID number must be included.

SECTION I--OWNER/OPERATOR

Enter the name of the person, company, firm, public organization, or any other entity which owns the facility (or operates the facility when the owner does not operate the facility) and check the box corresponding to the appropriate ownership status of the facility. The owner/operator information may or may not be the same as the facility information requested in Section II.

SECTION II--FACILITY/SITE INFORMATION

Enter the facility's official or legal name and provide the address, county, and contact person information for the facility. Facilities that do not have a street address must attach to the NOI a legal description of the facility site. The contact person should be the plant or site manager completely familiar with the facility and charged with compliance and oversight of the general permit.

SECTION III--BILLING ADDRESS

To continue coverage under the general permit, the annual fee must be paid. Use this section to indicate whether the annual fee invoices should be sent to the owner/operator, facility, or other party (include address).

SECTION IV--RECEIVING WATER INFORMATION

In Part A of this section, the owner/operator is required to indicate whether the facility's storm water runoff discharges to a separate storm sewer system, directly to waters of the United States, or indirectly to waters of the United States.

Discharges to separate storm sewer systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the United States will typically have an outfall structure directly from the facility to a river, creek, lake, ocean, etc. Indirect discharges are those that may flow over adjacent properties or right-of-ways prior to discharging to waters of the United States.

Regardless of point of discharge, the applicant must determine the closest receiving water for its storm water discharge. If

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discharge is to a separate storm sewer system, the owner of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V--INDUSTRIAL INFORMATION

Part A of this section requests the owner/operator to provide the standard industrial classification (SIC) codes(s) which best describes the industrial activity taking place at your facility. Briefly describe the nature of business in Part B. In Part C, check the general industrial activities that take place at the facility.

SECTION VI--MATERIAL HANDLING/MANAGEMENT PRACTICES

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If other types of materials other than those listed are maintained on site, please check "other" and describe the type of material.

Part B of this section requests information on any existing management practices employed at the facility. Check the appropriate categories or list other control measures you use at your facility. If none are used, leave this part blank.

SECTION VII--FACILITY INFORMATION

List the size, in acres or square feet, of the facility and the percentage of the site that is impervious.

SECTION VIII--REGULATORY STATUS

Check the appropriate box(es) and indicate the identification number of any permits currently in effect at the facility.

SECTION IX--CERTIFICATION

This section should be read by the owner/operator. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner/operator to certify that the provisions in the general permit will be complied with.

The NOI must be signed by:

For a Corporation: a responsible corporate officer (or authorized individual).

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For a Partnership or Sole Proprietorship: a general partner or the proprietor, respectively.

For a Municipality, State, or other non-federal Public Agency: either a principal executive officer or ranking elected official.

For a Federal Agency: either the chief or senior executive officer of the agency.

SITE MAP

Provide a "to scale" drawing of the site and its immediate surroundings. Include as much detail about the site as possible. At a minimum, show buildings, material handling areas, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets. The attached form may be used, if convenient. Thomas Guide maps, local street maps, or USGS quadrangle maps may be used to indicate the location of the facility if appropriate (e.g., very large facilities). The source of map and map number, or other identifiers should be shown in the lower left hand corner of the site map.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY (WQ ORDER Nos. (91-13 DWQ & 92-12-DWQ)
(Excluding Construction Activities)

MARK ONLY ONE ITEM	1. [ ] Existing Facility 2. [ ] New Facility	3. [ ] Change of Information WDID #

I. OWNER / OPERATOR

Name			A. Owner/Operator Type (Check one) 1. [ ] City 2. [ ] County 3. [ ] State 4. [ ] Federal 5. [ ] Special District 6. [ ] Gov. Combo 7. [ ] Private
Mailing Address			
City	State	Zip	Phone
Contact Person			B. 1. [ ] Owner 2. [ ] Operator 3. [ ] Owner/Operator

II. FACILITY / SITE INFORMATION

Facility Name			County
Street Address			Contact Person
City	State CIA	Zip	Phone

III. BILLING ADDRESS

Send to: [ ] OWNER / OPERATOR [ ] FACILITY [ ] OTHER (Enter information at right)	Name		
	Mailing Address		
	City	State	Zip

IV. RECEIVING WATER INFORMATION

A. Does your sites's storm water discharge to (Check one):

1. [ ] Storm drain system - Enter owners name
2. [ ] Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. [ ] Indirectly to waters of U.S.

B. Name of closest receiving water

STATE USE ONLY

WDID:	Regional Board Office		Date Permit Issued:
NPDES Permit Number: CA	Order Number:	Fee Amount Received: $	Date NOI Received:

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V. INDUSTRIAL INFORMATION

A. SIC Code(s) 1. ____ 2. ____ 3. ____ 4. ____

B. Type of Business

C. Industrial activities at facility (Check all that apply)

1. [ ] Manufacturing
2. [ ] Vehicle Maintenance
3. [ ] Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4. [ ] Material Storage
5. [ ] Vehicle Storage
6. [ ] Material Handling
7. [ ] Wastewater Treatment
8. [ ] Power Generation
9. [ ] Recycling
10. [ ] Landfill
99. [ ] Other: _____

VI. MATERIAL HANDLING / MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors (Check all that apply)

1. [ ] Solvents
2. [ ] Scrip Metal
3. [ ] Petroleum Products
4. [ ] Plating Products
5. [ ] Pesticides
6. [ ] Hazardous Wastes
7. [ ] Paints
8. [ ] Wood Treating Products
99. [ ] Other (Please list)

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges (Check all that apply)

1. [ ] Oil/Water Separator
2. [ ] Containment
3. [ ] Berms
4. [ ] Leachate Collection
5. [ ] Overhead Coverage
6. [ ] Recycling
7. [ ] Retention Facilities
8. [ ] Chemical Treatment
99. [ ] Other (Please list)

VII. FACILITY INFORMATION

A. Total size of site (Check one) [ ] Acres [ ] Sq. Ft.

B. Percent of site impervious (including rooftops) ____ %

VIII. REGULATORY STATUS (Check all that apply)

A. [ ] Regulated by Storm Water Effluent Guidelines (40 CFR Subchapter N)

B. [ ] Waste Discharge Requirements (Order Number) ____

C. [ ] NPDES Permit CA ____

D. [ ] RCRA Permit Number ____

E. [ ] Regulated by California Code of Regulations Article 6, Chapter 15 (Feedlots).

IX. CERTIFICATIONS

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date _____

Title: _____

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ATTACHMENT 4

DEFINITIONS

1. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

2. Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500 as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; 33 USC. 1251 et seq.

3. "Facility" is a collection of industrial processes discharging storm water associated with industrial activity within the property boundary of operational unit.

4. "Non-Storm Water Discharge" means any discharge to storm sewer systems that is not composed entirely of storm water except discharges pursuant to a NPDES permit and discharges resulting from fire fighting activities. (See fact sheet, page 8, for clarification on non-storm water dischargers unrelated to industrial activity).

5. "Significant Materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERLCA); any chemical the facility is required to report pursuant to Section 313 of Title III of Superfund Amendments and Reauthorization Act (SARA); fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

6. "Significant Quantities" is the volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and cause or contribute to a violation of any applicable water quality standards for the receiving water.

7. "Storm water" means storm water runoff, snow melt runoff, and surface runoff and drainage. It excludes infiltration and runoff from agricultural land.

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8. "Storm Water Associated with Industrial Activity" means "the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program. The term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR Part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The term also includes storm water discharges from all areas listed in the previous sentence (except access roads) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery <u>are exposed to storm water</u>. Material handling activities include the: storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product, or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are federally, state, or municipally owned or operated that meet the description of the facilities listed in this paragraph) include those facilities designated under 40 CFR 122.26(a)(1)(v).

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

STORM WATER PROGRAM - FACT SHEET

INDUSTRIAL STORM WATER GENERAL PERMIT

August 1994

THE GENERAL PERMIT - IN GENERAL

The State has adopted two General Permits for Industrial Storm Water Discharges (General Permit), one for most industrial storm water discharges in the State and one for industrial storm water discharges in the Santa Clara Valley. To obtain coverage under either of these permits, a discharger need only to submit the appropriate Notice of Intent (NOI) and the required fee. By submitting the NOI, the discharger is notifying the State that its facility is to be covered under the General Permit; that the discharger has read the permit, and *intends* to comply with its requirements.

WHAT IS COMPLIANCE?

Many industries believe that by filing the NOI they have complied with General Permit requirements, and fail to do anything else. The General Permit contains many requirements that must be met. Two key requirements are the development and implementation of the Storm Water Pollution Prevention Plan and the Monitoring and Reporting Program. These two elements are discussed in further detail below.

STORM WATER POLLUTION PREVENTION PLAN

The minimum requirements for the development of a Storm Water Pollution Prevention Plan (SWPPP) are contained in Section A of the General Permit. *The goal of the plan is just as its title is intended to mean - Pollution Prevention.* The purpose of the plan is to help you plan and organize your storm water pollution prevention efforts. Basically it should allow you to stop pollutants from entering storm water at their source. We believe this will be less costly and more effective than attempting to treat the storm water after it is polluted.

Briefly, the SWPPP must: 1) identify all industrial activities and sources of pollutants that have the potential to come in contact with storm water; 2) identify control measures that will eliminate or reduce the exposure; and, 3) discuss how the SWPPP effectiveness will be monitored.

Section A of the General Permit lists the required contents of the SWPPP. You should use this Section as checklist to develop your initial plan.

Your industry may also have other types of plans that could easily be incorporated into the SWPPP. For example, Spill Prevention Plans may already include many of the items required by the General Permit.

BEST MANAGEMENT PRACTICES

You are expected to prevent pollution of storm water and control sources of pollutants at your facility through the use of appropriate control measures or Best Management Practices, which are commonly referred to as BMPs. BMPs can be either structural or nonstructural control measures. An example of a structural BMP may be an oil/water separator. An example of a non-structural BMP may be implementing more stringent housekeeping procedures.

A key factor in the selection and implementation of the BMPs is that they are effective, both in pollutant removal and cost. Help documents are now available to industries to aid in the preparation of a SWPPP and selection of BMPs. The California Storm Water - Industrial/Commercial - Best Management Practice Handbook may be obtained for a nominal charge from:

Blue Print Service
1700 Jefferson Street
Oakland, CA 94612
(510) 444-6771 FAX: (510) 444-1282

The BMPs found in the guidance manuals are only suggested BMPs. You may develop alternative BMPs, not identified in these manuals, that are appropriate for your facility.

NON-STORM WATER DISCHARGES

The General Permit authorizes you to discharge storm water *only*. (The Santa Clara Valley General Permit allows certain permissable discharges other than storm water.) The General Permit requires that you evaluate your facility to ensure that only storm water or other permitted flows are being discharged from your facility. All other types of flows are considered non-storm water discharges and must be eliminated or permitted. You are required to certify prior to implementation of your storm water program that all non-storm water discharges have been eliminated. If they have not been, then you must notify the Regional Board that such discharges exist and provide them with a time schedule indicating when the discharge will be eliminated, or otherwise apply for a discharge permit. Examples of non-storm water discharges are: vehicle wash waters, cooling water, etc.

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MONITORING PROGRAM AND REPORTING REQUIREMENTS.

The minimum requirements for the Monitoring Program and Reporting Requirements are specified in Section B of the General Permit. The Monitoring Program is to be developed in a way that the effectiveness of the SWPPP can be evaluated. Examples of the types of questions that should be answered as a result of your monitoring program are: Did the SWPPP work? Where did it fail? Are there more discharge points than originally identified? Are there non-storm water discharges that have not been eliminated or identified? Did the BMPs work effectively; if not, why? What types of pollutants are present in our storm water runoff, and what are their potential sources?

The Monitoring Plan should include required procedures trained personnel should follow regarding sample collection, visual wet and dry weather and annual site inspections. Implementation of these elements of the plan should result in an industry being able to evaluate the effectiveness of its SWPPP. If it does not, then the plan should be amended or revised as appropriate. Section B of the General Permit may be used as a checklist to help you in developing your plan.

Annual Reports are to be submitted to the Regional Board by July 1st of each year. The annual report should provide a summary of all analytical results and inspections conducted at the site. It should also provide an indication of the effectiveness of the SWPPP and the compliance status of the facility.

A standard annual reporting format has been developed and may be obtained from the Regional Board office.

COMPLIANCE AND ENFORCEMENT - WHAT MIGHT YOU EXPECT?

The State and Regional Boards are developing a compliance and enforcement strategy. The consensus is that the strategy should be developed based on a cooperative approach to implementing the program. The strategy will include education, technical assistance, monitoring and inspections, and enforcement elements.

State and Regional Board staffs will focus most of their time in the early stages of this program identifying *non-participants, and getting them more actively involved in the program.* Non-participants will include industries that have not submitted NOIs, and those that have filed NOIs, but have done nothing else to comply with permit requirements; i.e., they have not developed or implemented a SWPPP.

Non-participants who avoid obtaining a permit or have simply taken the stand that they do not want to comply with any Federal or State regulations, may be subject to enforcement action. These industries must be aware of the consequences of such actions. Since this is a Federally mandated program, the cost of not complying can be substantial. For example, the Clean Water Act provides the State or Regional Boards the ability to administratively assess civil liability (ACL) in an amount up to $10,000 per day for every day an industry is found to be out of compliance. This would apply to every d they have not filed an NOI, or have not developed a implemented any requirement of the General Permit. In addition, if a discharge (storm water runoff) should occur during this time of non-compliance, then an additional fine of up to $10 per gallon of discharge over 1000 gallons may be imposed. The fines may be greater if the civil liability is imposed by the superior court. In addition to monetary fines, criminal penalties could also be imposed.

For the industries that are participating, Board staff emphasis will be towards developing educational and technical assistance programs to assist industries in the implementation and enhancement to their programs. If an industry is found to be making a good faith effort and is taking appropriate action to comply with General Permit requirements, Regional Board staff will work in a cooperative effort with the industry. The emphasis will be to try and avoid such enforcement actions as outlined above.

We encourage you to work with Regional Board staff during all phases of your storm water program.

NOTICE OF INTENT CHANGE OF INFORMATION

During the term of coverage under the General Permit, there may be times when the information provided in an NOI needs to be revised; such as:

- Change in the type or scope of industrial activity or activities being conducted at the site;
- Change in ownership;
- Change in address of the owner, billing location, etc.;
- Change in phone number for the owner, facility, etc.;
- Change in owner or facility contact name; or
- Change in signature authorities.

To change NOI information, complete a new NOI with the correct information, check the box Change of Information and provide your WDID number at the top of the NOI form. The revised NOI must be submitted to the SWRCB.

ADDITIONAL INFORMATION

If you have questions concerning the General Permit or the Regional Board's Storm Water Program, or if you would like to obtain a copy of the General Permit or other forms, please contact :

Erlindo Dela Cruz
(510) 286-0968

Storm Water Permit Section
San Francisco Bay Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland, CA 94612

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

STORM WATER PROGRAM - FACT SHEET

INDUSTRIAL STORM WATER MONITORING

August 1994

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MONITORING REQUIREMENTS

Section B of the General Permit establishes requirements for individual site monitoring and for industries that are participating in a group monitoring plan. Many of the requirements are the same for every industry, regardless if they are members of a group plan or not. The following summarizes these requirements. More detailed information regarding monitoring requirements can be found in Table 1.

Monitoring Requirements for all Industries - Individual Sites and all Participants of a Group Monitoring Plan

1. Annual Site Inspection - Conduct an annual site inspection to certify compliance.
2. Dry Weather Observations - Conduct two inspections during the dry season (May through September).
3. Wet Weather Visual Observations - Conduct visual inspections during the wet season (Oct. through April) for one storm event per month.
4. Annual Reports - All industries must submit an annual report by July 1 of each year to the Regional Board.
5. Record Keeping - Records are to be kept for a period of at least five years.
6. Signature Requirements - All reports, Certifications, or other information required by the General Permit or regulatory agency must be signed by a person described in Provision C.9 of the General Permit and accompanied by the appropriate certification that is provided in Provision C.10 of the General Permit.

Sampling Requirements for Individual Sites and Designated Participants of a Group Plan

1. Collect and analyze samples during two storm events.
2. All samples shall be analyzed for pH, total suspended solids (TSS), specific conductance, and either total organic carbon (TOC) or oil and grease (O&G), and toxic chemicals and other pollutants.
3. Samples are to be collected from all locations where storm water is discharged.

WHY DO MONITORING AND WHAT TO DO WITH YOUR RESULTS

The General Permit requires that each facility develop and implement a Storm Water Pollution Prevention Plan (Plan). Once your Plan is implemented you are to check to see if your Plan is effective in reducing or eliminating pollutants from leaving your site in storm water runoff. This is done through your monitoring activities. Typical questions your monitoring program should answer are: Did the Plan work? Where did it fail? Are there more discharge points than originally identified? Are there non-storm water discharges that have not been identified or eliminated? Did the Best Management Practices (BMPs) work? If not, why? What types of pollutants are present in your runoff, what are the potential sources of these pollutants, and what BMPs need to be revised or implemented to eliminate the source of pollutants?

All monitoring activity should be recorded on forms or logs, and evaluated by the appropriate personnel to determine if your Plan is effective. *If the Plan is ineffective, then revisions must be made.*

So what do you do with the monitoring results? To help explain this we have developed two different scenarios involving visual monitoring activities at a hypothetical trucking facility. Each scenario will describe the monitoring activity being conducted, and the corrective action taken as a result of the monitoring observations.

The Site: The site is approximately five acres, and has three points of storm water discharge. It has an administrative office, employee building, a truck maintenance shed, and a storage shed. Most of the area is paved with the exception of the truck parking area. Storm water runoff from the maintenance area is discharged through two of the three points of discharge. The third point consists only of runoff from the administrative building. Maintenance activities include routine and major maintenance, and fueling and washing of the trucks and trailers.

The Site's Monitoring Program: An employee named Pete has been authorized and trained to conduct dry and wet weather visual monitoring, and collect storm water samples. The monitoring activities will be conducted at the two points of discharge associated with industrial activities.

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TABLE 1

MONITORING REQUIREMENTS FOR ALL INDUSTRIES - INDIVIDUAL SITES AND ALL PARTICIPANTS OF A GROUP MONITORING PLAN

- *Annual Site Inspection:* Conduct a minimum of one annual site inspection to identify industrial activities that could be a source of pollutants, and evaluate whether the facility's Storm Water Pollution Prevention Plan is effective. After the inspection, a responsible person at the site must certify the site is in compliance with the General Permit and the facility's Storm Water Pollution Prevention Plan. Certification should be submitted with the Annual Report. Facilities that cannot be certified should report deficiencies in the Annual Report, and provide a plan and schedule for corrective action.

- *Dry Weather Observations:* No less than twice during the dry season (May through September) industries are to inspect their facilities to observe or test for the presence of non-storm water discharges, such as wash waters. Observations noted should include the presence of an actual flow, or evidence that non-storm water flows have occurred. Evidence would include stain marks, wet spots, residual material, etc. Non-storm water discharges should be reported to the Regional Board.

  Records shall be maintained of the observations, including date, locations observed, name of inspector, and all other pertinent information. Inspection findings and corrective action should be reported in the Annual Report.

- *Wet Weather Visual Observations:* During the wet season (October through April) industries shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharges to observe and characterize the runoff.

  Examples of what should be observed are: does the flow have a sheen, an odor, is it muddy, are there floatable materials, etc.? Records must also be maintained for this activity similar to that for the dry weather observations. Inspection findings and corrective action should be reported in the Annual Report.

- *Annual Reports:* All industries must submit an Annual Report by July 1 of each year to the Regional Board. A recommended annual report format has been developed which includes forms for dry and wet weather observations. The report must summarize all your activities and findings relating to your facility's Storm Water Pollution Prevention Plan and monitoring program.

- *Record Keeping:* Records of all storm water monitoring information and copies of all reports required by the general permit are to be retained for a period of at least five years from the date of the sample, measurement, observation or report.

SAMPLING REQUIREMENTS FOR INDIVIDUAL SITES AND DESIGNATED PARTICIPANTS OF A GROUP PLAN

- *When to Collect Samples:* During the wet season (October through April) industries must collect and analyzed samples during two storm events that produce significant storm water discharges. Each sampling event must be proceeded by at least 72 hours of dry weather.

- *All samples must be analyzed for:* pH, total suspended solids (TSS), specific conductance, and either total organic carbon (TOC) or oil and grease (O&G). Samples must also be analyzed for: toxic chemicals and other pollutants that the industry believes could be present in storm water discharges in significant quantities. *The industry is to determine these pollutants.*

  Sampling and analysis for additional constituents may be eliminated if toxic chemical or other pollutants are not detected in significant quantities after two consecutive sampling events.

  Samples must be collected as grab samples unless otherwise required by the Federal Regulations, or approved by the Regional Board. Sample results and evaluation of results should be submitted in the Annual Report.

- *Sampling locations:* Samples are to be collected from all locations where storm water is discharged. Facilities with multiple discharge points may reduce the number of locations to be sampled if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

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STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
1111 WEBSTER STREET, SUITE 500
OAKLAND, CA 94612
(510) 464-1255

September 15, 1992

To: Interested Parties

From: Thomas Mumley
Storm Water Permit Program Coordinator

The attached overview of the NPDES Industrial Storm Water Regulations and the State NPDES General Permit for Industrial Storm Water Discharges was produced by the American Public Works Association/State Water Resources Control Board Stormwater Quality Task Force. Staff of the Regional Water Quality Control Boards participate on the Task Force. The overview represents the State's interpretation of the regulations.

The State is continuing to accept Notices of Intent (NOI) for coverage under its General Permit for Discharges of Storm Water Associated with Industrial Activity (Order No. 91-13-DWQ, NPDES No. CAS000001). All facilities subject to the industrial storm water regulations are encouraged to submit a NOI for coverage under the State's general permit. Federal law requires facilities which discharge industrial storm water to obtain NPDES permits by October 1, 1992. Facilities that have not obtained coverage under the State's general permit by that time may be subject to enforcement action including monetary penalties.

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APWA STORM WATER TASK FORCE

OVERVIEW OF THE NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES

The California NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES, EXCLUDING CONSTRUCTION ACTIVITIES (General Permit) was adopted by the State Water Resources Control Board (SWRCB) on November 19, 1991. Notices of Intent for coverage under the General Permit must be submitted to the SWRCB between the dates of January 15, 1992 and March 30, 1992. A California General Permit for Discharges of Storm Water Associated with Construction Activities is scheduled for adoption in Summer 1992.

The Federal storm water regulations identify the industry types, which are subject to storm water runoff, that require a permit. These industry types are described either by a specific description or by Standard Industrial Classifications (SIC) Code. The industry types identified include some facilities which may not typically be thought of as "industrial" and some facilities which are typically owned and operated by public agencies.

The General Permit covers storm water runoff from 10 of the following 11 categories listed in the Federal storm water regulations. The facilities included in each category are described in Attachment I and listed in the tables shown below in parentheses.

EPA Categories

i. Facilities subject to storm water effluent guidelines, new source performance standards or toxic pollutant effluent standards under 40CFR Subchapter N (Table 1)

ii. Certain manufacturing facilities (Table 2)

iii. Active and inactive oil and gas operations and mining facilities (Table 2)

iv. Hazardous waste treatment, storage, or disposal facilities (Table 4)

v. Landfills, land application sites, and open dumps that receive or have received any industrial wastes from facilities listed herein (Table 4)

vi. Recycling facilities, including metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards (Table 2)

vii. Steam electric power generating facilities (Table 4)

viii. Transportation facilities which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations (Table 2)

ix. Wastewater treatment plants with design flows greater than 1.0 mgd or plants required to have a pretreatment program (Table 4)

x. Construction (will be covered under the separate General Permit for Discharges of Storm Water Associated with Construction Activities)

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xi. Other manufacturing facilities where materials, machinery, or products are exposed to storm water (Table 3)

General Information

A. Permit Fee

1. $250 in areas with a municipal NPDES permit
2. $500 in all other areas

B. To obtain a permit application form (NOI), call Stefanie Gordon at 916/657-0752

C. You will receive a letter 2 to 3 weeks after submitting your application confirming that you are covered by the General Permit

D. If you fail to submit an NOI by the March 30, 1992 deadline, submit an NOI anyway with an explanation why you were delayed

E. Certain determinations about this permitting process by the U.S. Environmental Protection Agency (EPA) may not apply in California. Procedures and applicability of the General Permit will be determined by the State Water Resources Board

F. The two major requirements of the General Permit are development and implementation of a Storm Water Monitoring and Reporting Program and a Storm Water Pollution Prevention Plan

G. Submit your completed NOI and permit fee to:

State Water Resources Control Board
Division of Water Quality
P.O. Box 1977
Sacramento, CA 95812-1977

Attention: Storm Water Permitting Section

H. A Standard Industrial Classification (SIC) Manual can be found at most libraries. To order a manual call:

1-800-872-6386 or 1-800-562-0245
Specify Title Code #84161-9.

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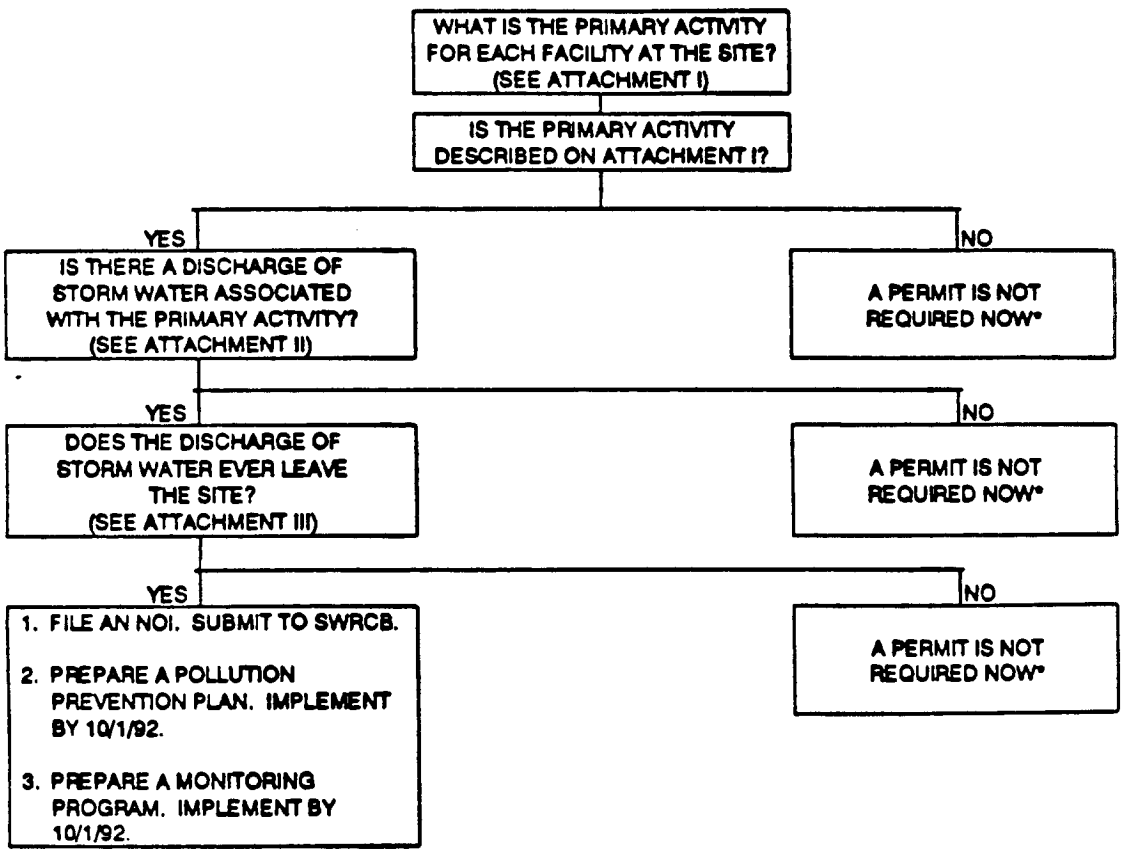
DECISION TREE

DOES THE GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES APPLY TO MY SITE?



* LOCAL AGENCIES MAY ADOPT OTHER PERMITS, CONDITIONS, RULES OR ORDINANCES THAT APPLY TO YOUR INDUSTRY.

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ATTACHMENT I

INTRODUCTION

The State NPDES General Permit for Discharges of Storm Water Associated with Industrial Activities (General Permit) covers 10 of the 11 categories of industrial facilities described in the federal storm water regulations. All 11 categories are described below. Industrial facilities owned or operated by governmental entities (including federal, state, and municipal facilities) and included in any of the 10 designated categories (Categories i through ix, and xi) are subject to General Permit requirements. Category x facilities will be covered by a separate General Permit for Discharges of Storm Water Associated with Construction Activities (scheduled for adoption in Summer 1992).

Category i through ix facilities must file a Notice of Intent to be covered by the General Permit if they discharge industrial storm water (see Attachment II) to waters of the United States (see Attachment III). Category xi facilities must file a Notice of Intent to be covered by the General Permit only if they have equipment or material (outdoor activities) exposed to storm water (see Attachments II and III).

Five categories of facilities (ii, iii, vi, viii, and xi) are defined by Standard Industrial Classification (SIC) codes. Application of SIC codes is described below. Affected SIC codes are listed in Tables 2 and 3.

The remaining six categories of facilities (i, iv, v, vii, ix, and x) are defined by industrial activity descriptions.

APPLICATION OF SIC CODES

Identify Each Facility Contained at the Site

A facility is defined as "something that is built, installed, or established to serve a particular purpose" (Webster's Ninth New College Dictionary, 1986). Therefore, identifying the "purpose" is critical in defining a facility, i.e., each facility will achieve a particular end which can be described with a SIC code.

If more than one activity is occurring, the site may involve two separate, but contiguous facilities. Factors to consider include physical barriers and separate management. For example, a hotel complex could include a marina facility managed by a separate party or separated by a physical barrier from the hotel complex. In this case, the marina would be considered a separate facility associated with industrial activity subject to the Permit requirements (Transportation SIC 4493).

Identify Primary Activity

Once all facilities are identified, determine the primary purpose for each facility. The primary purpose is determined by the principal product or groups of products produced or distributed, or services rendered. The principal product or service should be determined by its relative share of value added (gross production, sales, receipts, or revenues) at the facility. Once the primary purpose of facility is identified, you will be able to determine if the primary purpose is described by one of the listed SIC codes.

In issuing the General Permit, the SWRCB indicated that a facility must be permitted if the primary activity (purpose) at the facility is described by one of the listed SIC codes (whether or not the activity is primary or auxiliary to the owner or operator of the facility). Thus, the primary activity at the facility should be considered when applying the SIC codes rather than the primary business of the owner or operator.

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For example, a school bus maintenance facility is required to obtain a permit since establishments operating school buses (SIC 4151) are in one of the categories described in the storm water permit regulations, even though the facility is owned by an educational institution (e.g., a school district) which is not described by one of the listed SIC codes.

If a site contains two or more facilities each described by designated SIC codes, only one NPDES permit may be necessary if the owner of the site assumes responsibility for all facilities (see Attachment III - Who is Responsible for Obtaining the NPDES permit?). As an alternative, the operators for each facility could apply for separate permits.

GENERAL DESCRIPTION OF INDUSTRIAL FACILITY CATEGORIES

Category I

Facilities Listed Under 40 CFR Subchapter N

These consist of all facilities subject to promulgated: a) storm water effluent limitation guidelines, b) new source performance standards, or c) toxic pollutant effluent standards under 40 CFR Subchapter N. All affected industrial categories are identified in Table 1.

Industries listed with the new source performance standards group need only be permitted if they are a "new source"; meaning an industrial facility built after the performance standards were promulgated by EPA. Industries that believe that they may be included in Category i should review the Subchapter N guidelines and/or consult their local Regional Water Quality Control Board.

Excluded are facilities with toxic pollutant effluent standards which are exempted under Category xi (i.e. because materials, equipment, and products are not exposed to storm water).

Category ii

Manufacturing Facilities

These consist of facilities engaged in the mechanical or chemical transformation of materials or substances into new products, and are usually described as plants, factories, or mills and characteristically use power driven machines and materials handling equipment. Establishments engaged in assembling component parts of manufactured products or in the blending of materials such as lubricating oils, plastics, or liquors are included. Table 2 includes all four digit SIC codes within this category.

All facilities identified by this category are required to file to be covered by the General Permit, regardless of whether equipment and/or materials are exposed to storm water. These facilities should also note that the definition of "storm water discharge associated with industrial activity" (see Attachment II) includes, but is not limited to, discharges from the specified industrial activity areas. Included in the definition are manufacturing buildings and material and waste storage areas (whether totally enclosed or not) including tank farm areas. Activities of concern include emissions from stacks or air exhaust systems, use of unhoused manufacturing and heavy industrial equipment, and generation of dust or particulates.

Excluded are facilities engaged in services or wholesale or retail trade.

Category iii

Oil and Gas/Mining Facilities

These consist of active or inactive mining operations and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water

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contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products, or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Included are SIC Codes 10 (Metal Mining), 11 (Anthracite Mining), 12 (Coal Mining), 13 (Oil and Gas Extraction), and 14 (Mining and Quarrying of Nonmetallic Minerals, Except Fuels). Table 2 includes all four digit SIC codes within this category.

Excluded are inactive mining sites where mining claims are being maintained prior to disturbances associated with the extraction, benefaction, or processing of mined material, nor sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim. Also excluded are certain areas of coal mining meeting the definition of a reclamation area under 40 CFR 434.11(1) and certain areas of non-coal mining which have been released from state or federal reclamation requirements after December 17, 1990.

Category iv

Hazardous Waste Treatment, Storage, or Disposal Facilities

These consist of hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or permit under Subtitle C of the Resource Conservation and Recovery ACT (RCRA). These include only hazardous waste facilities under the federal definition of hazardous waste (RCRA hazardous waste as defined in Title 22, Section 66261.3, CA Health and Safety Code). The California definition of hazardous waste is broader and includes non-RCRA hazardous wastes. Only hazardous waste facilities based on the federal definition are required to obtain a NPDES storm water permit. However, non-RCRA hazardous waste facilities are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency. See Table 4 for further detail.

Category v

Landfills, Land Application Sites, and Open Dumps

These consist of landfills, land application sites, and dumps that received any industrial wastes, including active and inactive sites that receive or have received industrial waste from any of the types of facilities described as industrial facilities in the storm water regulations (i.e., these eleven categories), sites subject to regulation under Subtitle D of RCRA, and sites that have accepted wastes from construction activities (construction activities include any clearing, grading, or excavation that results in disturbance of five acres or more). It is probable that most active and inactive landfills have received industrial waste. See Table 4 for further detail.

Excluded are properly closed landfills that now function as a different land use (e.g., park, golf course, etc.) and which do not pose a threat of discharging storm water exposed to landfill waste.

Category vi

Recycling Facilities

These consist of facilities involved in the recycling of materials, including facilities engaged in assembling, breaking up, sorting, and wholesale distribution of motor vehicle motors and parts, scrap, and other waste materials, and include metal scrap yards, battery reclaimers, salvage yards, and automobile junkyards. Included are facilities which store and recycle paper, glass, metals, oil, rubber, plastics, and other synthetics. These include SIC Code 5015-Used Motor Vehicle Parts and SIC Code 5093-Scrap and Waste Materials.

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Excluded are municipal waste collection sites where bottles, cans, and papers are collected for recycling purposes.

Category vii

Steam Electric Power Generating Facilities

These consist of steam electric power generating facilities, including coal handling sites. See Table 4 for further detail.

Excluded are onsite and offsite ancillary transformer facilities, as long as such facilities have regular inspections and management practices in place, including spill prevention, response, and clean up.

Category viii

Transportation Facilities

These consist of transportation facilities classified by the SIC indicated below which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or other operations identified under Categories i through vii or ix through xi must be permitted.

In determining whether a facility is covered by the transportation category, first determine whether the facility is involved in providing transportation to individual customers or for other companies or establishments, or provides long-distance trucking services to anyone. Maintenance facilities owned or operated by companies or public agencies which are involved in providing transportation services to the public or other businesses are covered, including the transportation of individuals (such as by buses, vans, or taxies) and goods (such as by trucks, rail, ships, or airplanes). All long-distance trucking facilities are covered.

Excluded are transportation facilities which only transport goods for the company or enterprise of which it is a part or only transport its own employees. Municipal corporation yards are excluded unless they perform the functions described in the SIC codes below, such as the service of an urban or suburban bus line (SIC 4111 - Local and Suburban Transit), or contain a warehousing and storage facility described by SIC codes 4225 or 4226. However, all municipal corporation yards are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a Permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

Also excluded are fuel stations, vehicle repair or service stations, and body shops which are not associated with the establishments described in the SIC codes below. However, these establishments are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

Major transportation groups covered by the Permit are described below:

SIC 40 - Railroad Transportation

This major group includes establishments furnishing transportation by line-haul railroad, and switching and terminal establishments. Railways serving a single municipality, contiguous municipalities, or a municipality and its suburban areas are classified in Major Group 41.

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SIC 41 - Local and Suburban Transit and Interurban Highway Passenger Transportation

This major group includes establishments primarily engaged in furnishing local and suburban passenger transportation, such as those providing passenger transportation within a single municipality, contiguous municipalities, or a municipality and its suburban areas by bus, rail, or subway, either separately or in combination, and establishments engaged in furnishing transportation to local scenic features. Also included are establishments primarily engaged in furnishing highway passenger transportation and establishments furnishing highway passenger terminal or maintenance facilities. Intercity bus lines are included in this major group, but interurban railways are classified in Major Group 40.

SIC 42 - Motor Freight Transportation and Warehousing (except SIC 4221-25 (Public Warehousing) which are included in Category xi)

This major group includes establishments furnishing local or long-distance trucking or transfer services or those engaged in the storage of special products (SIC 4226) such as automobiles (dead storage only), furs (for the trade), textiles, whiskey, and goods at foreign trade zones.

SIC 43 - United States Postal Service

SIC 44 - Water Transportation

This major group includes establishments engaged in freight and passenger transportation on the open seas or inland waters, and establishments furnishing such incidental service as lighterage, towing, and canal operation. This major group also includes excursion boats, sightseeing boats, and water taxis. Establishments engaged in the operation of charter or party fishing boats are not included.

SIC 45 - Transportation by Air

This major group includes establishments engaged in furnishing domestic and foreign transportation by air and also those operating airports and flying fields and furnishing terminal services. Establishments primarily engaged in performing services which may incidentally use airplanes (e.g. crop dusting and aerial photography) are not included.

SIC 5171 - Petroleum Bulk Stations and Terminals

These include establishments primarily engaged in the wholesale distribution of crude petroleum and petroleum products, including liquefied petroleum gas, from bulk liquid storage facilities.

Table 2 includes a complete list of all four digit SIC codes within this category. All facilities identified by this category are required to obtain NPDES permits for the discharge of industrial storm water regardless of material, equipment, or product exposure.

Category ix

<u>Sewage or Wastewater Treatment Works</u>

These consist of treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day (MGD) or more, or required to have an approved pretreatment program under 40 CFR Part 403. Industrial activity areas at these facilities include, but are not limited to, onsite sludge composting;

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storage of chemicals such as ferric chloride, alum polymers, and chlorine; and areas which experience spills and bubbleovers. See Table 4 for further detail.

Excluded are farm lands, domestic gardens, or lands used for sludge management or reclamation of municipal wastewater where the sludge or wastewater is beneficially reused and which are not physically located in the confines of the facility.

Category x

Construction Activities

These include, but are not limited to, clearing, grading, and excavation activities. The State intends to issue a separate General Permit for Discharges of Storm Water Associated with Construction Activities to cover storm water discharges from these activities. The General Permit for Construction Activities will further delineate the extent of affected construction activities.

Excluded from the General Permit for Construction Activities will be operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale. However, such operations are still expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by local permitted municipal storm water agencies.

Category xi

Manufacturing Facilities

These consist of manufacturing facilities identified by SIC code which have storm water discharges "associated with industrial activities" from areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. Discharges of storm water "associated with industrial activity" and "exposure" to storm water are addressed in Attachment II.

Areas of industrial activity include manufacturing buildings and storage areas. Areas of industrial activity do not include access roads and rail lines.

Table 3 is a complete list of four digit SIC codes included in this category.

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ATTACHMENT II

IS THERE A DISCHARGE OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY?

The term "discharges of storm water associated with industrial activity" means discharges of storm water from areas at a facility where storm water may contact pollutants or activities may release pollutants to storm water. Such discharges include, but are not limited to, discharges from the following:

a. Industrial plan yards;
b. Immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility (except for category xi);
c. Material handling sites;
d. Refuse sites;
e. Sites used for the application or disposal of process waste waters; 40 CFR 401
f. Sites used for the storage and maintenance of material handling equipment;
g. Sites used for residual treatment, storage, or disposal;
h. Shipping and receiving areas;
i. Storage areas (including tank farms) for raw materials, and intermediate and finished products;
j. Manufacturing buildings; and
k. Areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water.

Significant materials include, but are not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Access roads and rail lines include those used or traveled by carriers of raw materials, manufactured products, waste materials, or by-products used or created by the facility. Included are haul roads or rail lines dedicated to transportation of industrial products at facilities and roads and rail lines which are exclusively or primarily dedicated for use by the facility. They do not include public access roads or roads used to transport bulk samples of raw materials or products in small-scale prior to industrial production.

Note that the definition of industrial activity areas is not limited to the specified areas. Any area at a facility where storm water may contact pollutants or activities may release pollutants to storm water must be considered. Also note that the definition includes manufacturing buildings and material and waste storage areas (whether totally enclosed or not). Activities of concern in these areas include emissions from stacks or air exhaust systems, use of unhoused manufacturing and heavy industrial equipment, generation of dust or particulates, use of material handling equipment, and material handling activities.

Non-industrial Areas are areas located at facilities such as office buildings and accompanying parking lots are generally excluded, as long as the drainage from the excluded areas is discharged separately from storm water drained from areas with industrial activities. The intent of the regulations is to control industrial activity storm water discharges. Non-industrial areas are considered equivalent to residential or commercial land-use areas and should be managed as such. These areas may be subject to other requirements imposed by local agencies which have jurisdiction over or manage storm drain systems or waterways.

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For the manufacturing facilities identified by Category xi, storm water discharge associated with industrial activity includes only storm water discharges from the areas (except access roads and rail lines) that are listed above where material handling equipment or activities, raw materials, intermediate products, final products, waste material, by-products, or industrial machinery are exposed to storm water.

Exposure means either direct contact with storm water or the possibility of release (e.g., spills) of pollutants to storm water. For example, roof drainage from manufacturing buildings must be considered when determining exposure. Exposure in this circumstance would include direct or potential contact or release of pollutants (associated with raw materials, products, or waste) from roof stacks to storm water. Manufacturing facilities may also be sources of dust or particulates associated with material handling equipment or activities, raw materials, products, or waste, or industrial machinery. Enclosed storage areas are also defined as areas of industrial activity where there may be exposure during loading/unloading of materials or exposure due to spills.

Category xi facilities are expected to use reasonable and professional judgment when making the determination of exposure from the listed areas and activities. In order to demonstrate that these areas are not exposed to storm water, the following conditions must be met:

1. All illicit (un-permitted) connections to the storm drainage system must be eliminated;

2. All materials must be completely contained at all times so, if spilled, they will not directly or indirectly contact storm water, and

3. All emissions from stacks or air exhaust systems, unhoused manufacturing and heavy industrial equipment, and emissions of dust or particulates must not be exposed to storm water.

If a facility demonstrates that there is no exposure, documentation of the rationale for the determination should be retained on site. Written approval by a Regional Board and a NPDES industrial storm water discharge permit is not required for such facilities. However, such facilities are expected to effectively manage storm water discharges and may be required by a Regional Board to obtain a permit on a case-by-case basis. They must also comply with any conditions imposed by a permitted municipal storm water agency.

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ATTACHMENT III

IS THERE A DISCHARGE OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY TO WATERS OF THE UNITED STATES?

The answer is yes, and a General Permit is required, if either of the following applies:

a. The discharge of industrial storm water is directly to waters of the United States through any conveyance. The conveyance does not have to be a pipe or ditch. It includes "sheet flow" discharges resulting from any manipulation of land surface (e.g., pavement).

b. The discharge of industrial storm water is to a storm drain system which ultimate discharges to waters of the United States. In this case all "sheet flow" discharges are included.

The answer is no, and General Permit is not required, if either of the following applies:

a. The discharge of industrial storm water is to a municipal sanitary sewer system or combined sewer system (combined sanitary and storm sewer system).

b. The discharge of industrial storm water is to evaporation ponds, percolation ponds, or dry wells (groundwater injection wells), and there is no discharge to surface waters under any circumstances.

Even though these types of discharges are not required to obtain a General Permit, the discharges may be subject to separate waste discharge requirements issued by a Regional Water Quality Control Board (Regional Board) if they pose a threat to groundwater. If there is a question, call the local Regional Board to obtain guidance.

IS A SEPARATE STORM WATER PERMIT REQUIRED IF THE FACILITY ALREADY HAS A NPDES PERMIT?

A separate General Permit is not required if an existing NPDES permit identifies and addresses all industrial storm water discharges from the facility.

An existing NPDES permit may be modified to address all industrial storm water. Normally, this modification will occur when the existing permit is reissued or amended by a Regional Board. In the interim, the facility should obtain coverage under the General Permit.

WHO IS RESPONSIBLE FOR OBTAINING THE GENERAL PERMIT?

Either the owner or operator of the facility may obtain the Permit. Generally, the operator will be responsible for obtaining the permit. The operator is usually responsible for the industrial activity, and therefore, more appropriately, the best entity to manage the activity in compliance with the permit. However, owners may obtain coverage for a facility with the understanding that they will be directly responsible for the storm water discharge and consequently, responsible for compliance with permit conditions.

For example, a tenant which operates an industrial facility at an airport complex may be responsible for submitting a NOI for coverage under the General Permit and would be responsible for implementing a Storm Water Pollution Prevention Plan (SWPP Plan) for its facility. Alternatively, the airport owner may choose to assume responsibility for its tenants, in addition to its own industrial activities. In this case, the airport owner would submit a NOI and would be responsible for implementing a SWPP Plan that addresses all noted activities at the airport complex.

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TABLE 1
SUBCHAPTER N - EFFLUENT GUIDELINES AND STANDARDS
(Category I)

Group 1	Group 2	Group 3	Part	Description
	X		405	Dairy products processing point source category
	X		406	Grain mills point source category
	X		407	Canned and preserved fruits and vegetables processing point source category
	X		408	Canned and preserved seafood processing point source category
	X		409	Sugar processing point source category
	X	X	410	Textile mills point source category
X	X		411	Cement manufacturing point source category
X	X		412	Feedlots point source category
	X	X	413	Electroplating point source category
	X	X	414	Organic chemicals, plastics, and synthetic fibers
	X	X	415	Inorganic chemicals manufacturing point source category
	X		417	Soap and detergent manufacturing point source category
X	X		418	Fertilizer manufacturing point source category
X	X	X	419	Petroleum refining point source category
	X	X	420	Iron and steel manufacturing point source category
	X	X	421	Nonferrous metals manufacturing point source category
X	X		422	Phosphate manufacturing point source category
X	X	X	423	Steam electric power generating point source category
	X	X	424	Ferroalloy manufacturing point source category
	X	X	425	Leather tanning and finishing point source category
	X	X	426	Glass manufacturing point source category
	X		427	Asbestos manufacturing point source category
	X	X	428	Rubber manufacturing point source category
	X	X	429	Timber products processing point source category
	X	X	430	Pulp, paper, and paperboard point source category
	X		431	The builders' paper and board mills point source category
	X		432	Meat products point source category
	X	X	433	Metal finishing point source category

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TABLE 1 (Continued)
SUBCHAPTER N - EFFLUENT GUIDELINES AND STANDARDS
(Category i)

Group 1	Group 2	Group 3	Part	Description
X	X		434	Coal mining point source category; BPT, BAT, BCT limitations and new source performance standards
			435	Oil and gas extraction point source category
X			436	Mineral mining and processing point source category
	X	X	439	Pharmaceutical manufacturing point source category
X	X	X	440	Ore mining and dressing point source category
X	X		443	Effluent limitations guidelines for existing sources and standards of performance and pretreatment standards for new sources for the paving and roofing materials (tars and asphalt) point source category
	X		446	Paint formulating point source category
	X		447	Ink formulating point source category
			454	Gum and wood chemicals manufacturing point source category
		X	455	Pesticide chemicals
			457	Explosives manufacturing point source category
	X		458	Carbon black manufacturing point source category
		X	459	Photographic point source category
			460	Hospital point source category
	X	X	461	Battery manufacturing point source category
	X		463	Plastics molding and forming point source category
	X	X	464	Metal molding and casting point source category
	X	X	465	Coil coating point source category
	X	X	466	Porcelain enameling point source category
	X	X	467	Aluminum forming point source category
	X	X	468	Copper forming point source category
	X	X	469	Electrical and electronic components point source category
	X	X	471	Nonferrous metals forming and metal powders point source category

Group 1: Storm water effluent limitations guidelines - Permit Mandatory
Group 2: New source performance standards - Permit Mandatory
Group 3: Toxic pollutant effluent standards - Permit conditional on exposure to storm water (Category xi)

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TABLE 2

MANDATORY INDUSTRIES (Categories ii,iii, vi, and viii)
Permit Required in Any Case

Metal Mining

1011	Iron Ores
1021	Copper Ores
1031	Lead & Zinc Ores
1041	Gold Ores
1044	Silver Ores
1061	Ferroalloy Ores, Except Vanadium
1081	Metal Mining Services
1094	Uranium-Radium-Vanadium Ores
1099	Miscellaneous Metal Ores, N.E.C.

Coal Mining

1221	Bituminous Coal and Lignite Surface Mining
1222	Bituminous Coal Underground Mining
1231	Anthracite Mining
1241	Coal Mining Services

Oil & Gas Extraction

1311	Crude Petroleum & Natural Gas
1321	Natural Gas Liquids
1381	Drilling Oil & Gas Wells
1382	Oil & Gas Field Exploration Services
1389	Oil & Gas Field Services, N.E.C.

Mining & Quarrying of Nonmetallic Minerals, Except Fuels

1411	Dimension Stone
1422	Crushed & Broken Limestone
1423	Crushed & Broken Granite
1429	Crushed & Broken Stone, N.E.C
1442	Construction Sand & Gravel
1446	Industrial Sand
1455	Kaoline & Ball Clay
1459	Clay & Related Minerals, N.E.C.
1474	Potash, Soda, & Borate Minerals
1475	Phosphate Rock
1479	Chemical & Fertilizer Mineral Mining, N.E.C.
1481	Nonmetallic Minerals Services, Except Fuels
1499	Miscellaneous Nonmetallic Minerals, Except Fuels, N.E.C.

Lumber & Wood Products, Except Furniture

2421	Sawmills & Planing Mills, General
2426	Hardwood Dimension & Flooring Mills
2429	Special Product Sawmills, N.E.C.
2431	Millwork
2435	Hardwood Veneer & Plywood
2436	Softwood Veneer & Plywood
2439	Structural Wood Members, N.E.C.
2441	Nailed and Lock Corner Wood Boxes & Shook
2448	Wood Pallets & Skids
2449	Wood Containers, N.E.C.
2451	Mobile Homes

Lumber & Wood Products, Except Furniture (Cont.)

2452	Prefabricated Wood Buildings
2491	Wood Preserving
2493	Reconstituted Wood Products
2499	Wood Products, N.E.C.

Paper & Allied Products

2611	Pulp Mills
2621	Paper Mills
2631	Paperboard Mills

Chemicals & Allied Products

2812	Alkalies & Chlorine
2813	Industrial Gases
2816	Inorganic Pigments
2819	Industrial Inorganic Chemicals, N.E.C.
2821	Plastics Materials, Synthetic Resins, & Nonvolcanizable Elastomers
2822	Synthetic Rubber
2823	Cellulosic Manmade Fibers
2824	Manmade Organic Fibers, Except Cellulosic
2841	Soap & Other Detergents, Except Specialty Cleaners
2842	Specialty Cleaning, Polishing, & Sanitation Preparations
2843	Surface Active Agents, Finishing Agents, Sulfonated Oils, and Assistants
2844	Perfumes, Cosmetics, & Other Toilet Preparations
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
2861	Gum & Wood Chemicals
2865	Cyclic Organic Crudes & Intermediates, & Organic Dyes & Pigments
2869	Industrial Organic Chemicals, N.E.C.
2873	Nitrogenous Fertilizers
2874	Phosphatic Fertilizers
2875	Fertilizers, Mixing Only
2879	Pesticides & Agricultural Chemicals, N.E.C.
2891	Adhesives & Sealants
2892	Explosives
2893	Printing Ink
2895	Carbon Black
2899	Chemicals & Chemical Preparations, N.E.C.

Petroleum Refining & Related Industries

2911	Petroleum Refining
2951	Asphalt Paving Mixtures & Blocks
2952	Asphalt Felts & Coatings
2992	Lubricating Oils & Greases
2999	Products of Petroleum & Coal, N.E.C.

Leather Tanning & Finishing

3111	Leather Tanning & Finishing

Note: N.E.C. means Not Elsewhere Classified.

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Stone, Clay, Glass, & Concrete Products

3211	Flat Glass
3221	Glass Containers
3229	Pressed & Blown Glass & Glassware, N.E.C.
3241	Cement, Hydraulic
3251	Brick & Structural Clay Tile
3253	Ceramic Wall & Floor Tile
3255	Clay Refractories
3259	Structural Clay Products, N.E.C.
3261	Vitreous China Plumbing Fixtures & China & Earthenware Fittings & Bathroom Accessories
3262	Vitreous China Table and Kitchen Articles
3263	Fine Earthenware (Whiteware) Table and Kitchen Articles
3264	Porcelain Electrical Supplies
3269	Pottery Products, N.E.C.
3271	Concrete Block & Brick
3272	Concrete Products, Except Block & Brick, N.E.C.
3273	Ready-Mixed Concrete
3274	Lime
3275	Gypsum Products
3281	Cut Stone & Stone Products
3291	Abrasive Products
3292	Asbestos Products
3295	Minerals & Earths, Ground or Otherwise Treated
3296	Mineral Wool
3297	Nonclay Refractories
3299	Nonmetallic Mineral Products, N.E.C.

Primary Metal Industries

3312	Steel Works, Blast Furnaces (Including Coke Ovens), & Rolling Mills
3313	Electrometallurgical Products, Except Steel
3315	Steel Wiredrawing & Steel Nails & Spikes
3316	Cold-Rolled Steel Sheet, Strip, & Bars
3317	Steel Pipe & Tubes
3321	Gray & Ductile Iron Foundries
3322	Malleable Iron Foundries
3324	Steel Investment Foundries
3325	Steel Foundries, N.E.C.
3331	Primary Smelting & Refining of Copper
3334	Primary Production of Aluminum
3339	Primary Smelting & Refining of Nonferrous Metals, Except Copper & Aluminum
3341	Secondary Smelting & Refining of Nonferrous Metals
3351	Rolling, Drawing, & Extruding of Copper
3353	Aluminum Sheet, Plate, & Foil
3354	Aluminum Extruded Products
3355	Aluminum Rolling & Drawing, N.E.C.
3356	Rolling & Drawing of Nonferrous Metals, Except Copper & Aluminum
3357	Drawing & Insulating of Nonferrous Wire
3363	Aluminum Die-Castings
3364	Nonferrous Die-Castings, Except Aluminum
3365	Aluminum Foundries
3366	Copper Foundries

Primary Metal Industries (Cont.)

3369	Nonferrous Foundries, Except Aluminum & Copper
3398	Metal Heat Treating
3399	Primary Metal Products, N.E.C.

Fabricated Structural Metal Products

3441	Fabricated Structural Metal

Ship & Boat Building & Repairing

3731	Ship Building & Repairing
3732	Boat Building & Repairing

Railroads

4011	Railroads, Line-Haul Operating
4013	Railroad Switching & Terminal Establishments

Local & Suburban Transit & Interurban Highway Passenger Transportation

4111	Local & Suburban Transit
4119	Local Passenger Transportation, N.E.C.
4121	Taxicabs
4131	Intercity & Rural Bus Transportation
4141	Local Bus Charter Service
4142	Bus Charter Service, Except Local
4151	School Buses
4173	Terminal & Service Facilities for Motor Vehicle Passenger Transportation

Motor Freight Transportation & Warehousing

4212	Trucking, Local Without Storage
4213	Trucking, Except Local
4214	Local Trucking & Storage
4215	Courier Services, Except By Air
4226	Special Warehousing & Storage, N.E.C.
4231	Terminal Facilities & Joint Terminal Maintenance Facilities for Motor Freight Transportation

United States Postal Service

4311	United States Postal Service

Water Transportation

4412	Deep Sea Foreign Transportation of Freight
4424	Deep Sea Domestic Transportation of Freight
4432	Freight Transportation on the Great Lakes - St. Lawrence Seaway
4449	Water Transportation of Freight, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Water Transportation (Cont.)

4481 Deep Sea Transportation of Passengers, Except by Ferry
4482 Ferries
4489 Water Transportation of Passengers, N.E.C.
4491 Marine Cargo Handling
4492 Towing & Tugboat Services
4493 Marinas
4499 Water Transportation Services, N.E.C.

Transportation By Air

4512 Air Transportation, Scheduled
4513 Air Courier Services
4522 Air Transportation, Nonscheduled
4581 Airports, Flying Fields, & Airport Terminal Services

Wholesale Trade - Durable Goods

5015 Motor Vehicle Parts, Used
5093 Scrap & Waste Materials

Petroleum & Petroleum Products
5171 Petroleum Bulk Stations & Terminals

Note: N.E.C. means Not Elsewhere Classified.

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TABLE 3

CONDITIONAL INDUSTRIES (Category xi)
Permit required only if materials, machinery, or products are exposed to stormwater

Food & Kindred Products

2011	Meat Packing Plants
2013	Sausages & Other Prepared Meat Products
2015	Poultry Slaughtering & Processing
2021	Creamery Butter
2022	Natural, Processed, & Imitation Cheese
2023	Dry, Condensed, & Evaporated Dairy Products
2024	Ice Cream & Frozen Desserts
2026	Fluid Milk
2032	Canned Specialities
2033	Canned Fruits, Vegetables, Preserves, Jams, & Jellies
2034	Dried & Dehydrated Fruits, Vegetables, & Soups Mixes
2035	Pickled Fruits & Vegetables, Vegetable Sauces & Seasonings, & Salad Dressings
2037	Frozen Fruits, Fruit Juices, & Vegetables
2038	Frozen Specialities, N.E.C.
2041	Flour & Other Grain Mill Products
2043	Cereal Breakfast Foods
2044	Rice Milling
2045	Prepared Flour Mixes & Doughs
2046	Wet Corn Milling
2047	Dog & Cat Food
2048	Prepared Feeds & Feed Ingredients for Animals & Fowls, Except Dogs & Cats
2051	Bread & Other Bakery Products, Except Cookies & Crackers
2052	Cookies & Crackers
2053	Frozen Bakery Products, Except Bread
2061	Cane Sugar, Except Refining
2062	Sugar Cane Refining
2063	Beet Sugar
2064	Candy & Other Confectionery Products
2066	Chocolate & Cocoa Products
2067	Chewing Gum
2068	Salted & Roasted Nuts & Seeds
2074	Cottonseed Oil Mills
2075	Soybean Oil Mills
2076	Vegetable Oil Mills, Except Corn, Cottonseed, & Soybean
2077	Animal & Marine Fats & Oils
2079	Shortening, Table Oils, Margerine, & Other Edible Fats & Oils, N.E.C.
2082	Malt Beverages
2083	Malt
2084	Wines, Brandy, & Brandy Spirits
2085	Distilled & Blended Liquors
2086	Bottled & Canned Soft Drinks & Carbonated Waters
2087	Flavoring Extracts & Syrups, N.E.C.
2091	Canned & Cured Fish & Seafoods
2092	Prepared Fresh or Frozen Fish & Seafoods
2095	Roasted Coffee
2096	Potatoe Chips, Corn Chips, & Similar Snacks
2097	Manufactured Ice
2098	Macaroni, Spaghetti, Vermicelli, & Noodles

Food & Kindred Products (Cont.)

2099	Food Preparations, N.E.C.

Tobacco Products

2111	Cigarettes
2121	Cigars
2131	Chewing & Smoking Tobacco & Snuff
2141	Tobacco Stemming & Redrying

Textile Mill Products

2211	Broadwoven Fabric Mills, Cotton
2221	Broadwoven Fabric Mills, Manmade Fiber & Silk
2231	Broadwoven Fabric Mills, Wool (Including Dyeing & Finishing)
2241	Narrow Fabric & Other Smallwares Mills: Cotton, Wool, Silk, & Manmade Fiber
2251	Women's Full-Length & Knee-Length Hosiery, Except Socks
2252	Hosiery, N.E.C.
2253	Knit Outerwear Mills
2254	Knit Underwear & Nightwear Mills
2257	Weft Knit Fabric Mills
2258	Lace & Warp Knit Fabric Mills
2259	Knitting Mills, N.E.C.
2261	Finishers of Broadwoven Fabrics of Cotton
2262	Finishers of Broadwoven Fabrics of Manmade Fiber & Silk
2269	Finishers of Textiles, N.E.C.
2273	Carpets & Rugs
2281	Yarn Spinning Mills
2282	Yarn Texturizing, Throwing, Twisting, & Winding Mills
2284	Thread Mills
2295	Coated Fabrics, Not Rubberized
2296	Tire Cord & Fabrics
2297	Nonwoven Fabrics
2298	Cordage & Twine
2299	Textile Goods, N.E.C.

Apparel & Other Finished Products Made From Fabrics & Similar Materials

2311	Men's & Boy's Suits, Coats, & Overcoats
2321	Men's & Boy's Shirts, Except Work Shirts
2322	Men's & Boy's Underwear & Nightwear
2325	Men's & Boy's Separate Trousers & Slacks
2326	Men's & Boy's Work Clothing
2329	Men's & Boy's Clothing, N.E.C.
2331	Women's, Misses' & Juniors' Blouses & Shirts
2335	Women's, Misses' & Juniors' Dresses
2337	Women's, Misses' & Juniors' Suits, Skirts, & Coats
2339	Women's, Misses' & Juniors' Outerwear, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Apparel & Other Finished Products Made From Fabrics & Similar Materials (Cont.)

2341	Women's, Misses, Children's, & Infants' Underwear & Nightwear
2342	Brassieres, Girdles, & Allied Garments
2353	Hats, Caps, & Millinery
2361	Girls' Children's & Infants' Dresses, Blouses, & Shirts
2369	Girls', Childrens', & Infants' Outerwear, N.E.C.
2371	Fur Goods
2381	Dress & Work Gloves, Except Knit & All-Leather
2384	Robes & Dressing Gowns
2385	Waterproof Outerwear
2386	Leather & Sheep-Lined Clothing
2387	Apparel Belts
2389	Apparel & Accessories, N.E.C.
2391	Curtains & Draperies
2392	Housefurnishings, Except Curtains & Draperies
2393	Textile Bags
2394	Canvas & Related Products
2395	Pleating, Decorative & Novelty Stitching, & Tucking for the Trade
2396	Automotive Trimmings, Apparel Findings, & Related Products
2397	Schiffli Machine Embroideries
2399	Fabricated Textile Products, N.E.C.

Millwork, Veneer, Plywood, & Structural Wood Members

2434	Wood Kitchen Cabinets

Furniture & Fixtures

2511	Wood Household Furniture, Except Upholstered
2512	Wood Household Furniture, Upholstered
2514	Metal Household Furniture
2515	Mattresses, Foundations, & Convertible Beds
2517	Wood Television, Radio, Phonograph, & Sewing Machine Cabinets
2519	Household Furniture, N.E.C.
2521	Wood Office Furniture
2522	Office Furniture, Except Wood
2531	Public Building and Related Furniture
2541	Wood Office & Store Fixtures, Partitions, Shelving, & Lockers
2542	Office & Store Fixtures, Partitions, Shelving, & Lockers, Except Wood
2591	Drapery Hardware & Window Blinds & Shades
2599	Furniture & Fixtures, N.E.C.

Paper & Allied Products

2652	Setup Paperboard Boxes
2653	Corrugated & Solid Fiber Boxes
2655	Fiber Cans, Tubes, Drums & Similar Products
2656	Sanitary Food Containers, Except Folding

Paper & Allied Products (Cont.)

2657	Folding Paperboard Boxes, Including Sanitary
2671	Packaging Paper & Plastics Film, Coated & Laminated
2672	Coated & Laminated Paper, N.E.C.
2673	Plastics, Foil & Coated Paper Bags
2674	Uncoated Paper & Multiwall Bags
2675	Die-Cut Paper, Paperboard, & Cardboard
2676	Sanitary Paper Products
2677	Envelopes
2678	Stationery Tablets & Related Products
2679	Converted Paper & Paperboard Products, N.E.C.

Printing, Publishing, & Allied Industries

2711	Newspapers: Publishing, or Publishing & Printing
2721	Periodicals: Publishing, or Publishing & Printing
2731	Books: Publishing, or Publishing & Printing
2732	Book Printing
2741	Miscellaneous Publishing
2752	Commercial Printing, Lithographic
2754	Commercial Printing, Gravure
2759	Commercial Printing, N.E.C.
2761	Manifold Business Forms
2771	Greeting Cards
2782	Blankbooks, Looseleaf Binders & Devices
2789	Bookbinding & Related Work
2791	Typesetting
2796	Platemaking & Related Services

Drugs

2833	Medicinal Chemicals & Botanical Products
2834	Pharmaceutical Preparations
2835	In Vitro & In Vivo Diagnostic Substances
2836	Biological Products, Except Diagnostic Substances

Paints, Varnishes, Lacquers, Enamels, & Allied Products

2851	Paints, Varnishes, Lacquers, Enamels, & Allied Products

Rubber & Miscellaneous Plastics Products

3011	Tires & Inner Tubes
3021	Rubber & Plastics Footwear
3052	Rubber & Plastics Hose & Belting
3053	Gaskets, Packing & Sealing Devices
3061	Molded, Extruded, & Lathe-Cut Rubber Mechanical Goods
3069	Fabricated Rubber Products, N.E.C.
3081	Unsupported Plastics Film & Sheet
3082	Unsupported Plastics Profile Shapes
3083	Laminated Plastics Plate, Sheet, & Profile Shapes
3084	Plastics Pipe
3085	Plastics Bottles

Note: N.E.C. means Not Elsewhere Classified.

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Rubber & Miscellaneous Plastics Products

3086 Plastics Foam Products
3087 Custom Compounding of Purchased Plastics Resins
3088 Plastics Plumbing Fixtures
3089 Plastics Products, N.E.C.

Leather & Leather Products

3131 Boot & Shoe Cut Stock & Findings
3142 House Slippers
3143 Men's Footwear, Except Athletic
3144 Women's Footwear, Except Athletic
3149 Footwear, Except Rubber, N.E.C.
3151 Leather Gloves & Mittens
3161 Luggage
3171 Women's Handbags & Purses
3172 Personal Leather Goods, Except Women's Handbags & Purses
3199 Leather Goods, N.E.C.

Glass Products, Made Of Purchased Glass

3231 Glass Products Made of Purchased Glass

Fabricated Metal Products, Except Machinery & Transportation Equipment

3411 Metal Cans
3412 Metal Shipping Barrels, Drums, Kegs, & Pails
3421 Cutlery
3423 Hand & Edge Tools, Except Machine Tools & Handsaws
3425 Saw Blades & Handsaws
3429 Hardware, N.E.C.
3431 Enameled Iron & Metal Sanitary Ware
3432 Plumbing Fixture Fittings & Trim
3433 Heating Equipment, Except Electric & Warm Air Furnaces
3442 Metal Doors, Sash, Frames, Molding, & Trim
3443 Fabricated Plate Work (Boiler Shops)
3444 Sheet Metal Work
3446 Architectural & Ornamental Metal Work
3448 Prefabricated Metal Buildings & Components
3449 Miscellaneous Structural Metal Work
3451 Screw Machine Products
3452 Bolts, Nuts, Screws, Rivets, & Washers
3462 Iron & Steel Forgings
3463 Nonferrous Forgings
3465 Automotive Stampings
3466 Crowns & Closures
3469 Metal Stampings, N.E.C.
3471 Electroplating, Plating, Polishing, Anodizing, & Coloring
3479 Coating, Engraving, & Allied Services, N.E.C.
3482 Small Arms Ammunition
3483 Ammunition, Except for Small Arms
3484 Small Arms
3489 Ordinance & Accessories, N.E.C.
3491 Industrial Valves
3492 Fluid Power Valves & Hose Fittings

Fabricated Metal Products, Except Machinery & Transportation Equipment (Cont.)

3493 Springs, Steel, Except Wire
3494 Valves & Pipe Fittings, N.E.C.
3495 Wire Springs
3496 Miscellaneous Fabricated Wire Products
3497 Metal Foil & Leaf
3498 Fabricated Pipe & Pipe Fittings
3499 Fabricated Metal Products, N.E.C.

Industrial & Commercial Machinery & Computer Equipment

3511 Steam, Gas, & Hydraulic Turbines, & Turbine Generator Set Units
3519 Internal Combustion Engines, N.E.C.
3523 Farm Machinery & Equipment
3524 Lawn & Garden Tractors & Home Lawn & Garden Equipment
3531 Construction Machinery & Equipment
3532 Mining Machinery & Equipment, Except Oil & Gas Field Machinery & Equipment
3533 Oil & Gas Field Machinery & Equipment
3534 Elevators & Moving Stairways
3535 Conveyors & Conveying Equipment
3536 Overhead Traveling Cranes, Hoists, & Monorail Systems
3537 Industrial Trucks, Tractors, Trailers, & Stackers
3541 Machine Tools, Metal Cutting Types
3542 Machine Tools, Metal Forming Types
3543 Industrial Patterns
3544 Special Dies & Tools, Die Sets, Jigs, & Fixtures, & Industrial Molds
3545 Cutting Tools, Machine Tool Accessories, & Machinists' Precision Measuring Devices
3546 Power Driven Handtools
3547 Rolling Mill Machinery & Equipment
3548 Electric & Gas Welding & Soldering Equipment
3549 Metalworking Machinery, N.E.C.
3552 Textile Machinery
3553 Woodworking Machinery
3554 Paper Industries Machinery
3555 Printing Trades Machinery & Equipment
3556 Food Products Machinery
3559 Special Industry Machinery, N.E.C.
3561 Pumps & Pumping Equipment
3562 Ball & Roller Bearings
3563 Air & Gas Compressors
3564 Industrial & Commercial Fans & Blowers, & Air Purification Equipment
3565 Packaging Machinery
3566 Speed Changers, Industrial High-Speed Drives, & Gears
3567 Industrial Process Furnaces & Ovens
3568 Mechanical Power Transmission Equipment, N.E.C.
3569 General Industrial Machinery & Equipment, N.E.C.
3571 Electronic Computers
3572 Computer Storage Devices
3575 Computer Terminals
3577 Computer Peripheral Equipment, N.E.C.

Note: N.E.C. means Not Elsewhere Classified.

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Industrial & Commercial Machinery & Computer Equipment

3578	Calculating & Accounting Machines, Except Electronic Computers
3579	Office Machines, N.E.C.
3581	Automatic Vending Machines
3582	Commercial Laundry, Drycleaning, & Pressing Machines
3585	Air Conditioning & Warm Air Heating Equipment & Commercial & Industrial Refrigeration Equipment
3586	Measuring & Dispensing Pumps
3589	Service Industry Machinery, N.E.C.
3592	Carburetors, Pistons, Piston Rings, & Valves
3593	Fluid Power Cylinders & Actuators
3594	Fluid Power Pumps & Motors
3596	Scales & Balances, Except Laboratory
3599	Industrial & Commercial Machinery & Equipment, N.E.C.

Electronic & Other Electrical Equipment & Components, Except Computer Equipment

3612	Power, Distribution, & Specialty Transformers
3613	Switchgear & Switchboard Apparatus
3621	Motors & Generators
3624	Carbon & Graphite Products
3625	Relays & Industrial Controls
3629	Electrical Industrial Apparatus, N.E.C.
3631	Household Cooking Equipment
3632	Household Refrigerators, & Home & Farm Freezers
3633	Household Laundry Equipment
3634	Electrical Housewares & Fans
3635	Household Vacuum Cleaners
3639	Household Appliances, N.E.C.
3641	Electric Lamps Bulbs & Tubes
3643	Current-Carrying Wiring Devices
3644	Noncurrent-Carrying Wiring Devices
3645	Residential Electric Lighting Fixtures
3646	Commercial, Industrial, & Institutional Electric Lighting Fixtures
3647	Vehicular Lighting Equipment
3648	Lighting Equipment, N.E.C.
3651	Household Audio & Video Equipment
3652	Phonograph Records & Prerecorded Audio Tapes & Disks
3661	Telephone & Telegraph Apparatus
3663	Radio & Television Broadcasting & Communications Equipment
3669	Communications Equipment, N.E.C.
3671	Electron Tubes
3672	Printed Circuit Boards
3674	Semiconductors & Related Devices
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils, Transformers, & Other Inductors
3678	Electronic Connectors
3679	Electronic Components, N.E.C.
3691	Storage Batteries
3692	Primary Batteries, Dry & Wet

Electronic & Other Electrical Equipment & Components, Except Computer Equipment (Cont.)

3694	Electrical Equipment for Internal Combustion Engines
3695	Magnetic & Optical Recording Media
3699	Electrical Machinery, Equipment, & Supplies, N.E.C.

Transportation Equipment

3711	Motor Vehicles & Passenger Car Bodies
3713	Truck & Bus Bodies
3714	Motor Vehicle Parts & Accessories
3715	Truck Trailers
3716	Motor Homes
3721	Aircraft
3724	Aircraft Engines & Engine Parts
3728	Aircraft Parts & Auxiliary Equipment, N.E.C.
3743	Railroad Equipment
3751	Motorcycles, Bicycles, & Parts
3761	Guided Missiles & Space Vehicles
3764	Guided Missile & Space Vehicle Propulsion Units & Propulsion Unit Parts
3769	Guided Missile & Space Vehicle Parts & Auxiliary Equipment, N.E.C.
3792	Travel Trailers & Campers
3795	Tanks & Tank Components
3799	Transportation Equipment, N.E.C.

Measuring, Analyzing & Controlling Instruments; Photographic, Medical, & Optical Goods; Watches & Clocks

3812	Search, Detection, Navigation, Guidance, Aeronautical, & Nautical Systems & Instruments
3821	Laboratory Apparatus & Furniture
3822	Automatic Controls for Regulating Residential & Commercial Environments & Appliances
3823	Industrial Instruments for Measurement, Display, & Control of Process Variables, & Related Products
3824	Totalizing Fluid Meters & Counting Devices
3825	Instruments for Measuring & Testing of Electricity & Electrical Signals
3826	Laboratory Analytical Instruments
3827	Optical Instruments & Lenses
3829	Measuring & Controlling Devices, N.E.C.
3841	Surgical & Medical Instruments & Apparatus
3842	Orthopedic, Prosthetic, & Surgical Appliances & Supplies
3843	Dental Equipment & Supplies
3844	X-Ray Apparatus & Tubes & Related Irradiation Apparatus
3845	Electromedical & Electrotherapeutic Apparatus
3851	Ophthalmic Goods
3861	Photographic Equipment & Supplies
3873	Watches, Clocks, Clockwork Operated Devices, & Parts

Note: N.E.C. means Not Elsewhere Classified.

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Miscellaneous Manufacturing Industries

3911	Jewelry, Precious Metal
3914	Silverware, Plated Ware, & Stainless Steel Ware
3915	Jewelers' Findings & Materials, & Lapidary Work
3931	Musical Instruments
3942	Dolls & Stuffed Toys
3944	Games, Toys, & Children's Vehicles, Except Dolls & Bicycles
3949	Sporting & Athletic Goods, N.E.C.
3951	Pens, Mechanical Pencils, & Parts
3952	Lead Pencils, Crayons, & Artists' Materials
3953	Marking Devices
3955	Carbon Paper & Inked Ribbons
3961	Costume Jewelry & Costume Novelties, Except Precious Metal
3965	Fasteners, Buttons, Needles, & Pins
3991	Brooms & Brushes
3993	Signs & Advertising Specialties
3995	Burial Caskets
3996	Linoleum, Asphalted-Felt-Base, & Other Hard Surface Floor Coverings, N.E.C.
3999	Manufacturing Industries, N.E.C.

Public Warehousing & Storage

4221	Farm Product Warehousing & Storage
4222	Refrigerated Warehousing & Storage
4225	Warehousing & Storage, General

Note: N.E.C. means Not Elsewhere Classified.

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TABLE 4
MANDITORY INDUSTRIES (Categories iv, v, vii, and ix)
Permit Required in Any Case
April 1992

TYPE OF FACILITY	FACILITIES INCLUDED	FACILITIES EXCLUDED	COMMENTS
Hazardous Waste Treatment Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) use any method, technique, or process, to change the physical, chemical, or biological character or composition of RCRA hazardous wastes for the purpose of neutralization; energy or material resource recovery; rendering such waste nonhazardous, less hazardous, or safer to transport, store, or dispose; reducing waste volume; or making such waste more amenable for recovery or storage.		RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Hazardous Waste Storage Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) hold RCRA hazardous wastes from onsite or offsite locations for a temporary period until the waste is treated, disposed of, or stored elsewhere.	Temporary hazardous waste storage facilities operated for less than 90 days are not covered by RCRA.	RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Hazardous Waste Disposal Facilities	Facilities regulated by the State Department of Toxic Substances Control, which: a) operate under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), and b) discharge, deposit, inject, or place RCRA hazardous wastes on or into any land or water.		RCRA hazardous wastes are defined in Section 66261.3 of Title 22 of the California Code of Regulations.
Landfills	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.		A Landfill is defined as an area of land or excavation in which wastes are placed for permanent disposal, excluding land application sites, surface impoundments, injection wells, and waste piles (40 CFR Part 257.2).

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TABLE 4
MANDITORY INDUSTRIES (Categories iv, v, vii, and ix)
Permit Required in Any Case
April 1992

TYPE OF FACILITY	FACILITIES INCLUDED	FACILITIES EXCLUDED	COMMENTS
Land Application Sites	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.	Manure spreading operations.	A Land Application Site is defined as an area where wastes are applied onto or incorporated into the soil surface for agricultural purposes or for treatment and disposal (40 CFR Part 257.2).
Open Dumps	Active, inactive, and closed sites that: a) receive or have received wastes from other facilities covered by the General Industrial Stormwater NPDES Permit, b) are subject to regulation under Subtitle D of RCRA, or c) have accepted wastes from construction activities involving clearing, grading, or excavation of five acres or more.		An Open Dump is a municipal landfill failing to satisfy the Criteria for Municipal Solid Waste Landfills specified in 40 CFR Part 258. Open dumps are prohibited under Section 4005 of RCRA.
Steam Electric Power Generating Facilities	Facilities that generate electricity utilizing fossil type fuel (coal, oil, or gas) and raw material storage areas, including coal handling sites.	Facilities with NPDES permits which regulate stormwater discharges.	
Wastewater Treatment, Storage, Recycling, or Reclamation Facilities	Facilities that treat, store, recycle, or reclaim municipal wastewater, including adjoining land dedicated to sewage sludge disposal.	1. Facilities with NPDES permits which regulate stormwater discharges. 2. Facilities with design capacities of less than 1 MGD which are not required to have a pretreatment program under 40 CFR Part 403. 3. Farm lands and domestic gardens where sludge is beneficially reused, or sludge management facilities which are not located on land adjoining the treatment, storage, recycling, or reclamation facilities site. 4. Facilities that are in compliance with Section 405 of the Clean Water Act (federal regulations governing sewage sludge disposal). 5. Facilities that collect all stormwater runoff and discharge the runoff back to the headworks of the treatment facility.	

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Appendix D

Agreements To Coordinate Inspection Responsibilities and Services

1) Memorandum of Understanding (MOU) Between the Alameda Countywide Clean Water Program (ACCWP) and the San Francisco Bay Regional Water Quality Control Board

2) Update to the ACCWP/Regional Board MOU - Letter to Steven Ritchie, February 25, 1993

3) Update to the ACCWP/Regional Board MOU - Letter to Steven Ritchie, March 24, 1994

4) MOU Between the San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) and the San Francisco Bay Regional Water Quality Control Board

5) Contractual Services Agreement Between the City of Fremont and the Union Sanitary District

6) Agreement for Industrial Inspection Services Between the City of Emeryville and the Alameda County Department of Environmental Health

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Memorandum of Understanding
To Coordinate Industrial/Business Storm Water Pollution Control Activities
Conducted by the Alameda County Urban Runoff Clean Water Program and the
California Regional Water Quality Control Board
San Francisco Bay Region

I. BACKGROUND AND PURPOSE

This memorandum of understanding (MOU) is entered into between the Alameda County Urban Runoff Clean Water Program (ACURCWP) and the San Francisco Bay Regional Water Quality Control Board (Regional Board) staff to define their mutual roles and responsibilities in implementing industrial/business storm water pollution control activities. There are parallel and overlapping responsibilities placed on both agencies in regulating storm water discharges from business and industry. This MOU addresses the need to describe the working relationship between the ACURCWP's and Regional Board staff's programs for the mutual benefit of the two programs and for the benefit of the industrial/business facilities being regulated.

The benefits to the ACURCWP member agencies and to the Regional Board staff include sharing information, coordinating the implementation of the industrial/business storm water program so that the limited resources available to both groups are used effectively, and communicating a clear and consistent message to industry/business about what the expectations and requirements are of both programs.

The following describes the basis for the Regional Board's involvement in regulating the discharge of pollutants in storm water from industrial/business facilities.

1. EPA's storm water regulations define storm water associated with industrial activity to include storm water from specific categories of industrial facilities which are required to obtain industrial storm water NPDES permit coverage.

2. The Regional Water Quality Control Boards and the State Water Resources Control Board (SWRCB) of the State of California are authorized by EPA to issue general or individual NPDES permits to regulate industrial storm water discharges as well as other types of discharges.

3. The California State Water Resources Control Board (SWRCB) adopted a General Industrial Storm Water NPDES permit on November 19, 1991 which provides a mechanism for industries subject to the EPA regulations to obtain NPDES permit coverage and as part of the NPDES permit these facilities are required to do the following:

    - Eliminate non-storm water discharges (including illicit connections) to storm water systems;

    - Develop and implement a storm water pollution prevention

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plan; and

- Perform monitoring of discharges to storm water systems.

4. The Regional Board already regulates certain categories of industry and business such as Publicly Owned Treatment Works (POTWs), municipal landfills, federal and state facilities (such as the Lawrence Livermore National Laboratory and U.C. and state university campuses), and certain NPDES permitted facilities which would be wasteful for the ACURCWP to try to duplicate, and which in some cases it may be pre-empted from regulating by state and federal regulations.

5. The Regional Board staff is responsible for implementation of the NPDES program and cannot delegate that authority to local agencies, but it can define its working relationships with other groups and agencies with similar programs.

The following describes the basis for the ACURCWP's involvement in regulating the discharge of pollutants from industrial/business facilities.

1. The Clean Water Act and EPA's storm water regulations require that municipalities obtain NPDES permit coverage to effectively prohibit illicit discharges to their storm drain system and to regulate the discharge of pollutants in storm water from all sources including commercial, retail, and industrial facilities to the maximum extent practicable.

2. The ACURCWP was formed in 1991 by the fourteen cities in Alameda County, Alameda County, the Alameda County Flood Control and Water Conservation District (District) and Zone 7 of the District to obtain a municipal storm water NPDES permit and to implement a Storm Water Management Plan.

3. The Storm Water Management Plan for the ACURCWP describes pollutant control activities that will be performed to as part of the industrial discharger identification and runoff control program component to include in part the following:

   - Maintain and update an industrial/business database;
   - Develop annually a preliminary list of industries/businesses to be inspected;
   - Develop minimum qualifications, standards, and procedures for conducting industrial/business inspections;
   - Notify and survey industries/businesses about the ACURCWP's program, current BMPs being used, and the role of the Regional

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Board;

- Develop inspection plans and implement an inspection program on a preliminary, partial basis in FY 1992-93 (July 1 - June 30) and fully in FY 1993-94;

- Develop BMP guidelines using available information and information developed as part of surveys and distribute these to the municipal agencies conducting inspections; and

- Develop and distribute educational material about target industrial/business groups to municipalities and to the target groups.

2. **UNDERSTANDINGS REACHED**

A. The Regional Board staff will be the lead regulatory contact in controlling the quality of storm water runoff from POTWs, municipal landfills, existing individual NPDES-permitted facilities, state and federal facilities and from any other industrial discharges which it so chooses. For purposes of this agreement the lead regulatory contact means the public agency which will have the primary role in inspecting, communicating, and enforcing storm water pollution prevention requirements as described either in the Storm Water Management Plan for ACURCWP member agencies or as described in available agreements, procedures, and guidance for the Regional Board staff.

B. The ACURCWP member agencies will be the lead regulatory contact for other business and industrial facilities which it has assigned a high priority for regulating as determined on an annual basis by each of the responsible ACURCWP member agencies and as reported to the Regional Board staff.

C. The Regional Board staff and the ACURCWP member agencies will share information when requested as follows:

1. The Regional Board staff will supply public information on Notifications of Intent that have been filed, storm water pollution prevention plans received, monitoring results submitted, inspections it has conducted, and any other public information it has that the ACURCWP member agencies request for the specific purpose of implementing its storm water program.

2. The ACURCWP member agencies will supply public information on industrial storm water NPDES permitted facilities it is acting as the lead regulatory contact for which is requested by the Regional Board staff for the specific purpose of implementing its storm water program.

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D. During ACURCWP member agencies' current municipal NPDES permit period (until October 16, 1996), the Regional Board staff and the ACURCWP member agencies will focus their resources on requiring that industries and businesses implement Best Management Practices (BMPs) to reduce pollutants to the maximum extent practicable and on effectively eliminating illicit discharges. The BMPs which will be implemented will include those developed by the Stormwater Quality Task Force in the BMP Handbook and other lists of BMPs proposed by industry, proposed by either the Regional Board staff or the ACURCWP member agencies which are acceptable to both parties.

E. The Regional Board staff and the ACURCWP member agencies agree to emphasize efforts to notify and educate the owners and operators of industries and businesses as the primary means of beginning to achieve reductions in pollutants in storm water runoff. Where information about the requirements of the storm water program has been provided and this has failed to result in the reduction of pollutant discharges or the activities being conducted require an immediate or more active response, the lead regulatory contact will take appropriate enforcement actions. The enforcement procedures contained in the ACURCWP's October 1991 (or as amended) "Minimum Procedures, Qualifications, and Standards for Conducting Industrial Inspections for the Alameda County Urban Runoff Clean Water Program" will be used by the ACURCWP member agencies and these procedures are acceptable to the Regional Board staff.

F. The Regional Board staff and the ACURCWP member agencies agree to coordinate enforcement activities so as to maximize the use of existing resources and minimize the chance for regulatory overlap. To achieve this coordination the lead regulatory contact will conduct the enforcement activity. Nonetheless, either agency can request that the other take over the lead enforcement if more effective and expeditious enforcement is likely to result. These requests may be rejected by the agency being requested to take over the lead enforcement.

G. The Regional Board staff and the ACURCWP member agencies agree that this agreement will be effective when signed by representatives from the Regional Board and the ACURCWP. The agreement is expected to be amended and revised as the relationship between the Regional Board staff and the ACURCWP becomes better defined through actual experience implementing this new program.

H. The Regional Board staff agrees to explore the possibility of reimbursing ACURCWP member agencies under the following conditions:

1. The ACURCWP member agency has an industrial and business regulatory program acceptable to the Regional Board staff.

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2. The activities being conducted by the ACURCWP member agency supplant industrial storm water NPDES permit activities which the Regional Board staff would otherwise have to conduct.

I. The ACURCWP member agencies agree to continue to assist industries to become informed about their responsibilities for obtaining industrial storm water NPDES permit coverage.

J. The ACURCWP member agencies agree to work with interested industrial storm water dischargers to coordinate pollutant monitoring of storm water runoff from their industrial facilities with the ACURCWP.

The Chairperson of the ACURCWP is authorized by the unanimous vote of all the representatives or alternates present at the June 23, 1992 Management Committee meeting to sign this MOU on their behalf.

_____
Jack Lindley, Chairperson ACURCWP
Management Committee

_____
Date

APPROVED AS TO FORM:

_____
Alameda County Counsel

_____
Steven R. Ritchie, Executive Officer
San Francisco Bay Regional Water
Quality Control Board

_____
Date

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Alameda County
Urban Runoff
Clean Water Program
A Consortium of Local Agencies
399 Elmhurst Street, Hayward CA 94544
(510) 670-5543 FAX (510) 782-1939

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February 25, 1993

Mr. Steven Ritchie
Executive Officer
San Francisco Bay Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland, California 94612

Member Agencies:

Alameda County

Alameda County Flood Control District

Alameda

Albany

Berkeley

Dublin

Emeryville

Fremont

Hayward

Livermore

Newark

Oakland

Piedmont

Pleasanton

San Leandro

Union City

Zone 7 of the Alameda County Flood Control District

SUBJECT: ACURCWP Industrial and Commercial Business Inspections Assistance to Regional Board Staff with General Industrial Storm Water NPDES Permit Activities

Dear Mr. Ritchie:

This letter outlines the role of Alameda County Urban Runoff Clean Water Program (ACURCWP) member agencies' industrial and commercial business inspectors (inspectors) in assisting San Francisco Bay Regional Water Quality Control Board (Regional Board) staff in enforcing the general industrial storm water NPDES permit. The purpose of this letter is to further elaborate on the details of the Memorandum of Understanding (MOU) between the ACURCWP and the Regional Board staff to coordinate industrial business storm water pollution control activities. After extensive discussions with Regional Board staff, the Industrial and Commercial Businesses Subcommittee has made the following recommendations to the Management Committee, which the Management Committee adopted during its February 23, 1993 meeting.

Follow-up and Enforcement Activities

The ACURCWP Management Committee is fully committed to maintaining a good working relationship with the Regional Board. As such, the Management Committee feels that the ACURCWP business inspection program should have a comprehensive role for administering the general industrial storm water NPDES permit. This role would be in the best interest of everyone involved with inspecting industrial and commercial business facilities including business owners and operators, the Regional Board staff, and municipal inspectors. The Management Committee accepts that municipalities must perform industrial and commercial business inspections under its municipal storm water NPDES permit and accepts the cost necessary to perform these business inspections. However, the costs for the additional level of effort needed to administer the general industrial storm water NPDES permit is beyond the costs for the level of effort municipalities are required to perform under their municipal storm water permit. The Management Committee

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understands, but does not find feasible the Regional Board staff's suggestions that an additional $250 storm water fee be collected from facilities in Alameda County to cover administration of the general industrial storm water NPDES permit. The Management Committee requests that the Regional Board reimburse the municipalities in Alameda County for the administration of the general industrial storm water NPDES permit. The Industrial and Commercial Business Subcommittee is available to Regional Board staff to further discuss the details involved in administering the general industrial storm water NPDES permit.

General Industrial Storm Water NPDES Permit

If inspectors visit a facility they recognize by regulation should have an industrial storm water permit, but is presently not covered under the general industrial storm water NPDES permit, inspectors will:

1. Recommend to the facility representative that the facility obtain coverage under the general industrial storm water NPDES permit. Inspectors may provide the facility representative a copy of the general permit and Notice of Intent (NOI) form. *To the best of the inspector's ability*, they will answer any questions the facility representative may have concerning the general permit.

2. Refer further questions to Regional Board staff.

3. Communicate to Regional Board staff the names of facilities inspected that appear to need a storm water permit but have not filed a NOI.

The NOI database presently available to inspectors lists 365 facilities in Alameda County which have filed an NOI as of July 1992. No mechanism has been established for ACURCWP inspectors to receive updates to the NOI database on a regular basis. Based on ACURCWP member agencies' industrial and commercial business plans, inspectors anticipate visiting facilities in the NOI database by the end of fiscal year 1993/94 as described in each municipality's inspection plan. We request that the Regional Board staff notify the ACURCWP of additional facilities which have filed a NOI after July 1992.

Storm Water Pollution Prevention Plans

For applicable facilities currently listed in the NOI database that was distributed by the State Water Resources Control Board (State Board), inspectors will:

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1. Review the facility's Storm Water Pollution Prevention Plan (SWPPP). Inspectors may require additional best management practices (BMPs) if they feel the facility has inadequately reduced pollutants discharged to the storm drain system.

2. Communicate inspectors' professional view on the adequacy of SWPPPs to Regional Board staff. Inspectors may also describe additional BMPs suggested to facility representatives.

3. Communicate to Regional Board staff the names of facilities that have not completed a SWPPP or, for larger facilities, developed a schedule for its completion within a reasonable period of time.

Monitoring Programs

For applicable facilities currently listed in the NOI database that was distributed by the State Board, inspectors will:

1. Review the facility's Monitoring Program. Inspectors may require changes and/or additions to the Monitoring Program if they feel the facility has inadequately addressed the objectives of the Monitoring Program as described in Section B3 of the general industrial storm water NPDES permit.

2. Communicate inspectors' professional view on the adequacy of Monitoring Programs to Regional Board staff. Inspectors may also describe recommendations that were made to facility representatives.

3. Communicate to Regional Board staff which facilities have not completed a Monitoring Program or, for larger facilities, not developed a schedule for its completion within a reasonable time period.

Certification by ACURCWP Member Agencies

During past discussions with the Industrial and Commercial Business Subcommittee and Work Group, Regional Board staff has pointed out that local agencies under Section B9 of the general industrial storm water NPDES permit may "certify" that a facility has developed and implemented an effective SWPPP. This certification would qualify the facility for an exemption to the general permit's sampling and analysis requirements. The Industrial and Commercial Business Subcommittee and the Management Committee have not discussed whether ACURCWP member agencies will be issuing monitoring certifications and will address this issue at a later date.

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The Management Committee recognizes that this letter and the issues involved are parts of the evolving process of program development. The Management Committee will continue to work with the Regional Board staff to identify ways to best coordinate implementation of the ACURCWP business inspection program. We believe that the ongoing efforts to improve coordination will benefit local commercial and industrial businesses and increase the effectiveness of both the Regional Board staff's and the ACURCWP's inspection and education outreach activities.

If you have any questions, feel free to call either me at (510) 670-5563, or Joe Lucia at (510) 293-5060.

Very truly yours,

Jack Lindley
Management Committee Chairperson

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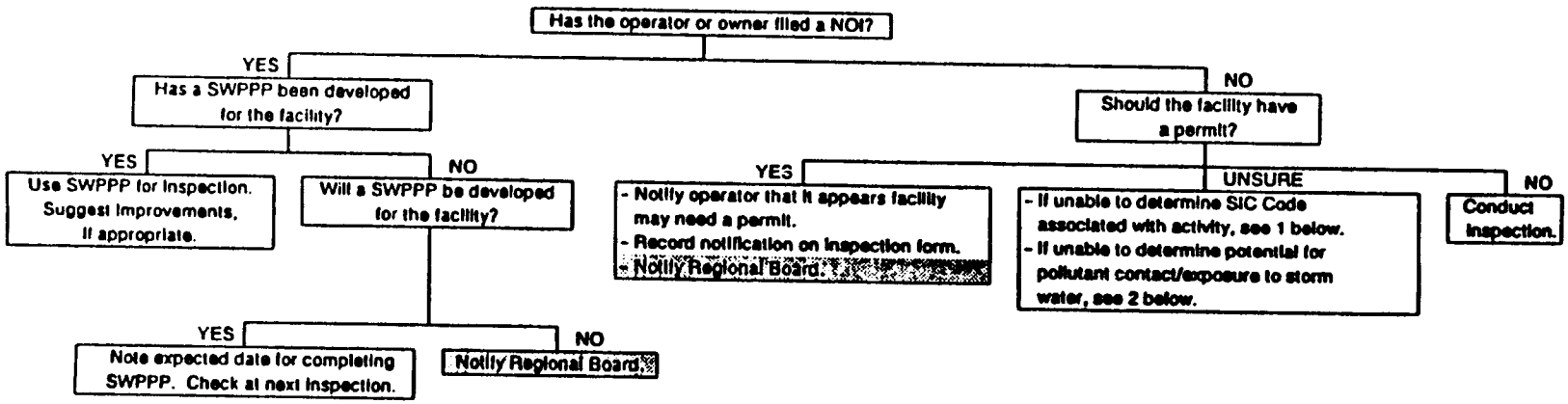
AGENDA ITEM 2

DRAFT

Decision Tree for Coordination between the Alameda County Urban Runoff Clean Water Program's Industrial and Commercial Business Inspections and the Regional Board's General Industrial Storm Water NPDES Permit Inspections



NOI	Notice of Intent
Regional Board	San Francisco Bay Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWPPP	Storm Water Pollution Prevention Plan

December 3, 1992
EOA, Inc.

R0035145

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AGENDA ITEM 2

DRAFT

Decision Tree for Coordination between the Alameda County Urban Runoff Clean Water Program's Industrial and Commercial Business Inspections and the Regional Board's General Industrial Storm Water NPDES Permit Inspections

1. Unable to determine SIC Code associated with activity

Give operator a copy of the guidance document from the Regional Board "Overview of the NPDES General Permit for Discharges of Storm Water Associated with Industrial Activities." (Refer to Attachment I of guidance document.)

If inspector feels facility needs a permit but the facility operator does not, note on inspection form and notify the Regional Board. Continue with inspection.

If operator feels facility needs a permit, instruct the operator he/she must file a NOI and annual filing fee, and develop and implement a SWPPP and Monitoring Program.

If operator feels facility activity falls under a conditional category (category xi) but it is not clear whether there potential for pollutant contact/exposure with storm water, proceed to number 2.

2. Unable to determine potential for pollutants contact/exposure to storm water

Refer to Attachment II of "Overview of the NPDES General Permit for Discharges of Storm Water Associated with Industrial Activities."

Conduct inspection and note where there is potential for pollutant contact/exposure to storm water and actions that should be taken, if appropriate.

Have operator determine if there is contact/exposure with storm water. If the operator determines there is no contact/exposure, the operator or owner should document that the following conditions are met:

1. All illicit (un-permitted) connections to the storm drainage system must be eliminated;
2. All materials must be completely contained at all times so, if spilled, they will not directly or indirectly contact storm water; and
3. All emissions from stacks or air exhaust systems, unhoused manufacturing and heavy industrial equipment, and emissions of dust or particulates must not be exposed to storm water.

These conditions are taken from Attachment II of "Overview of the NPDES General Permit for Discharges of Storm Water Associated with Industrial Activities." Documentation that these conditions apply to the facility should be kept on file at the site.

If the operator determines there is contact/exposure, instruct the operator he/she must file a NOI and annual filing fee, and develop and implement a SWPPP and Monitoring Program.

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Alameda County
Urban Runoff
Clean Water Program
A Consortium of Local Agencies
399 Elmhurst Street, Hayward CA 94544
(510) 670-5543 FAX (510) 782-1939

VOL 12

March 24, 1994

Mr. Steven Ritchie
Executive Officer
San Francisco Bay Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland, California 94612

SUBJECT:ACURCWP Industrial and Commercial Business Inspections Assistance to Regional Board Staff with General Industrial Storm Water NPDES Permit Activities

Dear Mr. Ritchie:

After a year of implementing the industrial inspection component of the Alameda County Urban Runoff Clean Water Program (ACURCWP), the member agencies have realized the need to update the details of the Memorandum of Understanding (MOU) between the ACURCWP and the San Francisco Bay Regional Water Quality Control Board (Regional Board) concerning the inspection of storm water pollution control activities of industrial businesses. This letter supersedes the letter dated February 25, 1993, under the subject title: ACURCWP Industrial and Commercial Business Inspections Assistance to Regional Board with General Industrial Storm Water NPDES Permit Activities.

Based on the recommendation of the Industrial & Illicit Discharge Control Subcommittee, the ACURCWP Management Committee adopted during its March 22, 1994 meeting the following procedures for coordinating its industrial inspection program with the Regional Board's General Permit process.

Follow-up and Enforcement Activities

The ACURCWP Management Committee is fully committed to maintaining a good working relationship with the Regional Board. As such, the Management Committee feels that the ACURCWP business inspection program should have a supporting role for administering the general industrial storm water NPDES permit (general permit). This role would be in the best interest of everyone involved with inspecting industrial and commercial business facilities, including business owners and operators, Regional Board staff, and municipal inspectors. The Industrial & Illicit Discharge Subcommittee remains available to Regional Board staff to further discuss issues relating to administering the general permit.

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General Industrial Storm Water NPDES Permit

If inspectors visit a facility they recognize by regulation should have an industrial storm water permit but is presently not covered under the general industrial storm water NPDES permit, inspectors will:

1. Recommend to the facility representative that the facility obtain coverage under the general industrial storm water NPDES permit. Inspectors may provide the facility representative a copy of the general permit and Notice of Intent (NOI) form. *To the best of the inspector's ability*, they will answer any questions the facility representative may have concerning the general permit.

2. Refer further questions to Regional Board staff.

3. Communicate to Regional Board staff the names of facilities inspected that appear to need a storm water permit but have not filed a NOI, and inform the business that they are doing so.

We request that Regional Board staff notify the ACURCWP on a quarterly basis regarding facilities that have filed a NOI.

Storm Water Pollution Prevention Plans

For applicable facilities listed in the most recent version of the NOI database distributed by the Regional Board staff, inspectors:

1. Will communicate to Regional Board staff the names of facilities that do not have a Storm Water Pollution Prevention Plan (SWPPP).

2. Will use the facility's SWPPP as a tool in assisting the agency's storm water pollution control activities. This will not imply approval or review of the adequacy of the SWPPP.

3. May require additional best management practices (BMP) if they feel the facility has inadequately reduced pollutants discharged to the storm drain system.

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Monitoring Programs

For applicable facilities listed in the recent version of the NOI database distributed by Regional Board staff, inspectors will communicate to Regional Board staff which facilities have not completed a Monitoring Program as documented on the Standard Industrial and Commercial Business Inspection Report.

Certification by ACURCWP Member Agencies

Section B9 of the general permit allows local agencies to "certify" that a facility has developed and implemented an effective SWPPP. This certification would qualify the facility for an exemption to the general permit's sampling requirements. The certification program is currently being developed by the Regional Board and has not yet been adopted.

The Management Committee recognizes that this letter and the issues involved are parts of the evolving process of program development. The Management Committee will continue to work with Regional Board staff to identify ways to best coordinate implementation of the ACURCWP business inspection program. We believe that ongoing efforts to improve coordination will benefit local businesses and increase the effectiveness of inspection and education outreach activities of both Regional Board and ACURCWP staff.

If you have any questions, feel free to call either me at (510) 670-6479, or Paul Zolfarelli, Industrial & Illicit Discharge Control Subcommittee Chairperson, at (510) 577-6030.

Very truly yours,

Robert Hale
Management Committee Chairperson

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Exhibit A

TASK ORDER NO. 1 to
AGREEMENT BETWEEN CITY OF FREMONT
AND UNION SANITARY DISTRICT FOR
SERVICES FOR
THE URBAN RUNOFF CLEAN WATER PROGRAM

- the checklists and other inspection criteria which will be used during the inspection.
- the activities and information gathering which will be completed as part of preparing to conduct an inspection.
- the procedures which will be used during the inspection.
- the procedures which will be used to remedy deficiencies found during an inspection.
- the criteria for follow-up inspections.

Task 3. Annual Reporting

This task includes the submittal of information requested by the General Program to complete the industrial dischargers identification and runoff control section of the annual report. The task will require summarizing all activities that have been conducted during FY 1992/93 for this program component.

Task 4. Co-ordinate with City

The District is to co-ordinate with the City to develop enabling ordinance granting the District limited enforcement powers necessary to obtain compliance with provisions of the Section 9.0 of the Management Plan.

Task 5. First Year Reporting Requirement Deliverables

- Preliminary list of industries to be inspected during the first year - Due by July 28, 1992.
- Inspection plan per Task 2.0 - Due by October 30, 1992.
- Final list of industries inspected - Due by July 15, 1993.
- Information to meet annual reporting requirements per Task 3.0 - Due July 15, 1993.
- Annual expenditure report for previous fiscal year activities - Due by August 15, 1993.

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Exhibit B

AGREEMENT BETWEEN CITY OF FREMONT
AND UNION SANITARY DISTRICT FOR
COMPENSATION SCHEDULE RATES
FOR
THE URBAN RUNOFF CLEAN WATER PROGRAM

Salaries: [1]

Technical Services Manager (Project Manager) ..... $ 35.66/Hr.

Environmental Compliance Supervisor ..... $ 26.45/Hr.

Environmental Compliance Inspector III ..... $ 22.88/Hr.

Vehicle Use: ..... $ 8.25/Hr.

Outside Laboratory Costs: ..... As billed

A multiplier of 2.53 shall be applied to all salary rates. The multiplier reflects the District's overhead rate and includes benefits, District-wide administrative costs and personnel support expenses such as safety supplies.

The maximum ceiling costs for the first year of services shall not exceed ..... $ 75,000.00

Invoices shall be sent to the City on a quarterly basis, with the first of four equal installments due on July 1, 1992.

[1] Salaries may be subject to slight upward adjustments (5% range) for FY 92-93 and annually thereafter due to bargaining agreements.

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Herb - Exhibit B

Agreement to Coordinate Industrial and Commercial Storm Water Pollution Prevention and Control Activities Conducted by the San Mateo Countywide Stormwater Pollution Prevention Program and the California Regional Water Quality Control Board San Francisco Bay Region

I. BACKGROUND AND PURPOSE

This Memorandum of Understanding (MOU) is entered into between City/County Association of Governments (C/CAG) for the San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) and the San Francisco Bay Regional Water Quality Control Board (Regional Board) staff to define their mutual roles and responsibilities in implementing storm water pollution prevention and control activities for industrial and commercial businesses. There are parallel and overlapping responsibilities placed on both groups in regulating storm water discharges from industrial and commercial businesses. This MOU addresses the need to describe the working relationship between the STOPPP and Regional Board staff's program for the mutual benefit of each and for the benefit of the industrial and commercial businesses being regulated.

The benefits of this MOU to the STOPPP and to the Regional Board staff include sharing information, coordinating the implementation of the industrial and commercial business storm water program so that the limited resources available to both groups are used effectively, and communicating a clear and consistent message to businesses about what the expectations and requirements are of both programs.

II. UNDERSTANDINGS REACHED

Classification of a Lead Regulatory Contact

1. The Regional Board staff will be the lead regulatory contact in controlling the quality of storm water runoff from Publicly Owned Treatment Works, municipal landfills, the San Francisco International Airport and operations conducted by tenants and users of this facility, businesses covered by the Regional Board's "General Waste Discharge Requirements for: Discharges of Stormwater from Boat Repair Facilities," existing individual NPDES-permitted facilities, state and federal facilities and any other industrial discharges which is deemed necessary. For purposes of this MOU, the lead regulatory contact means the public agency which will have the primary role in inspecting, communicating, and enforcing storm water pollution prevention requirements as described either in the San Mateo County Storm Water Management Plan (Plan) for the STOPPP or as described in available permits, procedures, and guidance for the Regional Board staff. Although different agencies may serve as lead regulatory contact, this agreement is not intended to limit any agency's ability to exercise its jurisdiction or enforcement authority as provided by law.

2. The STOPPP will be the lead regulatory contact for other industrial and commercial businesses and will conduct inspections and educational outreach according to the schedule contained in the Plan.

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Implementation Approach That Will Be Used

3. The Regional Board staff and the STOPPP will share information when requested as follows:

   a. The Regional Board staff will supply public information on Notifications of Intent that have been filed, storm water pollution prevention plans received, monitoring results submitted, inspections conducted, and any other public information they have that the STOPPP requests for the specific purpose of implementing its storm water program.

   b. The STOPPP will supply available public information on industrial storm water NPDES permitted facilities and other facilities for which it is acting as the lead regulatory contact that are requested by the Regional Board staff for the specific purpose of implementing its storm water program.

4. During STOPPP's current municipal NPDES permit period (until September 15, 1998), the Regional Board staff and the STOPPP intend to focus their limited resources on requiring that industries and businesses implement Best Management Practices (BMPs) to reduce pollutants to the maximum extent practicable and on effectively eliminating illicit discharges. The BMPs which will be implemented will include those developed by the California Stormwater Quality Task Force in the BMP Handbook and other lists of BMPs proposed by business and proposed by either the Regional Board staff or the STOPPP.

5. The Regional Board staff and the STOPPP agree to emphasize efforts to notify and educate the owners and operators of industrial and commercial businesses as the primary means of beginning to achieve reductions in pollutants in storm water runoff. Where information about the requirements of the storm water program has been provided and this has failed to result in the reduction of pollutant discharges or the activities being conducted require an immediate or more active response, the intent is is for the lead regulatory contact to take appropriate enforcement actions.

6. The Regional Board staff and the STOPPP agree to coordinate enforcement activities so as to maximize the use of existing resources, to minimize the chance for regulatory overlap, and to minimize possible confusion by industrial and commercial businesses.

Facilities Covered by the Industrial Storm Water General Permit

7. The STOPPP agrees to begin to assist industries for which it is the lead regulatory contact to become informed about their responsibilities for obtaining industrial storm water NPDES permit coverage. To the extent that the STOPPP has available resources, it will also evaluate the sufficiency of Stormwater Pollution Prevention Plans, Monitoring Plans, and Annual Monitoring reports for those facilities that have obtained coverage under the General Permit for Discharges of Storm Water Associated with Industrial Activities (Industrial Storm Water General Permit). In addition, as possible within available resources, STOPPP will encourage improvements in these documents as appear necessary. The results of these evaluations will be reported to the Regional Board staff as part of the Annual Report.

8. The STOPPP agrees to work with facilities it is the lead regulatory contact on that have obtained coverage under the General Industrial Activities Storm Water permit to

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coordinate their pollutant monitoring of storm water runoff with the STOPPP and to explore ways to maximize the usefulness of these monitoring activities.

Effective Date

9. The Regional Board staff and the STOPPP agree that this MOU will be effective for a period of five years from the date signed by representatives from the Regional Board staff and C/CAG. The agreement may be amended, revised or terminated at any time as mutually agreed to in writing by Regional Board staff and C/CAG.

The Chairperson of C/CAG is authorized by vote of C/CAG on MAY 12, 1994 to sign this MOU on their behalf.

Raymond Miller, Chair, C/CAG

May 23, 1994
Date

APPROVED AS TO FORM:

5/17/94
C/CAG Counsel

Steven R. Ritchie, Executive Officer
San Francisco Bay Regional Water
Quality Control Board

6/7/94
Date

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CONTRACTURAL SERVICES AGREEMENT

Agreement for Reimbursement for conducting Activities Contained within THE URBAN RUNOFF CLEAN WATER PROGRAM

THIS AGREEMENT, is made and entered into on the 9th day of June, 1992 between the CITY OF FREMONT, a public agency of the State of California, hereinafter referred to as the "CITY", and the UNION SANITARY DISTRICT with offices located at 37532 Dusterberry Way, Fremont, California 94536 hereinafter referred to as DISTRICT.

WITNESSETH:

WHEREAS, the CITY has entered into an agreement dated April 21, 1992 with Alameda County Flood Control District entitled "Agreement to Implement the Alameda County Urban Runoff Clean Water Program"; and

WHEREAS. the agreement stipulates that CITY, to the extent of available funds, shall implement activities specified in "A Storm Water Management Plan for the Alameda County Urban Runoff Clean Water Program" hereinafter referred to as Management Plan; and

WHEREAS, the CITY is authorized to contract with the DISTRICT for the implementation of certain activities contemplated by this contract; and

WHEREAS, the DISTRICT is qualified to implement the activities as set forth in this Agreement;

ACCORDINGLY, CITY and DISTRICT for consideration hereinafter set forth, mutually agree as follows:

I. SCOPE OF WORK

For implementing activities specified herein, CITY shall pay DISTRICT a sum not to exceed $75,000 for work performed during the period July 1, 1992 through June 30, 1993 and $150,000 during the period July 1, 1993 through June 30, 1994. DISTRICT shall implement or assist CITY in those activities described in Section 8.0 and in Section 9.0 in the Management Plan contained in the National Pollutant Discharge Elimination System (NPDES) permit issued to Alameda County, the City of Fremont, and the thirteen other cities

in Alameda County on October 16, 1991. It is anticipated DISTRICT will implement activities summarized in Exhibit "A" of this Agreement.

This Agreement shall be reviewed annually in March by the CITY and the DISTRICT through the life of the NPDES permit. For purposes of this agreement, the expiration date shall be June 30, 1996.

II. PAYMENT

Terms and conditions for payment are described in Exhibit B of this agreement.

The DISTRICT will be paid equal quarterly installments with 1st payment due July 1, 1992. DISTRICT will provide to CITY an annual expenditure report for the currently completed Fiscal Year by August 15 of the succeeding Fiscal Year. Adjustments of actual expenditures of each completed Fiscal Year shall be made in the billing for the second quarterly installment in the following year.

In the event of the termination of this Agreement, the DISTRICT shall have the right to expend reasonable additional time to assemble work in progress for the purposes of proper closing of the work. Such additional effort and the associated costs shall not exceed 10% (ten percent) of the annual costs expended to the date of notice of termination.

III. EMPLOYER/EMPLOYEE RELATIONSHIP

No personnel employed by either CITY or DISTRICT shall acquire any rights or status in the agency providing such employment or the Agency which is the other party to this Agreement by virtue of this Agreement.

IV. CONFORMITY/COMPLIANCE WITH LAW

DISTRICT shall observe and comply with all applicable laws, ordinances, codes and regulations of governmental agencies, including federal, state, municipal, and local governing bodies, having jurisdiction over the scope of services or any part hereof, including all provisions of the Occupational Safety and Health Act of 1979 and all amendments thereto. DISTRICT shall indemnify and save CITY harmless from any and all liability, fines, penalties and consequences from DISTRICT noncompliance or violation of such laws, ordinances, codes and regulations.

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V. ASSIGNMENT OF CONTRACT

Nothing contained in this agreement shall be construed to permit assignment or transfer by DISTRICT of any rights under this Agreement and such assignment or transfer is expressly prohibited. However, the assignment prohibitions do not prevent the DISTRICT from retaining services from third parties to perform any of the individual tasks required in the implementation of the agreement.

VI. CONFIDENTIALITY OF INFORMATION

DISTRICT agrees to hold all project results and products confidential and not release them unless authorized by the CITY.

VII. FEDERAL AND STATE AUDITS

Until the expiration of five years after the furnishing of any services pursuant to this Agreement, DISTRICT shall make available, upon written request, to the Federal/State/County government or any of their duly authorized representatives, this Agreement, and such books, documents, and records of DISTRICT that are necessary to certify the nature and extent of the reasonable cost of services to CITY.

VIII. TERMINATION

If the conditions contained herein are not complied with by the DISTRICT, CITY may terminate agreement without incurring any liability to DISTRICT, by written notice to DISTRICT. If the conditions contained herein are not complied with by CITY, DISTRICT may terminate Agreement by written notice to CITY. Windup costs related to such termination shall be paid for as described in Section II Payment. In either such event, the party terminating this agreement shall give thirty (30) days notice to the other party of such termination.

IX. MODIFICATION

No alteration or variation of the terms of this Agreement shall be valid unless made in writing and signed by the parties hereto.

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X. HOLD HARMLESS/INDEMNIFICATION

DISTRICT agrees to defend, indemnify and hold harmless CITY, its officers, employees and agents, from any and all acts, claims, omissions, liabilities and losses by whomever asserted arising out of acts or omissions of DISTRICT in the performance of the scope of work except those arising by reason the sole negligence of the CITY, its officers, employees or agents

CITY agrees to defend, indemnify, hold harmless DISTRICT, its officers, employees and agents, from any and all acts, claims, omissions, liabilities and losses by whomever asserted arising out of acts or omissions of CITY in the performance of the scope of work except those arising by reason of the sole negligence of the DISTRICT, its officers, employees or agents.

XI. INSURANCE/SELF-INSURANCE

DISTRICT is self-insured as to any requirements under this Agreement. No policies or bonds are required of either party as to any provisions of this Agreement.

XII. WORKERS' COMPENSATION

DISTRICT shall provide Workers' Compensation insurance at DISTRICT cost and expense and further, neither the CITY nor its carrier shall be entitled to recover costs, settlements, or expenses of Workers' Compensation claims from the CITY arising out of this Agreement.

XIII. EXECUTION

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the day and year first above written.

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UNION SANITARY DISTRICT

By: _____
Chairperson, The Board of Directors
Union Sanitary District

By: _____
Stephen T. Hayashi
General Manager/District Engineer

Approved as to form:

By: _____
District Legal Counsel

CITY OF FREMONT

By: _____
Mayor

Attest:

_____
City Clerk

Approved as to content:

By: _____
Public Works Director

Approved as to form:

By: _____
Deputy City Attorney

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Exhibit A

TASK ORDER NO. 1 to
AGREEMENT BETWEEN CITY OF FREMONT
AND UNION SANITARY DISTRICT FOR
SERVICES FOR
THE URBAN RUNOFF CLEAN WATER PROGRAM

1. Purpose
The purpose of this Task Order No. 1 is to authorize Union Sanitary District to provide technical support in the implementation of Section 9; "Industrial Discharge Identification and Runoff Control" of the Management Plan.

The costs of this Task Order relate directly to the tasks specified below. Each task includes an allowance for project management. Project management responsibilities include coordination of all activities in the task, including budget control, scheduling of work, subcontract preparation, and other necessary administrative duties. It also includes assisting and supervising project staff, reviewing work products, and monitoring and controlling work schedule, work scope, and budget. Deliverables to be submitted to the City are described under reporting requirements.

Task 1. Develop and Maintain a Preliminary List of Industries to be Inspected

This task consists of developing a preliminary list of industries to be inspected within Fremont's jurisdiction during the first year of the inspection program. This list will be developed based on a list of industries currently available in the County's Urban Runoff Clean Water Program industrial database which will be supplied by the City. The criteria which will be used in preparing this preliminary list shall be based on what is known about the following factors as well as any other relevant information:

- Chemicals stored, transferred, or used on site
- Current permits and regulations governing the industries
- Budget available during the first year of the inspection program

Task 2: Develop an Inspection Plan

This task includes the development of an inspection plan which will include the final list of industries which will be inspected during the first year of the inspection program and a draft list of facilities that will be inspected during the duration of the NPDES permit. This plan will identify:

- the details of who will conduct the inspections.
- the staff training and experience needed to conduct the inspections.
- assurances that adequate training has been provided.
- the equipment that will be used and health and safety procedures that will be followed while conducting inspections.

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Memorandum of Agreement

TO PROVIDE FOR IMPLEMENTATION AND ENFORCEMENT OF THE FREMONT STORM WATER MANAGEMENT AND DISCHARGE CONTROL ORDINANCE.

URBAN RUNOFF CLEAN WATER PROGRAM

This agreement is made between the CITY of FREMONT (City) and UNION SANITARY DISTRICT (District) for the purposes of implementing enforcement procedures for the Fremont Storm Water Management and Discharge Control Ordinance (Ordinance Number 2012, Fremont Municipal Code 8-11100 et. seq.). As provided in the Contractual Services Agreement dated June 9, 1992.

Fremont Municipal Code 8-11102 (b) (3) authorizes the Fremont city manager to designate authorized enforcement officers to enforce the provisions of FMC 9-11100 et. seq. The District's general manager may appoint such employees of the District as in the manager's opinion are best suited by training and experience to carry out enforcement functions under this ordinance.

Persons appointed as authorized enforcement officer pursuant to FMC 9-11100 et. seq. shall have all the authority vested by the ordinance in the authorized enforcement officer.

District acknowledges it has agreed to accept the designation of authorized enforcement officer for its employees appointed to participate in the implementation of this agreement. District agrees to faithfully and competently enforce the provisions of FMC 8-11100 et. seq. in full cooperation with staff of the City of Fremont.

The parties agree that the District shall be responsible for inspections of premises in the City of Fremont for potential violation of said ordinance. District shall advise property owners and managers of the obligation imposed by the ordinance to comply with the requirements therein. Should formal enforcement actions be necessary as are provided for in FMC 8-11304 to 8-11331 the City of Fremont shall assume full responsibility for formal prosecution and hearing procedures. District is authorized to carry full enforcement powers whenever there exists an immediate danger to the public health, safety and welfare.

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The Fremont city manager shall prepare and issue appropriate credentials for District appointed authorized enforcement officers when requested by the District manager.

This agreement shall be effective upon execution by the Fremont city manager and the District manager and shall continue until canceled by the city manager or the District manager. Notice of cancellation by either party shall be given in writing 30 days prior to the effective date of the cancellation.

CITY OF FREMONT	UNION SANITARY DISTRICT
BY: Ross Mirkarimi City Manager	BY: Stephen T. Hayashi General Manager/District Engineer
DATE: 1/26/93	DATE: 1/22/93

approved as to form
Deputy city attorney

ATTEST: Sharon Whitten
CITY CLERK

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R. Brandlab

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CITY OF EMERYVILLE
AGREEMENT FOR INDUSTRIAL INSPECTION SERVICES FOR
THE ALAMEDA COUNTY URBAN RUNOFF CLEAN WATER PROGRAM

THIS AGREEMENT, is made and entered into on the 15th day of November, 1994 between ALAMEDA COUNTY, a local public agency through its duly authorized representative, the President of the Board of Supervisors, hereinafter referred to as "COUNTY", and the City of Emeryville with offices located at 2200 Powell Street, Emeryville, CA hereinafter referred to as "City".

WITNESSETH:

WHEREAS, the CITY has entered into an agreement titled "Agreement To Implement The Alameda County Urban Runoff Clean Water Program" with Alameda County Flood Control and Water Conservation District, and

WHEREAS, the agreement stipulates that the CITY is responsible for implementing activities specified in "A Storm Water Management Plan For the Alameda County Urban Runoff Clean Water Program"; and

WHEREAS, the CITY is required by that Agreement to perform Industrial Inspections for storm water runoff, and

WHEREAS, the COUNTY has the qualifications to perform and implement the Industrial Inspection activities, and

WHEREAS, the COUNTY is performing like services for the COUNTY and will be performing this service for other jurisdictions;

ACCORDINGLY, CITY and COUNTY for consideration hereinafter set forth, mutually agree as follows:

I. SCOPE OF WORK

For implementing activities specified herein, the CITY will pay the COUNTY a sum not to exceed $35,000 for work performed during the period August 1, 1994 through June 30, 1995. This Agreement may be extended once for a period of one (1) year without further action of the City Council and County Board of Supervisors upon mutual agreement of the City Manager and County Administrator provided the amount to be paid COUNTY by CITY does not exceed $35,000. COUNTY shall implement those activities described in EXHIBIT "A" of this agreement. Terms and conditions for payment are described in EXHIBIT "B" of this agreement.

1. The COUNTY will be paid monthly based on a statement reflecting work performed.

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2. In the event of termination of this Agreement, the COUNTY shall have the right to expend reasonable additional time to assemble work in progress for the purposes of proper closing of the work. Such additional time, and the costs for that time, shall not exceed 10% (ten percent) of the total time and costs expended to the date of notice of termination. Should the agreement or any portion thereof be abandoned, to the extent of available funds, CITY shall pay the COUNTY for all services performed theretofore in accordance with the terms of this Agreement.

II. EMPLOYER/EMPLOYEE RELATIONSHIP

No personnel employed be either COUNTY or CITY shall acquire any rights or status in the agency providing such employment or the Agency which is the other party to this Agreement by virtue of this Agreement.

II. CONFORMITY WITH LAW AND SAFETY

a. COUNTY shall observe and comply with all applicable laws, ordinances, codes and regulations of governmental agencies, including federal, state, municipal, and local governing bodies, having jurisdiction over the scope of services or any part hereof, including all provisions of the Occupational Safety and Health Act for 1979 and all amendments thereto, and all applicable federal, state, municipal, and local safety regulations. All services performed by COUNTY must be in accordance with these laws, ordinances, codes, and regulations. COUNTY shall indemnify and save CITY harmless form any and all liability, fines, penalties and consequences from any noncompliance or violation of such laws, ordinances, codes and regulations.

b. Accidents: If a death, serious personal injury or substantial property damage occurs in connection with the performance of this contract, COUNTY shall immediately notify the CITY by telephone. COUNTY shall promptly submit to CITY a written report, in such form as may be required by CITY of all accidents which occur in connection with this contract. This report must include the following information: (1) name and address of the injured of deceased person(s); (2) name and address of the COUNTY'S subcontractor, if any; (3) name and address of COUNTY liability insurance carrier; and (4) a detailed description of accident and whether any of CITY equipment, tools, materials, or staff were in involved.

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IV. CONFLICT OF INTEREST

No officer, member, or employee of COUNTY and no member of their governing bodies shall have any pecuniary interest, direct or indirect, in this Agreement or the proceeds thereof. No officer, member, or employee of COUNTY shall serve on a CITY board, committee or hold any such position which either by rule, practice or action nominates, recommends supervises COUNTY operations, or authorizes funding to COUNTY.

V. ASSIGNMENT OF CONTRACT

Nothing contained in this agreement shall be construed to permit assignment or transfer by COUNTY of any rights under this Agreement and such assignment or transfer is expressly prohibited and void.

VI. CONFIDENTIALITY OF INFORMATION

Confidential information is defined as all information disclosed to COUNTY which relates to CITY'S past, present, and future activities, as well as activities under this Agreement. COUNTY will hold all such information in trust and confidence. Upon cancellation or expiration of this agreement, COUNTY will return to CITY all written or descriptive matter which may contain any such confidential information.

VII. NON-DISCRIMINATION

COUNTY assures that it will comply with Title VII of Civil Rights Act of 1964 and that no person shall, on the grounds of race, creed, color, disability, sex, sexual orientation, national origin, age, religion, Vietnam era Veteran's status, political affiliation, or any other non-merit factors be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under this Agreement.

VIII. DRUG-FREE WORKPLACE

COUNTY and COUNTY employees shall comply with the CITY'S policy of maintaining a drug-free workplace. Neither COUNTY nor COUNTY employees shall unlawfully manufacture, distribute, dispense, possess or use controlled substances, as defined in 21 U.S. Code section 812, including marijuana, heroin, cocaine, and amphetamines, at any CITY facility or work site. If COUNTY or any employee of COUNTY is convicted or pleads nolo contendere to a charge for violation of the above, the COUNTY within five days thereafter shall notify the head of the CITY department/agency for which the contract services are performed. Violation of this provision shall constitute a material breach of this Agreement.

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IX. USE OF DISTRICT PROPERTY

COUNTY shall not use CITY premises, property (including equipment, instruments and supplies) or personnel for any purpose other than in the performance of its obligations under this Agreement.

X. FEDERAL AND STATE AUDITS

Until the expiration of five years after the furnishing of any services pursuant to this Agreement, COUNTY shall make available, upon written request, to the Federal/State government or any of their duly authorized representatives, this Agreement, and such books, documents, and records of COUNTY that are necessary to certify the nature and extent of the reasonable costs of services to CITY. If COUNTY enters into any Agreement with any related organization to provide services pursuant to this Agreement with a value or cost of $10,000 or more over a twelve-month period, such Agreement shall contain a clause to the effect that until the expiration of five years after the furnishing of services pursuant to such subcontract, the related organization shall make available, upon written authorized representatives, the subcontract, and books, documents, and records of such organization that are necessary to verify the nature and extent of such costs. This paragraph shall be of no force and effect when and if it is not required by law.

XI. TERMINATION

If the conditions contained herein are not complied with by the COUNTY, CITY may terminate this Agreement without incurring any liability to COUNTY, by written notice to COUNTY. If the conditions contained herein are not complied with by CITY, COUNTY may terminate this Agreement by written notice to CITY. Windup costs related to such termination shall be paid for as described in Section I. (2) herein. In either such event, the party terminating this Agreement shall give thirty (30) days prior written notice to the other party of such termination.

XII. MODIFICATION

No alteration or variation of the terms of this agreement shall be valid unless made in writing and signed by the parties hereto.

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XIII. HOLD HARMLESS/INDEMNIFICATION

It is understood and agreed that neither CITY nor any of its agents, contractors, officers or employees shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by COUNTY, its agents, contractors, officers or employees under or in connection with any work, authority, or jurisdiction delegated or exercised under this Agreement. It is also understood and agreed that COUNTY shall fully defend, indemnify and hold CITY, its agents, contractors, officers and employees harmless from any and all liability occurring by reason of anything done or omitted to be done by COUNTY, its agents, contractors, officers and employees under or in connection with any work, authority or jurisdiction delegated or exercised under this Agreement.

It is understood and agreed that neither COUNTY nor any of its agents, contractors, officers or employees shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by CITY its agents, contractors, officers or employees under or in connection with any work, authority, or jurisdiction delegated or exercised under this Agreement. It is also understood and agreed that CITY shall fully defend, indemnify and hold COUNTY, its agents, contractors, officers and employees harmless from any and all liability occurring by reason of anything done or omitted to be done City, its agents, contractors, officers and employees under or in connection with any work, authority or jurisdiction delegated or exercised under this agreement.

XIV. INSURANCE/SELF-INSURANCE

COUNTY shall furnish services as described in Exhibit A of this Agreement. Terms and conditions for payment are attached in Exhibit B. COUNTY is self-insured as to any requirements under this Agreement. No policies or bonds are required of either party as to any provisions of this agreement.

XV. WORKER'S COMPENSATION

COUNTY shall provide Workers' Compensation insurance at COUNTY'S own cost and expense and further, neither the COUNTY nor its carrier shall be entitled to recover any costs, settlements, or expenses of Workers's Compensation claims arising out of this Agreement from CITY.

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XVI. EMPLOYMENT ELIGIBILITY

Persons providing services under this contract will be required to provide the necessary documentation to establish identity and employment eligibility as required by the Immigration and Reform and Control Act of 1986. Failure to provide the necessary documentation will result in the termination of this Agreement as required by the Immigration Reform and Control Act of 1986.

XVII. EXECUTION

IN WITNESS THEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

ALAMEDA COUNTY, a local public agency of the state of California

By: Edward R. Campbell
President, The Board of Supervisors, Alameda County

CITY OF EMERYVILLE

John Flores,
City Manager

Approved as to form:
Kelvin H. Booty, Jr., County Counsel

By: Denise M. Brown
Deputy County Counsel

I hereby certify under penalty of perjury that the President the Board of Supervisors was duly authorized to execute document on behalf of the County of Alameda by a major vote of the Board on [illegible] and that a copy [illegible] been delivered to the President as provided by Government Code Section 25103. Attest: DEC 05 1994
WILLIAM MEHRWEIN, Clerk, Board of Supervisors, County of Alameda, State of California
BY [illegible]

Approved As to Form:
[illegible]
City Attorney

Attest:
WILLIAM MEHRWEIN, Clerk, Board of Supervisor,
Alameda County Flood Control and Water Conservation District
County of Alameda, State of California

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EXHIBIT A

SCOPE OF WORK

TASKS

Alameda County Department of Environmental Health will commit at least two (2) inspectors and two support staff to assist the City in implementing the NPDES Clean Water Act Industrial Inspection Program. Total costs per task are listed in Exhibit B.

The County will provide, under mutual agreement, full or partial services in the following areas:

1. **MAINTAIN AND UPDATE INDUSTRIAL DATABASES AS REQUIRED.**

   The County has, at present, a database of 201 facilities in Emeryville. (96 food handling establishments, and 105 hazardous materials handling facilities, including 88 hazardous waste generators, 23 underground tank sites and 67 hazardous materials management plan sites. Our database accepts NPDES information for each facility inspected and produces suitable reports for the City of Emeryville. We will continue to enter data as sites are inspected. We will also continue to update the list as businesses move in and out of the City and as newly discovered businesses are located and placed on the inventory.

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2. **DEVELOP A LIST OF INDUSTRIES TO BE INSPECTED ANNUALLY.**

The County, in coordination with the City, will develop a list of facilities to be inspected on a priority basis. The County with the cities agreement will select and inspect 100% of the listed businesses during the 1994/95 fiscal year for a total of 1335 inspections.

The County will use the following lists in developing its priority list:

- Facilities that have filed a SARA Title III Report
- Facilities within the County's database with specific SIC codes or key identifying words in their names where stormwater runoff occurs and there is a potential relationship between the industrial or commercial activity and stormwater runoff.
- Facilities with pretreatment permits
- Facilities with existing stormwater pollution prevention plans

3. **IMPLEMENT MINIMUM QUALIFICATIONS, STANDARDS AND PROCEDURES FOR CONDUCTING INDUSTRIAL INSPECTIONS, MONITORING AND FOLLOW-UP ACTIVITIES.**

The County, in coordination with the City, has developed

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priorities for inspections and established protocols utilizing standardized forms for inspections and agency reporting for quarterly and annual reports required by the NPDES Permit.

4. **NOTIFY TARGET INDUSTRIES OF THE PROGRAM AND SURVEY SITE CONDITIONS.**

In order to inform target businesses of program objectives and NPDES permit requirements, the County, with the city, has implemented an educational program. This effort includes distributing a notification letter and an informational pamphlet to newly inspected businesses and participating in public education events for industry. Currently, the County presents Best Management Practices information to various industries through its NPDES inspections and industry workshops offered through the NPDES and waste minimization programs. The County also participates in developing and presenting hazardous waste management curriculum at local colleges and universities.

5. **IMPLEMENT THE INSPECTION PLAN.**

In conjunction with its established regulatory inspection program, the County will continue to inspect listed industries utilizing a mutually agreed upon format which will include, but not be limited to the inspection of:

- Existing storm water prevention plans, spill prevention

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contingency plans or similar plans.

- Any physical evidence of spills that have or could have reached storm drains.
- Areas where potential pollutants are stored, unloaded, shipped and/or repacked for use or transportation, including railroad siding, loading decks, and roads within the industrial portion of the facility.
- Areas where historic use or handling of chemicals or food poses a significant potential contact with stormwater runoff.
- The active manufacturing, chemical use and food handling areas of the facility.
- All drainage and discharge structures and their discharge points.
- All paved areas and buildings, including roof gutters discharge areas.
- Any surface water location on the site.

6. **CITY/COUNTY INTERACTION**

The County will provide the City a Monthly Report identifying the sites inspected during the reporting period, best management practices instituted, any illicit discharges found, improper handling or storage of materials, wastes or other substances that could potentially pollute stormwater, and follow-up action

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required, if any. The County will meet with the City monthly or as mutually agreed to discuss the program and mutual needs of the two agencies including any potential litigation or enforcement the City wishes the County to pursue.

FINANCE

Alameda County Environmental Health, Hazardous Materials Division has an inventory database of 201 facilities in Emeryville. Based upon the priorities noted above for inspecting facilities we anticipate the number of facilities requiring inspection to be approximately 133. Based upon 133 sites the following cost per task, annual cost and cost per unit is presented.

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EXHIBIT B

COST PROJECTIONS FOR STORMWATER PROGRAM 1994/95

HazMat Facilities	=	105
Food Handling Facilities	=	96
Estimated Total Inventory	=	201

Target Inspection Totals for 94/95:

New HazMat Facilities	=	21
HazMat Reinspections	=	21
Follow-up, All Sites	=	21
New Food Facilities	=	70
Total # of Inspections to Perform	=	133

Task and Cost/Site: Hourly rate is $90 unless stated otherwise				
1-Data Input	unit cost X #			Total $ 5,957
New sites	@ $53 X 91	=	$4823	
Annual insp.	@ 27 X 21	=	567	
Follow-ups	@ 27 X 21	=	567	
2-Preliminary Food List	NO CHARGE			
3-Program Development	NO CHARGE			
4-Notify Business- New sites	unit cost X # @ $ 6 X 91	=		$ 546
5-Monthly report & invoice	unit cost X # @ $34.5 X 133	=		$ 4,584
6-Inspections	% inv./unit cost X #			$23,940
2.5 hrs (new hazmat)	100% @ $225 X 21	=	$ 4725	
2.0 hrs (reinsp ")	20% @ 180 X 21	=	3780	
1.5 hr (follow-up,all)	10% @ 135 X 21	=	2835	
2.0 hrs(food site)	73% @ 180 X 70	=	12600	
7-Data development & Programming				$ 810
TOTAL				$35,000

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Appendix E

Summary of Existing Stormwater Inspection Programs

Table 1A - Municipality Profile

Table 1B - Inspection Priorities and Procedures

Table 1C - Enforcement, Outreach, and Municipal Facilities

Table 1D - Information Management and Training

Table 1E - Budget Information and Additional Comments

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Table 1A. Summary of Existing Industrial Storm Water Inspection Programs - Municipality Profile

Location	Contact Person	Municipality Profile					
		Population	Area (sq. mi.)	Number of Industrial/ Commercial Facilities	Number of NOI Facilities	Storm Water Permit (Program Name)	Have Storm Water Discharge Ordinance?
City of Fresno	Darren Cousineau, Staff Analyst (209)456-3292	500,000	198	>1,600	663	Fresno Areawide Stormwater Program	No (developing)
City of Los Angeles	Wayne C. Mohr, Assistant Division Engineer (213)847-4717	3,500,000	465	155,772	3,054	Los Angeles County	No (draft in review)
City of Manhattan Beach	Charles Emig Water Quality Coordinator (310)545-5621x424	35,000	3	unknown	2	Los Angeles County	No
City of Modesto	Garner Reynolds, Jr. Civil Engineer (209)571-5120	200,000	40	200-300	15	City of Modesto	Yes (being revised)
City of Richmond	Stephen Linsley, Laboratory Supervisor (510)412-2014	93,000	56	200	45	Contra Costa Clean Water Program	Yes (being revised)
City of San Jose	Carlos Azcona, Environmental Services Division (408)945-3093	806,000	136	25,000	196	Santa Clara Valley Nonpoint Source Pollution Control Program	Yes
City of San Leandro	Paul Zolfarelli Environmental Compliance Coordinator (510)577-6036	71,000	13	255	58	Alameda Countywide Clean Water Program	Yes
Los Angeles County	Carl Sjoberg, Chief, Industrial Waste Planning and Control (818)458-3539	950,000	1,527	22,000	3,600	Los Angeles County	No

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Table 1A. Summary of Existing Industrial Storm Water Inspection Programs - Municipality Profile

Location	Contact Person	Municipality Profile					
		Population	Area (sq. mi.)	Number of Industrial/ Commercial Facilities	Number of NOI Facilities	Storm Water Permit (Program Name)	Have Storm Water Discharge Ordinance?
County of San Mateo (unincorporated)	Duane O'Donnell, Environmental Health Specialist (415)363-4708	62,000	356	400	10	San Mateo Countywide Stormwater Pollution Prevention Program	Yes
City of Hayward	Gayle Gundell Senior Source Control Inspector (510) 881-7993	123,000	43	476	97	Alameda Countywide Clean Water Program	Yes
City of Simi Valley	Larry Whitney / Bob Zomalt Source Control Supervisor (805) 583-6420	105,000	39	3,000	40	Ventura County	No

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Table 1B. Summary of Existing Industrial Storm Water Inspection Programs - Inspection Priorities and Procedures

Municipality	Who Performs Inspections?	Approach to Inspection	Inspect NOI Facilities	Review and Evaluate SWPPP?	No. of Facilities Inspected Annually	Facilities Inspected (frequency)
City of Fresno	County hazardous materials program and county wastewater inspectors.	Currently on a complaint response basis; in the near future, NOI facilities will be inspected and all inspections will be consultation oriented with no inspection fees.	No (soon)	No	Currently no regularly scheduled inspections.	response to complaints (as required)
City of Los Angeles	Pretreatment inspectors (initial inspection) and dedicated inspection staff (follow-up, complaints).	Inspectors follow up on illegal discharges to storm drains noted by pretreatment inspectors, and respond to complaints. Plan to issue local stormwater permits and general permits for de minimis discharges (ordinance pending). Permit program includes incentives for compliance.	Yes	Yes	7,700	NOI facilities (complaint or referral) (1) other heavy and light industry *(1) automotive businesses *(1) restaurants *(1) other commercial businesses *(1) response to complaints (1) *only facilities that have wastewater or stormwater permits
City of Manhattan Beach	Source control (public works) and county health department.	"Ocean Safe Enterprise" program educates and recognizes businesses for complying with BMPs. Businesses must participate to avoid enforcement action.	No	No		automotive businesses (1) restaurants (1) other commercial businesses (1) response to complaints (as required)
City of Modesto	Fire department staff	Cooperation between facility and city.	Yes	No	just started	NOI facilities (N/D)
City of Richmond	Pretreatment inspectors	Educate facility operators and provide literature.	Yes	Yes	150	NOI facilities (1) heavy industry (1) light industry (N/D) automotive businesses (2) restaurants (N/D) other commercial businesses (N/D) response to complaints (1) industries which discharge contaminated stormwater to POTW (1)

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Table 1B. Summary of Existing Industrial Storm Water Inspection Programs - Inspection Priorities and Procedures (cont.)

Municipality	Who Performs Inspections?	Approach to Inspection	Inspect NOI Facilities	Review and Evaluate SWPPP?	No. of Facilities Inspected Annually	Facilities Inspected (frequency)
City of San Jose	Dedicated nonpoint source inspectors, pretreatment inspectors, and fire department staff.	Educate facility operators; enforcement applied to direct and or intentional stormwater discharges. Currently evaluating clean business award programs.	Yes	Yes (review only)	750	NOI facilities (1) other heavy and light industry (N/D) automotive businesses (N/D) restaurants (N/D) other commercial businesses (N/D) response to complaints (1) facilities in a geographic sector (N/D) pretreatment permitted facilities (1)
City of San Leandro	Pretreatment inspectors		Yes	Yes (review only)	225	NOI facilities (1) other heavy and light industry (1) automotive businesses (1) restaurants (N/D) other commercial businesses (N/D)
Los Angeles County	Pretreatment inspectors, maintenance staff, and source control inspectors.	Inspections limited to Industrial Waste Control Program (IWCP) and illicit connections. Incentive program for non-NOI facilities in development.	Yes (those that fall under IWCP)	No	10,000 (IWCP inspections)	heavy industry (4 times/year) light industry (1 to 3 times/year) automotive businesses (1 to 3 times/year) restaurants (1) other commercial businesses (1) response to complaints (as needed)
County of San Mateo (unincorporated)	County hazardous materials program, and county environmental health and food inspectors.	Educate facility operators; no fees are charged for initial inspections. Also conducts inspections for 11 cities. Stormwater violations that are also Health and Safety Code violations are enforced.	Yes	Yes (review only)	2,000 (in contract cities)	restaurants (1) other commercial businesses (1) all facilities that have filed a HMBP (1)
City of Hayward	Source control / Pretreatment inspectors	Source Control Inspectors have incorporated stormwater issues into pretreatment inspection. Inform facility operators of program requirements.	Yes	Yes	160	NOI facility (1) highly industrial areas (3) heavy industry (1) light industry (N/D) automotive businesses (2) restaurants and other commercial businesses (N/D) pretreatment facilities (1) response to complaints (as needed)

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Table 18. Summary of Existing Industrial Storm Water Inspection Programs - Inspection Priorities and Procedures (cont.)

Municipality	Who Performs Inspections?	Approach to Inspection	Inspect NOI Facilities	Review and Evaluate SWPPP?	No. of Facilities Inspected Annually	Facilities Inspected (frequency)
City of Simi Valley	Source control / Pretreatment inspecotrs (public works) and County Environmental Health Dept.	Educate facility operators and provide literature.	Yes	Yes (review only)		NOI facility (1) heavy industries (1) light industries (1) automotive businesses (1) restaurants (1) other commercial busionesses (3)

Notes: 1 = annually
2 = every two years
3 = every three years

N/D = frequency not determined
NOI = Notice of Intent
SWPPP = Stormwater Pollution Prevention Plan
IWCP = Industrial Waste Control Program

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Table 1C. Summary of Existing Industrial Storm Water Inspection Programs - Enforcement, Outreach, and Municipal Facilities

Municipality	Methods of Enforcement	Educational Outreach	Municipality-Owned Facilities	
			Facilities Inspected?	How are these Inspections Included in program?
City of Fresno	Warning notice (limited enforcement authority).	Letters and verbal communication; currently developing brochures.	Wastewater treatment plants, District stormwater facilities.	Routine inspection by POTW and District inspectors.
City of Los Angeles	Warning notice, formal violation notice, and legal action. Citations for minor violations.	Handouts during inspections, brochures on stormwater and general permits, BMP brochures, letters, mailings, verbal communication, and PSAs.	Corporation yards and landfills.	Inspect corporation yard, and report landfill monitoring to AQMD and RWQCB.
City of Manhattan Beach	Warning notice, formal violation notice, and legal action.	Handouts during inspections, brochures on stormwater and general permits, BMP brochures and handbooks, letters, workshops and verbal communication.	Corporation yards	Ocean Safe Campaign requires an initial inspection and follow-up inspections every 6 months thereafter.
City of Modesto	No enforcement authority - revising stormwater ordinance to provide authority to inspectors.	Handouts during inspections, brochures on stormwater and general permits, BMP handbooks, letters, workshops, mailings, and verbal communication.	Corporation yards, bus yards, and wastewater treatment plants.	Inspected by program administrator annually.
City of Richmond	Formal violation notice and legal action.	Handouts during inspections, brochures on stormwater and general permits, BMP brochures and booklets, letters, workshops, verbal communication, and BMPs on wastewater permits.	Corporation yards, wastewater treatment plants, and port facilities.	Self-inspected under General Permit; other inspections conducted as needed by industrial waste inspections.
City of San Jose	Audit form narrative and legal action (citation).	Handouts during inspections, brochures on stormwater and general permits, BMP brochures, letters, workshops, mailings, verbal communication, and pre-inspection letters.	Corporation yards, wastewater treatment plants, and San Jose International Airport.	Inspections are performed by Environmental Services Dept., Municipal Compliance Division.
City of San Leandro	Warning notice and formal violation notice.	Handouts during inspections, brochures on stormwater and general permits, BMP brochures, letters, and verbal communication.	Bus yards, recycling centers, and landfills.	Inspections are performed annually in conjunction with pretreatment and pollution prevention inspections by the environmental compliance staff.

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Table 1C. Summary of Existing Industrial Storm Water Inspection Programs - Enforcement, Outreach, and Municipal Facilities (cont.)

Municipality	Methods of Enforcement	Educational Outreach	Municipality-Owned Facilities	
			Facilities Inspected?	How are these Inspections Included in program?
Los Angeles County	Warning notice, informal and formal violation notice, and legal action.	BMP brochures (being developed), letters, and verbal communication.	Corporation yards	Facilities under IWCP are inspected.
County of San Mateo (unincorporated)	Formal violation notice.	Handouts at inspections, BMP brochures, workshops, and verbal communication.	Corporation yards	Hazmat inspections on a yearly basis.
City of Hayward	Warning notice, informal and formal violation notice, legal action, and compliance time schedule.	Handouts during inspections, brochures on stormwater and general permits, BMP brochures and handbooks, letters, workshops and verbal communication.	Corporation yards and wastewater treatment plants.	Inspectors perform inspections on an information-only basis.
City of Simi Valley	Warning notices and informal violations (inspectors do not have enforcement authority).	Handouts during inspections, workshops and verbal communication.	Corporation yards, bus yard, and wastewater treatment plants.	Inspected monthly by Source Control Inspectors

Notes:
- POTW = Publicly Owned Treatment Works
- PSA = Public Service Announcement
- BMP = Best Management Practices
- AQMD = Air Quality Management District
- RWQCB = Regional Water Quality Control Board
- IWCP = Industrial Waste Control Program

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Table 1D. Summary of Existing Industrial Storm Water Inspection Programs - Information Management and Inspector Training

Municipality	Information Management			Inspector Training	
	Documentation Method(s)	Management Methods	Data Reporting (To whom, Frequency)	Methods Used	Frequency
City of Fresno	Inspection report forms, photos, samples, and lab results.	Hard copy in business file.	RWQCB, annually	In-house and District training; District trains County Environmental Health staff and City Wastewater staff.	annually
City of Los Angeles	Check list and narrative.	PC database	RWQCB, annually	In-house, off-site, and on the job training; distribution of educational information, and on-site training by certified instructors or by public agencies.	On going training throughout the year.
City of Manhattan Beach	Check list with specific best management practices, and photos.	Hard copy in business file.	Authorities are notified as needed.	In-house and on the job training.	as needed
City of Modesto	Inspection form being developed.	PC database	Program administrator, as needed	In-house training.	as needed
City of Richmond	Inspection checklist, and sample results.	Database and hard copies in business files.	RWQCB, annually	In-house, off-site, and on the job training; distribution of educational information.	on-going
City of San Jose	Audit form check sheet and audit form narrative, facility case files, photos, and sample results.	Database and hard copies in facility file.	RWQCB, annually	In-house, off-site, and on the job training; workshops, distribution of educational information, and inspector "roundtables".	as needed
City of San Leandro	Inspection form	Hard copy in business file.	RWQCB, quarterly	On the job training and workshops.	twice a year
Los Angeles County	Computer work orders, inspection forms, and survey forms.	Mainframe database	USEPA, local POTW, and RWQCB, annually.	In-house, off-site, and on the job training; distribution of educational information.	Bi-monthly and annually; bimonthly inspectors meeting.
County of San Mateo (unincorporated)	Inspection forms for hazmat and food facilities, standard stormwater inspection forms, and submit photos of major violations.	Database	General program, quarterly; RWQCB, annually.	In-house and on the job training; workshops and distribution of educational information.	quarterly

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Table 1D. Summary of Existing Industrial Storm Water Inspection Programs - Information Management and Inspector Training (cont.)

Municipality	Information Management			Inspector Training	
	Documentation Method(s)	Management Methods	Data Reporting (To whom, Frequency)	Methods Used	Frequency
City of Hayward	Countywide standard inspection form plus city supplemental checklist.	Hard copy in business file.	General program, quarterly; RWQCB, semi-annually.	In-house and on the job training, and workshops	annual workshop, as needed
City of Simi Valley	Inspection checklist	Database and hard copies in facility file.	Annual report to State.	In-house, off-site, and on the job training; workshops, distribution of educational information.	weekly

Notes:
- RWQCB = Regional Water Quality Control Board
- PC = Personal Computer
- USEPA = United States Environmental Protection Agency
- PSA = Public Service Announcement
- POTW = Publicity Owned Treatment Works
- BMP = Best Management Practices

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Table 1E. Summary of Existing Industrial Storm Water Inspection Programs - Budget Information and Additional Comments

Municipality	1994/95 Budget	No. of FTE Staff (Inspectors)	Funding Mechanism	Additional Comments
City of Fresno	$93,000	3 (0.25) (District staff)	Stormwater or sewer utility fee and property tax assessment.	Program will focus on public education rather than enforcement.
City of Los Angeles	$2,300,00	13 (10)	Stormwater or sewer utility fee.	Educational role or referral action to RWQCB, etc., inspectors issue citations on minor violations, and inspectors respond to public reports (through the "hotline") of emergency spills, abandoned waste on public rights-of-way, and illegal dumping.
City of Manhattan Beach				Partnership method is effective; the city and businesses work together to protect the ocean; there are reduced risks of being fined, public recognition and monetary savings for businesses.
City of Modesto	$20,000	1 (1)	Stormwater or sewer utility fee.	Program will focus on public education rather than enforcement.
City of Richmond	$80,000	2 (1.5)	Stormwater or sewer utility fee.	Have developed many public education materials, including BMP flyers, field screening manual, and workshop binders.
City of San Jose	$1,284,000	13 (11)	Stormwater or sewer utility fee.	Plan to inspect 1,700 facilities in 95/96.
City of San Leandro	$180,000	3 (2)	Stormwater or sewer facility fee.	
Los Angeles County	$700,000	10 (7)	Property tax assessment and inspection fee.	Starting July, 1995, will inspect additional 1,000 sites per year, including non-NOI facilities.
County of San Mateo (unincorporated)	$28,000	0.5 (0.25)	General fund appropriation and inspection fees.	At a hazmat site, stormwater inspections are conducted in conjunction with HMBP hazmat generator and UST inspections.
City of Hayward	$61,000	0.75 (0.5)	Stormwater utility fee.	Have integrated program that incorporates pretreatment, stormwater and pollution prevention
City of Simi Valley	$1,300,000	7 (4)	Special district assessment, Ad Valorem	Have integrated program that combines pretreatment, stormwater, and hazardous material inspections.

Notes:
- AQMD = Air Quality Management District
- UST = Underground Storage Tank
- IWCP = Industrial Waste Control Program
- POTW = Publicly Owned Treatment Works
- RWQCB = Regional Water Quality Control Board
- HMBP = Hazardous Materials Business Plan
- BMP = Best Management Practices
- FTE = Full-Time Equivalent

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Appendix F

Example Letter Of Request For Facility Certification

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(Municipality Letterhead)

Date_____
File No. _____
Facility WDID No._____

Mr. Blair Allen
San Mateo County Stormwater Permit Coordinator
San Francisco Bay Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland CA 94612

Subject: Certification of Industrial Stormwater Compliance Upon Ratification by Regional Water Quality Control Board staff.

Dear Mr. Allen:

Upon inspection of _____(name of facility)_____ on___(date)___ and review of its Stormwater Pollution Prevention Plan and monitoring data, we nominate this facility for relief from stormwater sampling and testing requirements. The facility owner/operator must continue wet and dry weather visual inspections and the annual site inspection as required by the stormwater general industrial NPDES permit.

The basis of this nomination includes all three of the following:

_____ 1. Inspection of this facility indicates a very low potential for stormwater pollution;

_____ 2. The Stormwater Pollution Prevention Plan identifies potential pollution sources and provides for the effective implementation of BMPs to control these sources;

_____ 3. Review of the attached monitoring data revealed no pollution problems.

We understand that after review of this facility's compliance status, you will send a letter either confirming or denying relief from sampling requirements for the time period of _____. If we become aware of any significant change in the status of this facility, we will review this nomination and notify you.

Inspector_____

Agency_____

Signed_____

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Appendix G

Example Performance Standards For Inspection Of Industrial And Commercial Businesses

1) Santa Clara Valley Nonpoint Source Pollution Control Program

2) Alameda Countywide Clean Water Program

(Note: These performance standards have not been formally approved by the San Francisco Bay Regional Water Quality Control Board.)

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January 2, 1996

Santa Clara Valley
Nonpoint Source Pollution
Control Program

INDUSTRIAL/COMMERCIAL DISCHARGER INSPECTION PROGRAM
PERFORMANCE STANDARD

This is the Performance Standard by which co-permittees of the Santa Clara Valley Nonpoint Source Pollution Control Program (Program) will conduct inspections of commercial and industrial facilities for storm water pollution problems. Performance Standards are being used to define levels of achievement for particular tasks carried out by all Program co-permittees. Individual tasks are detailed in the Program's Storm Water Management Plan, which is the basis for the 1995-2000 NPDES Permit period. Several Performance Standards are required under the provisions of the Program's renewed Permit. The development and implementation of these Performance Standards will be an important part of the Program during the upcoming five-year period under the NPDES Permit.

The following program components constitute an Industrial/Commercial Discharger Inspection Program Performance Standard developed for co-permittees to define the Maximum Extent Practicable (MEP) to which they will conduct facility inspection activities. Co-permittees must provide explanations for any component for which their MEP differs from the corresponding level of performance identified in this standard. There is no constraint to limit any inspection or type of inspection to only these program components. Each co-permittee may adopt this standard into its own inspection procedures as appropriate; however, all program components must be included. This Performance Standard is not intended to replace or supersede any co-permittee's existing program.

In those municipalities where industrial/commercial characteristics are such that some components do not apply, the specific components will not be included and a notation that the component is "not applicable because affected facilities are not located within this jurisdiction," or an equivalent statement, will appear in the co-permittee's annual report submittal and/or individual Performance Standard. Should characteristics change, the currently approved Performance Standard must be implemented, or changes to the standard developed and approved by the Program's Management Committee.

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PERFORMANCE STANDARD COMPONENTS

A. Notice of Intent (NOI) Filers

NOI filers are those facilities which have filed an NOI with the State and appear on a list provided by the State. The following shall be accomplished for all NOI filers and facilities with individual NPDES permits for storm water discharge:

1. A complete initial storm water inspection shall be performed within one (1) year of approval of this performance standard by the Regional Board. Inspections will be conducted using the standard SCV NPS Facility Inspection Checklist in Appendix A, or an individual co-permittee checklist that contains all of the elements in the Appendix A checklist.

2. A determination shall be made as to whether the facility constitutes a significant potential threat to discharge pollutants to the storm drain system.

3. Significant facilities (see #2 above) shall be inspected on an annual basis.

4. Non-significant NOI filers shall be inspected at least once every three (3) years.

5. At the beginning of each fiscal year, the lists of significant and non-significant NOI filers shall be reviewed and updated as needed.

6. Any facility filing a NOI after the date of adoption of this performance standard by the Regional Board shall undergo its initial inspection within one (1) year of filing. The determination contained in #2 above shall be made immediately thereafter.

7. During the inspection, it will be verified that the facility has submitted an NOI.

B. Non-Filer Investigations

All industries that conduct activities identified by the following Standard Industrial Classification (SIC) codes will undergo an initial inspection within one (1) year of adoption of this performance standard by the Regional Board: 5015 (Automobile Dismantlers), 5093 (Other Recycling Industries), the 3200 series (Stone Clay and Concrete Products Industry), and the 4100 & 4200 series (Trucking Facilities that perform on-site vehicle repair, maintenance, or washing). The frequency of follow-up inspections, if deemed necessary, will be determined by the co-permittee.

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PERFORMANCE STANDARD COMPONENTS *(Continued)*

C. Commercial Facilities

1. Facilities with Pretreatment permits will be inspected at least every two (2) years.

2. Pretreatment facilities inspected for "zero discharge" to the sanitary sewer system will be inspected every two (2) years.

3. Vehicle Service Facilities[1] will be inspected at least every two (2) years.

4. Food Service Facilities[2] will be inspected at least every three (3) years.

5. Facilities for which a referral or complaint is received will be responded to promptly; a full inspection will be performed at that time or within one (1) year.

D. General Administration

1. All inspected facilities will be inspected to determine the existence of discharges or threatened discharges which are illegal under local ordinances.

2. Facilities will be inspected to determine compliance with local storm water ordinances. The facility operator will be notified of observed areas of concern; official action on violations will take place under local authority.

3. Significant problems which cannot be addressed quickly and fully under local authority shall be referred to the Regional Board or other appropriate agency.

4. Inspections will be documented by, and the documentation maintained in the files of, the local agency or its contractor. Appendix "A" is the standard SCV NPS Facility Inspection Checklist. The standard checklist, or a checklist developed by a co-permittee that contains all of the elements in the standard checklist, will be used by all local agencies.

5. Best Management Practices (BMP) summary information will be distributed to those facilities which do not already have them at the time of the inspection. These BMP documents include the SCV NPS Program literature for: Industrial Facilities, Construction, Food service Facilities, and Vehicle Service Facilities, and will be distributed as appropriate depending on the type of facility inspected.

NOTES:

1 Vehicle Service Facilities include publicly and privately owned facilities that repair, fuel, clean, service, or dismantle cars, trucks, boats, airplanes, or other motor vehicles.

2 Food Service Facilities are defined as any commercial or industrial facility that prepares food for the public or for institutional patrons, and uses or generates grease when preparing this food. "Food Service Facility" does not include any facility that does not use or generate grease in cooking or preparing food, such as a facility that prepares food for off-site cooking and consumption.

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January 2, 1996

Santa Clara Valley
Nonpoint Source
Pollution Control Program

INDUSTRIAL/COMMERCIAL DISCHARGER INSPECTION PROGRAM PERFORMANCE STANDARD

Co-Permittee Reporting Form

1. Complete the following table:

	A. NOI Filers	B. Non-NOI Filers	C. Commercial Facilities*
Total Number of Facilities within Inspection Program			
Number of Initial Inspections			
Number of Facilities Inspected during annual reporting period			
Number of Inspections conducted during reporting period			
Number of Inspections of "Significant" Facilities			
Number of Inspections of "Non-significant" Facilities			
Number of Follow-up Inspections			

* Facilities which fall under more than one category of this table should be reported in the leftmost applicable column; "Commercial Facilities" for the purposes of this reporting form are defined in the Performance Standard.
Shaded Boxes = Not Applicable

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	A. NOI Filers	B. Non-NOI Filers	C. Commercial Facilities*
Number of Inspections of Facilities with Pretreatment Permits			
Number of Inspections of Pretreatment Facilities with "Zero Discharge" to Sanitary Sewer			
Number of Inspections of Vehicle Service Facilities			
Number of Inspections of Food Service Facilities			
Number of Violations			

2. Include audit/inspection form used if different from previous year.

3. Provide narrative effectiveness evaluation:

4. This certifies that, for the reporting period from _____ through _____, _____ has performed activities consistent with the Industrial/Commercial Discharger Inspection Program Performance Standard that we committed to implement.

Name _____

Title _____

Date _____

* Facilities which fall under more than one category of this table should be reported in the leftmost applicable column; "Commercial Facilities" for the purposes of this reporting form are defined in the Performance Standard.
Shaded Boxes = Not Applicable

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Alameda Countywide
Clean Water Program
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INTRODUCTION

The goal of these performance standards is for the ACCWP to achieve a countywide consistent and effective, to the maximum extent practicable, approach to implementing municipal industrial and commercial discharge control programs.

Performance Standards are defined by Regional Board staff as the level of implementation necessary to demonstrate that pollutants are being controlled in stormwater to the maximum extent practicable. These performance standards are part of the basis on which each agency's compliance with the National Pollutant Discharge Elimination System permit will be judged. These performance standards will be reviewed annually by the Industrial & Illicit Discharge Control Subcommittee.

The performance standards are divided into three tiers depending on when the implementation of the standard will occur.

DEFINITION OF TIERS

Tier I -	The baseline level of effort to be implemented now.
Tier II -	Practices to be implemented within one year (after a review by the Subcommittee).
Tier III -	Projects under consideration for possible implementetion.

PERFORMANCE STANDARDS FOR INDUSTRIAL AND COMMERCIAL DISCHARGE CONTROL PROGRAMS

I. Developing the Inspection Plan

Tier I

1. Each municipality will prepare a written Inspection Plan that outlines specific steps the municipality will take to conduct effective facility inspections in the following fiscal year. The written Inspection Plan will consist of:

   a. A review of the types of businesses within its jurisdiction that accounts for the variability of business types, complexity, and number;

   b. A listing by category of business types that have greater potential to cause stormwater pollution;

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c. A priority list of businesses or business types that includes the number of facilities that will be inspected during the coming fiscal year; and

d. As appropriate, a summary of efforts to coordinate inter/intra-agency issues.

The Inspection Plan will be submitted to the Regional Board every year with the ACCWP Fiscal Year-End Report.

2. Each municipality will ensure facility inspectors are adequately trained. This includes the knowledge and skills necessary to conduct effective stormwater inspections, with direction from the Industrial & Illicit Discharge Control Subcommittee.

3. Each municipality will inspect high priority facilities (defined in the Inspection Plan) at least once per year. The goal is to inspect the business community that has the potential to impact storm water quality, at least once during the five year permit period.

Tier II

1. Each municipality will evaluate inspection results from the previous year to assess which industry types had the most impact on stormwater quality. Adjustments to the Inspection Plan will be made based on this assessment.

Tier III

1. Municipalities will coordinate outreach information with other ACCWP subcommittees and stormwater inspection programs if such information is found to be effective

2. Each municipality will expand the inspection program to include additional types of outreach and inspection activities. Such activities may be identified by the Subcommittee at a future date.

II. Conducting the Inspection

A. Preparing for the Site Visit

Tier I

1. Inspectors will review existing information on the site and its regulatory history.

2. Whether the inspector notifies the facility representative of an inspection prior to the visit is discretionary.

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B. **During the Site Visit**

Tier I

1. Inspectors will review the facility layout to locate the storm drain system and/or stormwater drainage path storage areas, process areas, vehicle and heavy equipment wash and maintenance areas, and stormwater sampling locations, if applicable.

2. Inspectors will review/inspect the following for the potential to discharge pollutants from non-stormwater discharges or exposure to runoff:

   a. Outdoor process/manufacturing areas;

   b. Outdoor material storage areas;

   c. Outdoor waste storage and disposal areas;

   d. Outdoor vehicle and heavy equipment storage and maintenance areas;

   e. Outdoor parking areas and access roads;

   f. Equipment on rooftops;

   g. Outdoor wash areas;

   h. Outdoor drainage from indoor areas, and

   i. Stormwater conveyance system maintenance, and emergency response practices.

3. Inspectors will collect the information on the most recently adopted Standard Industrial and Commercial Business Inspection Report (Attachment A).

4. Inspectors will use the facility's SWPPP, if available, as a tool in assessing the facility's stormwater pollution control activities. This will not imply review or approval of the adequacy of the SWPPP.

5. Inspectors will identify and inform the facility representative about problems and violation(s), if applicable. A schedule for correcting problems identified during the inspection and a means for verifying its implementation will be coordinated between the inspector and the facility representative. This information will also be noted on the inspection form.

6. Inspectors will provide facility representatives with appropriate BMP information, education materials, and inter/intra-agency referrals as appropriate.

7. Inspectors will obtain ongoing training to support inspection activities and to

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continue to improve program implementation. Inspector(s) representing each municipality will attend General Program inspector training workshops. The Industrial & Illicit Discharge Control Subcommittee will assess annually inspector training needs.

III. Evaluating Facility Compliance

A. Repeat/Follow-up Inspection

Tier I

1. The inspector will determine if the facility is in compliance with the municipality's stormwater ordinance (i.e. there are no unpermitted non-stormwater discharges and pollutant exposure to rain is minimized).

2. Inspectors will prioritize the facility for re-inspection. If a problem was identified during the inspection, inspectors will perform a follow-up inspection or initiate a self-certification process where the facility representative certifies in writing that the problem has been removed or corrected within the time specified by the inspector.

3. Inspectors will begin enforcement procedures, if appropriate.

B. Enforcement

Tier I

1. Municipalities will conduct enforcement activities as outlined in the *Minimum Enforcement Protocol* adopted by the Industrial & Illicit Discharge Subcommittee and the Management Committee (Attachment B). These activities are set forth by the individual municipality ordinances.

IV. Reporting

Tier I

1. Each municipality will review annually the Inspection Plan and inspection results and assess whether goals were met. This review will be incorporated into the ACCWP's Fiscal Year-End Report to the Regional Board.

2. Submit summary information on facility inspection activities agreed upon by Regional Board staff and the Reporting Improvement Work Group. This information is included in the current standard inspection report form.

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ATTACHMENT A

Standard Stormwater Facility Inspection Report Form

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Alameda Countywide
Clean Water Program
Standard Stormwater Facility Inspection Report Form

Municipality: _____
Date: _____

Reason for Inspection: ☐ First Inspection ☐ Routine Inspection ☐ Response to Complaint ☐ Facility has closed or Facility Information has changed

NAME OF FACILITY		SITE ADDRESS	
CONTACT NAME	PHONE	BUSINESS TYPE/ACTIVITY	SIC

Is the property owner different than the facility owner? ☐ yes ☐ no If yes, complete the following:
NAME PHONE
MAILING ADDRESS

Is the facility covered under any other programs or permits? (Check all that apply.) ☐ None ☐ Sanitary sewer
☐ Air quality ☐ Hazmat business plan ☐ Underground storage tanks ☐ Aboveground storage tanks
☐ Fire department(hazmat storage) ☐ Hazmat waste generator ☐ Other _____

Is the facility covered under a storm water permit? ☐ Does not need Coverage ☐ No, but may need to be (Refer to Regional Board)
☐ Individual ☐ General: Does the facility have a SWPPP? ☐ yes ☐ no

N/A = Not Applicable; PTNL = POTENTIAL for Pollutant Discharge: 1 = low potential, 2 = medium potential, 3 = high potential
ACTUAL Type of Discharge: BMP: 0 = BMPs are effective, 1 = BMPs are fairly/almost effective, 2 = BMPs are not effective, 3 = No BMPs are implemented
PEX = Pollutant Exposure, NSW = Non-Stormwater Discharge

AREAS OF ACTIVITY	N/A	PTNL	ACTUAL Type of Discharge			REMARKS: Describe recommendations, requirements, and time to implement. Check box if remark is a *requirement*.
			BMP	PEX	NSW	
A. Outdoor Process/Manufacturing Areas						☐
B. Outdoor Material Storage Areas						☐
C. Outdoor Waste Storage/Disposal Areas						☐
D. Outdoor Vehicle and Heavy Equipment Storage, Maintenance Areas						☐
E. Outdoor Parking Areas and Access Roads						☐
F. Outdoor Wash Areas						☐
G. Rooftop Equipment						☐
H. Outdoor Drainage from Indoor Areas						☐
I. Other (describe):						☐

ADDITIONAL COMMENTS/REMARKS

☐ See attached for more comments.

FIRST Follow-up Inspection (Date & Findings)	SECOND Follow-up Inspection (Date & Findings)

PRIORITY FOR RE-INSPECTION ☐ 1; First ☐ 2; Second ☐ 3; Third

ENFORCEMENT: ☐ None ☐ Verbal Notice ☐ Warning Notice ☐ Administrative Action ☐ Administrative Action w/Penalty ☐ Legal Action

Facility Representative Signature: _____ Date: _____

Print Name of Facility Representative: _____ Inspector's Signature: _____

EOA, Inc. (F:\AL49-103\INSP.RPT; February 1996

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ATTACHMENT B

Minimum Enforcement Protocol

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Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

DRAFT

To: ACCWP Management Committee

From: Industrial & Illicit Discharge Control Subcommittee

The *Work Group* recommends the following breakdown of ACCWP follow-up/enforcement activities for reporting to the Regional Board. After some discussion, the *Work Group* decided not to include in the countywide protocol, specific time schedules for follow-up activities (e.g., written response, re-inspection, etc.) since an acceptable time to respond will vary on a case by case basis depending on the complexity of the site and the severity of the impact. However, it is understood that ACCWP agencies will escalate the level of enforcement until compliance is achieved. The *Work Group* agrees that this is a minimum procedure and does not prevent a municipality from skipping phases for more serious problems, as appropriate.

PROTOCOL FOR REPORTING ENFORCEMENT ACTIVITIES

Level I Enforcement **(Warnings)** Includes verbal notice to the facility owner/operator that is documented on the inspection form. This could also include a written informational letter to the facility owner/operator to follow-up inspection findings. A time frame to correct the identified problem should be specified based on the severity or complexity of the problem.

Level II Enforcement **(Administrative Actions)** Similar to Level I but with a more structured/formal notice or process. This includes as a Notice of Violation, Cease and Desist Order, Order to Abate, Notice to Clean or any other similar notification outlined in the municipality's storm water ordinance that identifies a problem, requires correction or abatement but does not assess fines. A time frame to correct the identified problem will be based on the severity or complexity of the problem.

Level III Enforcement **(Administrative Actions With Penalty)** Fine(s) are assessed administratively and/or the municipality's abatement costs are recovered..

Level IV Enforcement **(Legal Actions)** Includes any action taken by the municipality that brings the facility into the court system (e.g., Citation, Court Action, etc.).

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EOA, Inc.
February 8, 1996

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Appendix H

Sample Stormwater Discharge Control Ordinance

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October 1991

SAMPLE ORDINANCE

Prepared By:

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Prepared for:

Alameda County
Urban Runoff
Clean Water Program

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ORDINANCE NO. ____

AN ORDINANCE OF THE CITY COUNCIL OF THE
CITY OF _____ ADOPTING A
STORM WATER MANAGEMENT AND DISCHARGE CONTROL PROGRAM

WHEREAS, the 1987 Amendments to the federal Clean Water Act, as implemented by Environmental Protection Agency regulations adopted November 16, 1990, make necessary the adoption of plans and programs for storm water management meeting specified criteria; and

WHEREAS, Section 402(p) of the Clean Water Act (33 U.S.C. 1251 et seq.), as amended by the Water Quality Act of 1987, requires that all large and medium sized incorporated municipalities must:

(a) "effectively" prohibit non-storm water discharges into the storm sewer; and

(b) require controls to reduce the discharge of pollutants from storm water systems to waters of the United States to the maximum extent practicable ("MEP"); and

WHEREAS, the City of _____ seeks to comply with all provisions of state and federal law; and

WHEREAS, in order to implement the federal regulatory requirements described above, the City has entered into an "Agreement to Implement the Alameda County Urban Runoff Clean Water Program" dated July 1991; and

WHEREAS, on October 16, 1991 the California Regional Water Quality Control Board, San Francisco Bay Region issued Order No. 91-146, NPDES Permit No. CA 0029831, regulating, inter alia, storm water discharges by the City of _____; and

WHEREAS, the implementation of pollutant control measures described in the Plan in furtherance of these purposes is exempt from the provisions of the California Environmental Quality Act (CEQA); Chapter 3 (commencing with Section 21100) of Division 13 of the Public Resources Code as provided in categorical exemption classes 1, 4, 5, 7, 8, 9, and/or 21 of the CEQA Guidelines (Title 14, California Code of Regulations Sections 15301-15329); and

WHEREAS, this ordinance has been duly processed with proper public notice and full environmental review; and

WHEREAS, the City Council has conducted legally noticed public hearings and have provided all interested parties an opportunity to be heard on these issues; and

WHEREAS, the City Council has carefully considered the proposed Storm Water Management Program and finds that said proposed Storm Water Management Program complies with the

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requirements of applicable federal and state law, and further that said Program contributes to the comprehensiveness of the City of _____ General Plan and provides an acceptable plan for the conservation of water resources within the City of _____ and protection of the health, safety and general welfare of its citizens [NOTE: EACH CITY SHOULD EVALUATE THE CONSISTENCY OF THE ORDINANCE WITH THE GENERAL PLAN AND CONSIDER ANY APPROPRIATE REVISIONS TO THE GENERAL PLAN];

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF _____ DOES ORDAIN AS FOLLOWS:

Chapter ___, entitled "Storm Water Management and Discharge Control" is hereby adopted and added to the City of _____ Municipal Code, to read as follows:

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Article I

Title, Purpose and General Provisions

1. Title

This ordinance shall be known as the "City of _____ Storm Water Management and Discharge Control Ordinance" and may be so cited.

2. Purpose and Intent

The purpose of this Chapter is to ensure the future health, safety, and general welfare of City of _____ citizens by:

(a) eliminating non-storm water discharges to the municipal separate storm sewer.

(b) controlling the discharge to municipal separate storm sewers from spills, dumping or disposal of materials other than storm water.

(c) reducing pollutants in storm water discharges to the maximum extent practicable.

The intent of this ordinance is to protect and enhance the water quality of our watercourses, water bodies, and wetlands in a manner pursuant to and consistent with the Clean Water Act.

3. Definitions

3.1. Any terms defined in the federal Clean Water Act and acts amendatory thereof or supplementary thereto, and/or defined in the regulations for the storm water discharge permitting program issue by the Environmental Protection Agency on November 16, 1990 (as may from time to time be amended) as used in this ordinance shall have the same meaning as in that statute or regulations. Specifically, the definition of the following terms included in that statute or regulations are hereby incorporated by reference, as now applicable or as may hereafter be amended: discharge, illicit discharge, pollutant, and storm water. These terms presently are defined as follows:

3.1.1. Discharge: (a) any addition of any pollutant to navigable waters from any point source, or (b) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft.

3.1.2. Illicit discharge: any discharge to the City storm sewer system that is not composed entirely of storm water except discharges pursuant to a NPDES permit and discharges resulting from fire fighting activities.

3.1.3. Pollutant: dredged soil, solid waste, incinerator residue, sewage,

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garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharge into water.

A pollutant shall also include any increment of increase in the total volume or rate of storm water runoff resulting from any activity or development occurring after the effective date of this ordinance.

3.1.4. Storm water: storm water runoff, snow melt runoff, and surface runoff and drainage.

3.2. When used in this Chapter, the following words shall have the meanings ascribed to them in this Section:

3.2.1. Authorized Enforcement Official: the following City officials: [NOTE: THE FOLLOWING LIST NEEDS TO BE TAILORED FOR EACH CITY] chief of codes, inspection and zoning, zoning officer, building inspection supervisor, housing inspector, building inspector, project coordinator, license and collection supervisor, senior field representative, field representative, fire chief, deputy fire chief, assistant fire chief, fire marshal, deputy fire marshal, assistant fire marshal, fire inspector, parks/marina superintendent, parks/marina administrative analyst, marina supervisor, forestry supervisor, senior gardener supervisor, gardener supervisor, tree trimmer supervisor, tree topper supervisor, public works maintenance superintendent, senior public works supervisor, senior civil engineer, traffic engineer, assistant traffic engineer, associate civil engineer, assistant engineer, junior engineer, engineering inspector, recycling program administrator, refuse superintendent, senior refuse supervisor, refuse supervisor, chief of environmental health, supervising sanitarian, sanitarian, assistant sanitarian, vector control technician, animal services supervisor, and animal control officer.

3.2.2. Best management practices ("BMPs"): schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

3.2.3. City: the City of _____.

3.2.4. City Storm Sewer System: includes but is not limited to those facilities within the city by which storm water may be conveyed to waters of the United States, including any roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains, which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR ^U 122.2.

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3.2.5. Non-storm water discharge: any discharge that is not entirely composed of storm water.

3.2.6. Premises: any building, lot parcel, real estate, or land or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

4. Responsibility for Administration

This Chapter shall be administered for the City by the [Director of Public Works]. Where storm drain facilities and/or watercourses have been accepted for maintenance by the Alameda County Flood Control and Water Conservation District [ACFCWCD] or other public agency legally responsible for certain watercourses, then the responsibility for enforcing the provisions of this Chapter may be assigned to such agency (through contract or agreement executed by the City and such agency) with respect to those watercourses for which they have accepted maintenance.

5. Construction and Application

This ordinance shall be construed to assure consistency with the requirements of the federal Clean Water Act and acts amendatory thereof or supplementary thereto, applicable implementing regulations, and NPDES Permit No. CA0029831 and any amendment, revision or reissuance thereof.

6. Severability and Validity

If any portion of this ordinance is declared invalid, the remaining portions of this ordinance are to be considered valid.

7. Taking

The provisions of this ordinance shall not operate to deprive any landowner of substantially all of the market value of his/her property or otherwise constitute an unconstitutional taking without compensation. If application of this ordinance to a specific project would create a taking then pursuant to the ordinance the [City Council] may allow additional land uses, but only to the extent necessary to avoid a taking. Such uses shall be consistent with and carry out the purposes of this ordinance as stated in section 2 above.

8. Effective Date

This ordinance will take effect 30 days from the date of passage, and shall be published following passage as required by the Government Code.

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Article II

Discharge Regulations and Requirements

9. Discharge of Pollutants

The discharge of non-storm water discharges to the City storm sewer system is prohibited. All discharges of material other than storm water must be in compliance with a NPDES permit issued for the discharge (other than NPDES permit No. CA0029831).

9.1. Exceptions to Discharge Prohibition

The following discharges are exempt from the prohibition set forth in Section 9 above.

9.1.1. The prohibition on discharges shall not apply to any discharge regulated under a National Pollutant Discharge Elimination System (NPDES) permit issued to the discharger and administered by the State of California under authority of the United States Environmental Protection Agency, provided that the discharger is in full compliance with all requirements of the permit and other applicable laws or regulations.

9.1.2. Discharges from the following activities will not be considered a source of pollutants to waters of the United States when properly managed - water line flushing and other discharges from potable water sources, landscape irrigation and lawn watering, irrigation water, diverted stream flows, rising ground waters, infiltration to separate storm drains, uncontaminated pumped ground water, foundation and footing drains, water from crawl space pumps, air conditioning condensation, springs, individual residential car washings, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges or flows from fire fighting, and accordingly are not subject to the prohibition on discharges.

10. Discharge in Violation of Permit

Any discharge that would result in or contribute to a violation of NPDES Permit No. CA0029831, attached to this ordinance as Attachment A, and any amendment, revision or reissuance thereof, either separately considered or when combined with other discharges, is prohibited. Liability for any such discharge shall be the responsibility of the person(s) causing or responsible for the discharge, and such persons shall defend, indemnify and hold harmless the City in any administrative or judicial enforcement action relating to such discharge.

11. Illicit Discharge and Illicit Connections

It is prohibited to establish, use, maintain, or continue illicit drainage connections to the City storm sewer system, and to commence or continue any illicit discharges to the City storm sewer system. This prohibition is expressly retroactive and applies to connections made in

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the past, regardless of whether made under a permit or other authorization or whether permissible under the law or practices applicable or prevailing at the time of the connection.

12. Reduction of Pollutants in Storm Water

Any person engaged in activities which will or may result in pollutants entering the City storm sewer system shall undertake all practicable measures to reduce such pollutants. Examples of such activities include ownership and use of facilities which may be a source of pollutants such as parking lots, gasoline stations, industrial facilities, commercial facilities, stores fronting city streets, etc. The following minimal requirements shall apply.

12.1. Littering

No person shall throw, deposit, leave, maintain, keep, or permit to be thrown, deposited, placed, left or maintained, any refuse, rubbish, garbage, or other discarded or abandoned objects, articles, and accumulations, in or upon any street, alley, sidewalk, storm drain, inlet, catch basin, conduit or other drainage structures, business place, or upon any public or private lot of land in the City, so that the same might be or become a pollutant, except in containers or in lawfully established dumping grounds.

The occupant or tenant, or in the absence of occupant or tenant, the owner, lessee, or proprietor of any real property in the City of _____ in front of which there is a paved sidewalk shall maintain said sidewalk free of dirt or litter to the maximum extent practicable. Sweepings from said sidewalk shall not be swept or otherwise made or allowed to go into the gutter or roadway, but shall be disposed of in receptacles maintained on said real property as required for the disposal of garbage.

No person shall throw or deposit litter in any fountain, pond, lake, stream or any other body of water in a park or elsewhere within the City.

12.2. Standard for Parking Lots and Similar Structures

Persons owning or operating a parking lot, gas station pavement or similar structure shall clean those structures as frequently and thoroughly as practicable in a manner that does not result in discharge of pollutants to the City storm sewer system.

12.3. Best Management Practices for New Developments and Redevelopments

Any construction contractor performing work in the City shall endeavor, whenever possible, to provide filter materials at the catch basin to retain any debris and dirt flowing in to the City's storm sewer system. The [Director of Public Works] may establish controls on the volume and rate of storm water runoff from new developments and redevelopments as may be appropriate to minimize the discharge and transport of pollutants.

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12.4. Notification of Intent and Compliance with General Permits

Each industrial discharger, discharger associated with construction activity, or other discharger, described in any general storm water permit addressing such discharges, as may be adopted by the United States Environmental Protection Agency, the State Water Resources Control Board, or the California Regional Water Quality Control Board, San Francisco Bay Region, shall provide notice of intent, comply with, and undertake all other activities required by any general storm water permit applicable to such discharges.

Each discharger identified in an individual NPDES permit relating to storm water discharges shall comply with and undertake all activities required by such permit.

12.5. Compliance with Best Management Practices

Where best management practices guidelines or requirements have been adopted by any federal, State of California, regional, and/or city agency, for any activity, operation, or facility which may cause or contribute to storm water pollution or contamination, illicit discharges, and/or discharge of non-storm water to the storm water system, every person undertaking such activity or operation, or owning or operating such facility shall comply with such guidelines or requirements [as may be identified by the Director of Public Works].

13. Watercourse Protection

Every person owning property through which a watercourse passes, or such person's lessee or tenant, shall keep and maintain that part of the watercourse within the property reasonably free of trash, debris, excessive vegetation, and other obstacles which would pollute, contaminate, or significantly retard the flow of water through the watercourse; shall maintain existing privately owned structures within or adjacent to a watercourse, so that such structures will not become a hazard to the use, function, or physical integrity of the wetercourse; and shall not remove healthy bank vegetation beyond that actually necessary for said maintenance, nor remove said vegetation in such a manner as to increase the vulnerability of the watercourse to erosion.

No person shall commit or cause to be committed any of the following acts, unless a written permit has first been obtained from the [Director of Public Works]:

13.1. Discharge into or connect any pipe or channel to a watercourse;

13.2. Modify the natural flow of water in a watercourse;

13.3. Carry out development within thirty feet of the center line of any creek or twenty feet of the top of a bank;

13.4. Deposit in, plant in, or remove any material from a watercourse including its banks, except as required for necessary maintenance;

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13.5. Construct, alter, enlarge, connect to, change, or remove any structure in a watercourse; or

13.6. Place any loose or unconsolidated material along the side of or within a watercourse or so close to the side as to cause a diversion of the flow, or to cause a probability of such material being carried away by storm waters passing through such watercourse.

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Article III

Inspection and Enforcement

14. Authority to Inspect

Whenever necessary to make an inspection to enforce any of the provisions of this Chapter, or whenever an authorized enforcement official has reasonable cause to believe that there exists in any building or upon any premises any condition which constitutes a violation of the provisions of this Chapter, the official may enter such building or premises at all reasonable times to inspect the same or perform any duty imposed upon the official by this Chapter; provided that (i) if such building or premises be occupied, he or she shall first present proper credentials and request entry; and (ii) if such building or premises be unoccupied, he or she shall first make a reasonable effort to locate the owner or other persons having charge or control of the building or premises and request entry.

Any such request for entry shall state that the property owner or occupant has the right to refuse entry and that in the event such entry is refused, inspection may be made only upon issuance of a search warrant by a duly authorized magistrate. In the event the owner and/or occupant refuses entry after such request has been made, the official is hereby empowered to seek assistance from any court of competent jurisdiction in obtaining such entry.

Routine or area inspections shall be based upon such reasonable selection processes as may be deemed necessary to carry out the objectives of this ordinance, including but not limited to random sampling and/or sampling in areas with evidence of storm water contamination, illicit discharges, discharge of non-storm water to the storm water system, or similar factors.

14.1. Authority to Sample and Establish Sampling Devices

The City shall have the right to establish on any property such devices as are necessary to conduct sampling or metering operations. During all inspections as provided herein, the official may take any samples deemed necessary to aid in the pursuit of the inquiry or in the recordation of the activities onsite.

14.2. Notification of Spills

As soon as any person in charge of a facility or responsible for emergency response for a facility has knowledge of any confirmed or unconfirmed release of materials, pollutants or waste which may result in pollutants or non-storm water discharges entering the City storm sewer system, such person shall take all necessary steps to ensure the discovery and containment and clean up of such release and shall notify the City of the occurrence by telephoning _____ and confirming the notification by correspondence to _____.

14.3. Requirement to Test or Monitor

Any authorized enforcement official may request that any person engaged in any

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activity and/or owning or operating any facility which may cause or contribute to storm water pollution or contamination, illicit discharges, and/or discharge of non-storm water to the storm water system, undertake such monitoring activities and/or analyses and furnish such reports as the official may specify. The burden, including costs, of these activities, analyses and reports shall bear a reasonable relationship to the need for the monitoring, analyses and reports and the benefits to be obtained. The recipient of such request shall undertake and provide the monitoring, analyses and/or reports requested.

15. Violations Constituting Misdemeanors

Unless otherwise specified by ordinance, the violation of any provision of this Chapter, or failure to comply with any of the mandatory requirements of this Chapter shall constitute a misdemeanor; except that notwithstanding any other provisions of this Chapter, any such violation constituting a misdemeanor under this Chapter may, in the discretion of the enforcing authority be charged and prosecuted as an infraction.

16. Violations Constituting Infractions

Any person violating or failing to comply with any of the following provisions of this ordinance shall be guilty of an infraction, which shall be enforced and punishable in the manner prescribed by the Penal Code and the Government Code of the State of California or abated as a nuisance as provided herein:

[list]

17. Penalty for Violation

Upon conviction of a misdemeanor, a person shall be subject to payment of a fine, or imprisonment, or both, not to exceed the limits set forth in California Government Code Section 36901.

Upon conviction of an infraction, a person shall be subject to payment of a fine, not to exceed the limits set forth in California Government Code Section 36900. After a third conviction for a violation of the same provision subsequent violations within a twelve (12) month period may be charged as a misdemeanor.

18. Continuing Violation

Unless otherwise provided, a person, firm, corporation or organization shall be deemed guilty of a separate offense for each and every day during any portion of which a violation of this Chapter is committed, continued or permitted by the person, firm, corporation or organization and shall be punishable accordingly as herein provided.

19. Concealment

Causing, permitting, aiding, abetting or concealing a violation of any provision of this Chapter shall constitute a violation of such provision.

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20. Acts Potentially Resulting in Violation of Federal Clean Water Act and/or Porter-Cologne Act

Any person who violates any provision of this Chapter, any provision of any permit issued pursuant to this Chapter, or who discharges waste or wastewater which causes pollution, or who violates any cease and desist order, prohibition, or effluent limitation, may also be in violation of the federal Clean Water Act and/or Porter-Cologne Act and may be subject to the sanctions of those Acts including civil and criminal penalty. Any enforcement action authorized under this Article should also include notice to the violator of such potential liability.

21. Violations Deemed a Public Nuisance

In addition to the penalties hereinbefore provided, any condition caused or permitted to exist in violation of any of the provisions of this Chapter is a threat to the public health, safety and welfare, and is declared and deemed a nuisance, and may be summarily abated and/or restored by any authorized enforcement official, and/or civil action to abate, enjoin or otherwise compel the cessation of such nuisance may be taken by the city attorney.

The cost of such abatement and restoration shall be borne by the owner of the property and the cost thereof shall be a lien upon and against the property and such lien shall continue in existence until the same shall be paid. If the lien is not satisfied by the owner of the property within three (3) months after the completion by the authorized enforcement official of the removal of the nuisance and the restoration of the property to its original condition, the property may be sold in satisfaction thereof in a like manner as other real property is sold under execution.

If any violation of this Chapter constitutes a seasonal and recurrent nuisance, the City Council shall so declare. Thereafter such seasonal and recurrent nuisance shall be abated every year without the necessity of any further hearing.

22. California Code of Civil Procedure Section 1094.6

The provisions of Section 1094.6 of the California Code of Civil Procedure are applicable to judicial review of City decisions pursuant to this Chapter.

23. Civil Actions

In addition to any other remedies provided in this section, any violation of this section may be enforced by civil action brought by the City. In any such action, the City may seek, and the Court shall grant, as appropriate, any or all of the following remedies:

(1) A temporary and/or permanent injunction.

(2) Assessment of the violator for the costs of any investigation, inspection, or monitoring survey which led to the establishment of the violation, and for the reasonable costs of preparing and bringing legal action under this subsection.

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(3) Costs incurred in removing, correcting, or terminating the adverse effects resulting from the violation.

(4) Compensatory damages for loss or destruction to water quality, wildlife, fish and aquatic life. Assessmants under this subsection shall be paid to the City to be used exclusively for costs associated with monitoring and establishing storm water discharge pollution control systems and/or implementing or enforcing the provisions of this ordinance.

24. Administrative Enforcement Powers

In addition to the other enforcement powers and remedies established by this ordinance, any authorized enforcement official has the authority to utiliza the following administrative remedies.

24.1. Cease and Desist Orders

When an authorized enforcement official finds that a discharge has taken place or is likely to take place in violation of this Chapter, the official may issue an order to cease and desist such discharge, or practice, or operation likely to cause such discharge and direct that those persons not complying shall: a) comply with the requirement, b) comply with a time schedule for compliance, and/or c) take appropriate remedial or preventive action to prevent the violation from recurring.

24.2. Notice to Clean

Whenever an authorized enforcement official finds any oil, earth, dirt, grass, weeds, dead trees, tin cans, rubbish, refuse, waste or any other material of any kind, in or upon the sidewalk abutting or adjoining any parcel of land, or upon any parcel of land or grounds, which may result in an increase in pollutants entering the City storm sewer system or a non-storm water discharge to the City storm sewer system, he or she may give notice to remove such oil, earth, dirt, grass, weeds, dead trees, tin cans, rubbish, refuse, waste or other material, in any manner that he or she may reasonably provide. The recipient of such notice shall undertake the activities as described in the notice.

25. Authority to Arrest or Issue Citations

Authorized enforcement officials shall have and are hereby vested with the authority to arrest or cite any person who violates any Section of this Code in the manner provided by the California Penal Code for the arrest or release on citation of misdemeanor infractions as prescribad by Chapter 5, 5c, and 5d of Title 3, Part 2 of the Penal Code (or as the same may be hereinafter amended).

Such authorized enforcement officials or employees may issue a citation and notice to appear in the manner prescribed by Chapter 5c of Title 3, Part 2 of the Penal Code, including Section 853.6 (or as the same may hereafter be emended). It is the intent of the city council that the immunities prescribed in Section 836.5 of the Penal Code be applicable to public officers or employees or employees acting in the course and scope of employment pursuant to this

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Chapter.

[Bail for infractions shall be as set by resolution of the City Council.]

26. Remedies Not Exclusive

Remedies under this Article are in addition to and do not supersede or limit any and all other remedies, civil or criminal. The remedies provided for herein shall be cumulative and not exclusive.

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Article IV

Coordination with Other Programs

27. Coordination with Hazardous Materials Inventory and Response Program

The first revision of the business plan for any facility subject to the City's hazardous materials inventory and response program shall include a program for compliance with this Chapter, including the prohibitions on non-storm water discharges and illicit discharges, and the requirement to reduce storm water pollutants to the maximum extent practicable.

_____
MAYOR OF THE CITY OF _____

ATTEST: _____
CITY CLERK

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Appendix I

Example Enforcement Protocols And Guidelines

1) Alameda Countywide Clean Water Program (ACCWP) - Minimum Enforcement Protocol, January, 1994

2) ACCWP - Revised Protocol for Reporting Enforcement Activities, February 8, 1996

3) San Mateo Countywide Stormwater Pollution Prevention Program - Guidance on Enforcement Options for Illicit Discharges and Industrial/Commercial Business Stormwater Pollution Violations

4) Fairfield-Suisun Urban Runoff Management Program - Enforcement Guidance for Storm Water Discharge Ordinance Violations, July 1995

5) City of San Jose - Notice of Violation Letter and Request for Corrective Action

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Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

To: ACCWP Management Committee

From: Industrial & Illicit Discharge Control Subcommittee

The Subcommittee recommends the following breakdown of ACCWP follow-up/enforcement activities for reporting to the Regional Board. After some discussion, the Subcommittee decided not to include in the countywide protocol, specific time schedules for follow-up activities (e.g., written response, re-inspection, etc.) since an acceptable time to respond will vary on a case by case basis depending on the complexity of the site and the severity of the impact. However, it is understood that ACCWP agencies will escalate the level of enforcement until compliance is achieved. The Subcommittee agrees that this is a minimum procedure and does not prevent a municipality from skipping phases for more serious problems, as appropriate.

PROTOCOL FOR REPORTING ENFORCEMENT ACTIVITIES

Level I Enforcement **(Warnings)** Includes verbal notice to the facility owner/operator that is documented on the inspection form. This could also include a written informational letter to the facility owner/operator to follow-up inspection findings. A time frame to correct the identified problem should be specified based on the severity or complexity of the problem.

Level II Enforcement **(Administrative Actions)** Similar to Level I but with a more structured/formal notice or process. This includes a Notice of Violation, Cease and Desist Order, Order to Abate, Notice to Clean or any other similar notification outlined in the municipality's storm water ordinance that identifies a problem, requires correction or abatement but does not assess fines. A time frame to correct the identified problem will be based on the severity or complexity of the problem.

Level III Enforcement **(Administrative Actions With Fine and/or Cost Recovery)** Fine(s) are assessed administratively and/or the municipality's abatement costs are recovered.

Level IV Enforcement **(Legal Actions)** Includes any action taken by the municipality that brings the facility into the court system (e.g., Citation, Court Action, etc.).

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EOA, Inc.
February 8, 1996

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The Industrial & Illicit Discharge Control Subcommittee and later the Management Committed adopted the following *Minimum Enforcement Protocol* at its respective December meetings. The enforcement protocol is derived from several existing ACURCWP documents described below. The protocol will be included in the next update of the *Industrial and Commercial Business Inspectors Training Manual.*

Minimum Enforcement Protocol

To help reach the ACURCWP's goal of handling storm water discharge violations equitably and consistently throughout the County, the Industrial & Illicit Discharge Control Subcommittee (Subcommittee) and Management Committee have adopted the following four-phased enforcement procedure:

I. **Warning Notice** - Issue for anticipated violations due to poor housekeeping or management practices. A verbal warning is considered a warning notice. Appropriate BMP(s) may be recommended to prevent violation. Facility should receive the results of the inspection within seven calendar days. A follow up inspection may be conducted within four weeks as the inspector feels appropriate.

II. **Informal Violation** - Issue for minor violations. The facility operator shall respond within ten days of receiving inspection results with the following information: the cause of the violation, corrective actions being taken, and date anticipated for corrective action to be completed. A follow up inspection is conducted within 45 days of initial inspection. If violation persists, issue formal violation or begin legal action as the inspector feels appropriate.

III. **Formal Violation** - Issue for major violations or if the response to informal violation is inadequate. Facility operator shall respond within ten days of receiving the formal violation with the following information: cause of the violation, corrective actions being taken, and date anticipated for corrective action to be completed. If the formal violation is issued because corrective actions for an informal violation were inadequate, the facility operator shall submit a revised compliance schedule within fifteen calendar days of receiving the formal violation. Follow-up inspection is conducted within 45 days after the facility was last inspected. If the violation is not corrected, refer to city attorney or County District attorney.

IV. **Legal Action** - Failure to respond to previous violation notices should be referred to city attorney or County District attorney.

This enforcement protocol was previously outlined in three ACURCWP documents: *Minimum Procedures, Qualifications and Standards for Conducting Industrial Inspections for the ACURCWP* (EOA, October 1991), *Field Manual: Illicit Discharge Identification and Elimination Program* (WCC, May 1992), and *Industrial and Commercial Business Inspectors Training Manual* (EOA, July 1993).

The Subcommittee agrees that this is a *minimum* procedure and does not prevent a municipality from skipping phases for more flagrant problems, as appropriate. The inspector should also be aware that other regulatory agencies may need to be contacted if a formal violation is issued. The Subcommittee will review the four-phased approach by December 1994 to determine if additional or more specific guidelines are necessary.

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San Mateo Countywide Stormwater Pollution Prevention Program
Guidance on Enforcement Options for Illicit Discharges and Industrial/Commercial Business Storm Water Pollution Violations

Enforcement Action	Description
I Warning Notice	Issue for anticipated violations due to poor housekeeping or management practices. A verbal warning is considered a warning notice. Appropriate BMP(s) may be recommended to prevent violation. Facility should receive the results of the inspection within seven calendar days. A follow up inspection may be conducted within four weeks as the inspector feels appropriate.
II Informal Violation	Issue for minor violations. The facility operator shall respond within 14 calendar days of receiving inspection results with the following information: the cause of the violation, corrective actions being taken, and date anticipated for corrective action to be completed. A follow up inspection is conducted or an alternate method of self-reporting of completion of corrective measures by violator is completed within 45 days of initial inspection. If violation persists, issue formal violation or begin legal action as the inspector feels appropriate.
III Formal Violation	Issue for major violations or if the response to informal violation is inadequate. Facility operator shall respond within 14 calendar days of receiving the formal violation with the following information: cause of the violation, corrective actions being taken, and date anticipated for corrective action to be completed. If the formal violation is issued because corrective actions for an informal violation were inadequate, the facility operator shall submit a revised compliance schedule within fourteen calendar days of receiving the formal violation. A follow-up inspection is conducted or an alternate method of self-reporting of completion of corrective measures by violator is completed within 45 days of previous facility inspection. If the violation is not corrected, refer to city attorney or County District attorney.
IV Legal Action	Failure to respond to previous violation notices should be referred to city attorney or County District attorney. All potential legal actions will be reviewed by the County Environmental Health and the District Attorney for possible violations of Hazardous Waste and Hazardous Materials regulations.

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Guidance on Enforcement Options for Illicit Discharges and Industrial/Commercial Business Storm Water Pollution Violations

VIOLATION	ENFORCEMENT OPTIONS: Warning Notice	Informal Violation	Formal Violation	Legal Action[6]
1. Failure to effectively apply Best Management Practices (BMPs) to minimize potential exposure of raw materials, products, equipment, waste materials, and work, material storage, and material handling areas to storm water				
2. Release of small quantities[1] of pollutants where there is the potential to reach the storm drain system, creek, lagoon, marsh or bay/ocean.				
3. Evidence of discharges present (stains, sludge, eroded concrete, etc.)				
4. Emissions from short stacks or air exhaust systems or emissions of dust or particles that have the potential to contribute significant quantities of pollutants to storm water				
5. Discharge of washwaters[2] to the storm drain, or for certain types of washwaters specified by STOPPP, failure to effectively apply BMPs.				
6. Illicit connection to storm drainage system, such as a floor drain				
*** First failure to correct violations 1-6				
7. Failure of applicable facility to file a NOI				
8. Failure of applicable facility[3] to have a SWPPP,[4] Monitoring Plan or Annual Monitoring Report				
9. Failure of applicable facility to have an adequate SWPPP, Monitoring Plan or Annual Monitoring Report				
10. Discharge of small quantities[1] of pollutants that have reached the storm drain system, creek, lagoon, marsh or bay/ocean.				
11. Visible pollutants present in storm water runoff (during wet weather) such as oil sheen or litter.				
*** Second failure to correct violations 1-6, first failure to correct violations 7-11				
12. Discharge of large quantities of pollutants which have reached the storm drain system, creek, lagoon, marsh or bay/ocean.				
13. Industrial process wastewaters or sanitary sewage discharged to storm drainage system				
*** Failure to correct violations that resulted in formal violation notices				

Notes:

1. Small quantities are defined as less than 1-gallon for liquid materials based on RWQCB's Enforcement Policy's "ACL Ticket - Violation Categories"
2. Washwaters include wastewater from 1) businesses washing of automobiles, trucks, equipment (including buckets, mats and utensils), parking lots, or sidewalks, 2) mobile cleaners/steamers/rug cleaners, 3) high-pressure hosing for painting preparation, and 4) any other type of washing
3. Facilities required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Industrial Activities
4. Stormwater Pollution Prevention Plan
5. If sufficient resources exist to review such plans and documents
6. All potential legal actions will be reviewed by County Environmental Health and District Attorney for possible violations of Hazardous Waste and Hazardous Materials regulations

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June 9, 1994

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Fairfield-Suisun Urban Runoff Management Program
Enforcement Guidance for Storm Water Discharge Ordinance Violations

Enforcement Action	Description
I Warning Notice	Issue for conditions that may result in violations due to poor housekeeping or poor management practices. Appropriate BMP(s) may be recommended to prevent violation. Facility should receive the written results of the inspection with seven (7) calendar days. Facility operator shall take all reasonable steps to comply with recommendations of inspection within seven (7) calendar days. A follow-up inspection may be conducted within four (4) weeks as the inspector feels appropriate.
II Minor Violation	Issue for minor violations. Minor violations are first time spills of small quantities (under one gallon for most products), failure to implement appropriate BMP's as defined by the FSURMP after receiving a warning notice, or other minor infractions that have limited impact on the storm drainage system and the environment. The facility operator shall respond within 14 calendar days of receiving inspection results with the following information: the cause of violation, corrective actions taken, and date anticipated for corrective action to be completed. A follow-up inspection is conducted or an alternative method of self-reporting of completion of corrective measures by violator is completed within 45 days of initial inspection. If violation persists, issue major violation or begin legal action as the inspector feels appropriate.
III Major Violation	Issue for major violations or if the response to minor violation is inadequate as determined by the FSURMP. Major violations are all others not addressed by a warning notice or minor violation. Facility operator shall respond within 14 days of receiving the formal violation with the following information: cause of the violation, corrective actions being taken, and date anticipated for corrective action to be completed. If the major violation notice is issued because corrective actions for a minor violation were inadequate, the facility operator shall submit a revised compliance schedule within fourteen calendar days of receiving the formal violation. A follow-up inspection is conducted or an alternative method of self-reporting of completion of corrective measures by violator is completed within 45 days of previous facility inspection. If the violation is not corrected, refer to Sewer District's Attorney.
IV Legal Action	Failure to respond to previous violation notices should be referred to the Sewer District's Attorney or the Solano County District Attorney. All potential legal actions will be reviewed by the Solano County Department of Environmental Management and the Solano County Environmental Crimes Task Force for possible additional violations of Federal, State, or local laws.

Update: 7/21/95

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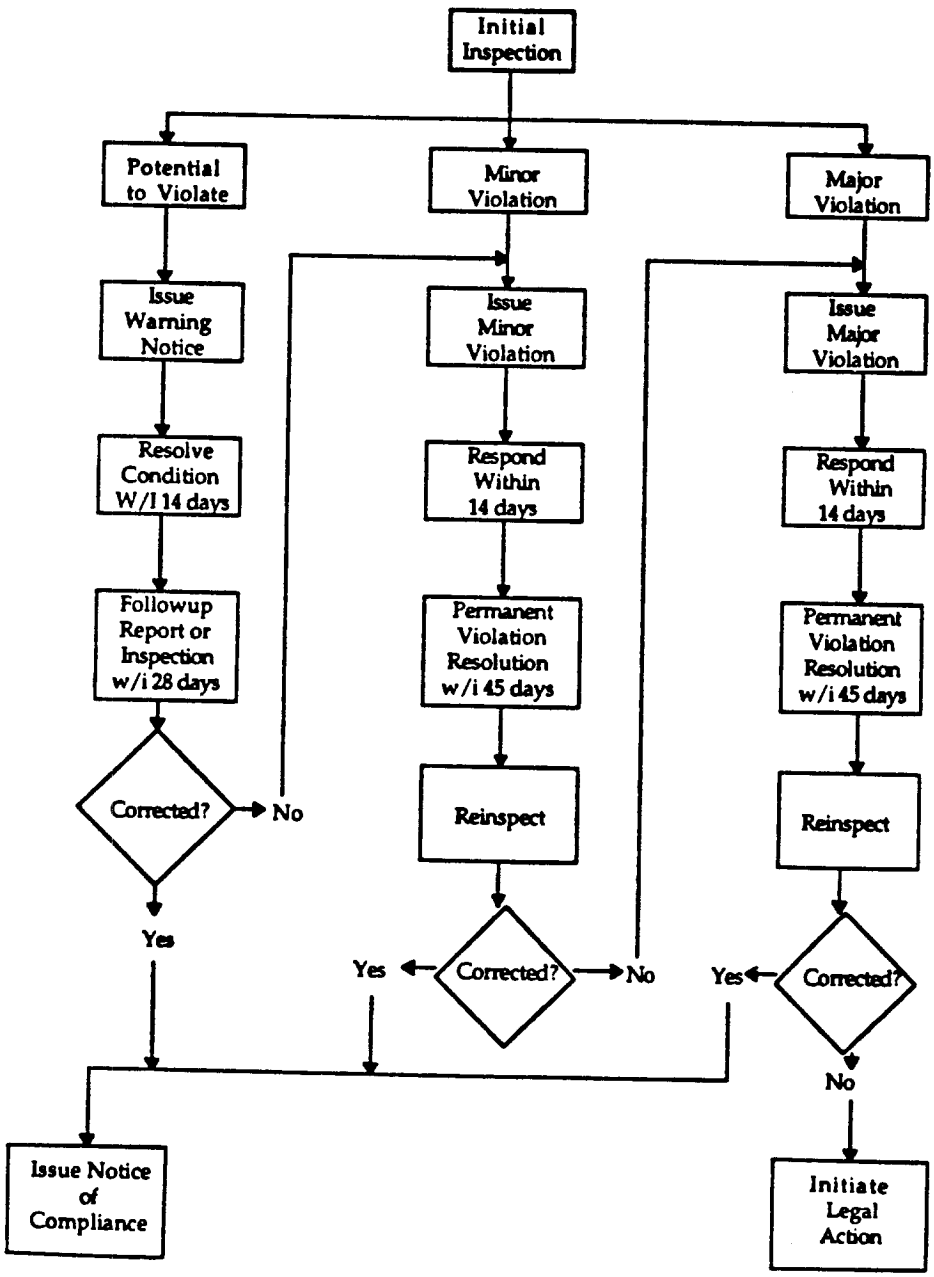
Fairfield-Suisun Urban Runoff Management Program
Enforcement Guidance



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CITY OF SAN JOSÉ, CALIFORNIA

4 NORTH SECOND STREET, SUITE 875
SAN JOSE, CALIFORNIA 95113
Phone Number (408) 277-5970
Fax Number (408) 277-3186

ENVIRONMENTAL
SERVICES DEPARTMENT
Environmental Enforcement Division

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«DATE»

«FACILITY NAME»
«STREET #» «STREET NAME»
«CITY»,«STATE»,«ZIP»
«SIC CODE»

Dear «ATTN»,

Your cooperation in helping our department conduct the Non Point Source Facility Inspection of your business on «INSP. DATE» was appreciated.

During the inspection violations were observed as indicated on page one of the attached Facility Inspection Audit Form. You are required to correct these violations as described on page two of the Audit Form by no later than «COMP DATE». Please send me a brief letter describing how the violations have been, or will be corrected, within 30 days of receipt of this notice.

As a continued service to you and the community we may be re-inspecting your facility at least anually and may perform a follow-up inspection related to the current audit before then. We are committed to providing assistance in the identification and elimination of sources of storm water pollution.

I want to emphasize again how much our department appreciates your cooperation. We want to do all we can to help you meet RWQCB requirements while minimizing any negative impacts on your business.

If you have any questions regarding this process please call me at (408) 277-5970.

Sincerely,

«INSPECTOR NAME»
Code Enforcement Inspector II

217-NP.WPS

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CITY OF SAN JOSE
ESD/ENVIRONMENTAL ENFORCEMENT DIVISION
NON POINT SOURCE FACILITY INSPECTION AUDIT FORM

CONTINUATION SHEET

SECTION 7.0 **INSPECTION SUMMARY**

Facility Name:

Address:

Inspection Date:

File No:

Inspec tor: JM **Badge#: 014B**

ITEM NO.	AREA OF CONCERN	REMEDIAL ACTIONS REQUIRED OR RECOMMENDATIONS	COMPLIANCE DATE

Re-inspection Date: To be Scheduled

Inspector Signature: J. Matthews

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Appendix J

Lists And Samples Of Educational Outreach Materials

1) Excerpts from the California Stormwater Quality Task Force, Public Information/Participation Subcommittee, *Stormwater Resource Guide*, January 1996.

2) Outreach to Vehicle Service/Automotive Repair Shops

3) Outreach to Restaurants and Food Industries

4) Introduction Letter to Businesses (City of San Jose)

5) Business Survey Form (City of Richmond)

6) Fact Sheets on BMPs (ACCWP and City of Richmond)

7) Business Newsletter (Union Sanitary District)

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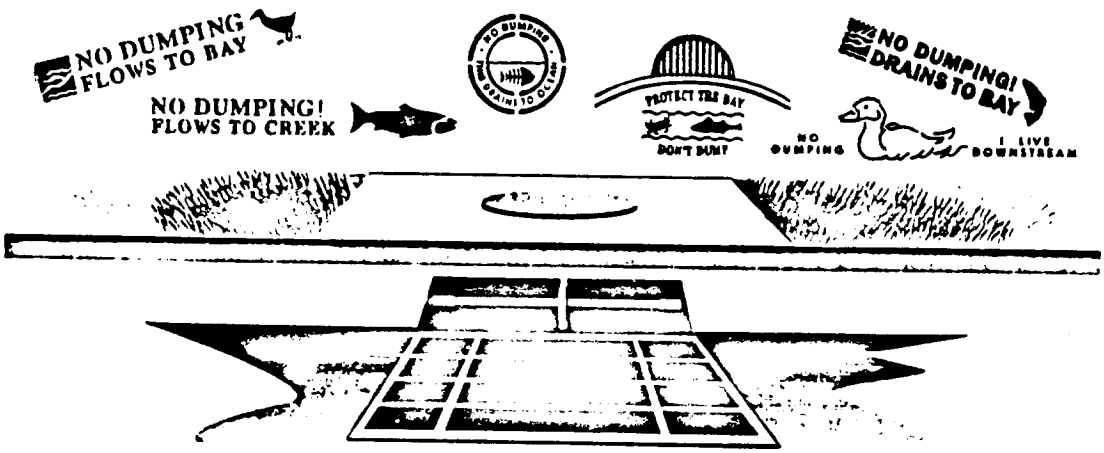
California
SWQTF
STORMWATER QUALITY TASK FORCE

Public Information/Public Participation
SUBCOMMITTEE

STORMWATER RESOURCE GUIDE



A Listing of Materials and Information Available in California Relating to Stormwater and Watershed Management

January 1996

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COMMERCIAL/BUSINESS OUTREACH

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Automotive-Related Industries Best Management Practices for Storm Water and Industrial Sanitary Sewer Pollution Control" and accompanying poster
Author	Santa Clara Valley Nonpoint Source Pollution Control Program/Alameda Countywide Clean Water Program
Abstract	A brochure and poster for auto-related businesses. The auto BMPs is a booklet filled with helpful and easy tips for a cleaner and safer shop. This 13-page book is designed to help the shop owner stay in compliance with local storm water pollution requirements. Accompanying this booklet is an informational poster that identifies some of the major and recurring problems throughout a typical shop. Solutions to the common problems are listed simply on the poster for quick reminder and reference.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Auto Radiator Service and Fishing", "Auto Wrecking and Fishing", and "Auto Body Repair and Refinishing and Fishing"
Author	Alameda Countywide Clean Water Program
Abstract	Three different tri-fold BMPs brochures for auto related industries that target auto repair and restoration, auto wrecking and auto radiator shops. These brochures explain how each of these shops contribute to urban runoff pollution and offers solutions.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"General Industrial Best Management Practices" Booklet
Author	Alameda Countywide Clean Water Program
Abstract	The "Best Management Practices for Industrial Stormwater Pollution Control" booklet explains the meaning of urban runoff and suggests many ways to help control it. The 21- page brochure offers recommended BMPs for storm water pollution prevention and advanced BMPs and structural controls for general industry.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94545 (510) 670-6547

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Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Best Management Practices for Municipal, Industrial/Commercial, Construction"
Author	Alameda Countywide Clean Water Program
Abstract	BMPs information for various workshops targeting industry, construction, development, municipal maintenance and operations.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Blueprint for a Clean Bay"
Author	Bay Area Stormwater Management Agencies Association
Abstract	Ten-page booklet provides Best Management Practices to prevent stormwater pollution from construction-related activities. It has been developed as a resource for all general contractors, home builders, and subcontractors working on construction sites.
Contact	Geoff Brosseau 518 Central Ave. Menlo Park, CA 94025-2807 (415) 322-3070

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Clean It Right!" Restaurant BMPs Poster
Author	Alameda Countywide Clean Water Program
Abstract	The "Clean It Right!" BMPs Poster explains urban runoff pollution and offers alternatives to hazardous activities that may be happening in restaurants, from the inside out.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	Various BMPs Outreach Flyers for Industry
Author	Alameda Countywide Clean Water Program
Abstract	BMPs outreach flyers for various industries (restaurants, industrial and commercial businesses, and contractors) that explain urban runoff. Flyers explain that daily activities are one of the causes of urban runoff pollution and gives simple alternatives to prevent it.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

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Name of Agency	Alameda Countywide Clean Water Program
Document Type	Commercial/Business Outreach
Document Title	"Adopt-A-Creek/Adopt-A-Spot"
Author	Alameda Countywide Clean Water Program
Abstract	The Adopt-A-Creek/Adopt-A-Spot is a program developed by the Public Works Agency to encourage and assist individuals, neighborhood groups, civic organizations and businesses to play an active role in beautifying and maintaining their neighborhoods, creeks and flood control channels.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Blueprint For a Clean Bay"
Document Type	Commercial/Business Outreach
Author	BASMAA (adapted from Santa Clara Valley program version)
Abstract	Booklet which provides guidance on BMPs to prevent storm water pollution from construction related activities. Audience is general, sub-contractors and home builders.
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Your Shop Can Make a Difference!"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Booklet which highlights specific activities and BMPs. Provides BMPs for vehicle maintenance/service facilities. This booklet was based on a review of eight BMPs documents developed and used by stormwater and wastewater agencies in the San Francisco Bay Area.
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Changing Oil and Other Fluids"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

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Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Engine & Parts Cleaning & Radiator Flushing"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Washing Cars and Other Vehicles"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Body Work"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Keeping a Clean Shop"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

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Name of Agency	Bay Area Stormwater Management Agencies Association (BASMAA)
Document Title	"Tips for Managers of Vehicle Service Facilities"
Document Type	Commercial/Business Outreach
Author	Bay Area Pollution Prevention Group
Abstract	Pamphlet which highlights specific guidelines, BMPs and practices for vehicle maintenance/service facilities which would lead to a cleaner Bay. Provides referral telephone numbers. Accompanies the booklet, "Your Shop Can Make a Difference!"
Contact	Geoff Brosseau BASMAA 2101 Webster St., Suite 500 Oakland, CA 94612 (510) 286-0615

Name of Agency	Bellflower (City)
Document Title	"Automotive Maintenance & Car Care" BMPs
Document Type	Commercial/Business Outreach
Author	City of Los Angeles
Abstract	A brochure produced and given out to all City-licensed auto shops, dealers and car washes, informing businesses of the many pollutants entering the storm drain system.
Contact	Victor M. Gonzalez, Executive Assistant City of Bellflower 16600 Civic Center Drive Bellflower, CA 90706 (310) 804-1424

Name of Agency	Bellflower (City)
Document Title	"Heavy Equipment & Earth-moving Activities" BMPs
Document Type	Commercial/Business Outreach
Author	City of Los Angeles
Abstract	A brochure produced and given out to all City-licensed contractor and all developers informing businesses of the many pollutants entering the storm drain system.
Contact	Victor M. Gonzalez, Executive Assistant City of Bellflower 16600 Civic Center Drive Bellflower, CA 90706 (310) 804-1424

Name of Agency	Bellflower (City)
Document Title	"Landscaping, Gardening & Pest Control" BMPs
Document Type	Commercial/Business Outreach
Author	City of Los Angeles
Abstract	A brochure produced and given out to all City-licensed landscaping companies informing businesses of the many pollutants entering the storm drain system and providing tips on preventing storm drain pollution.
Contact	Victor M. Gonzalez, Executive Assistant City of Bellflower 16600 Civic Center Drive Bellflower, CA 90706 (310) 804-1424

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Name of Agency	Fremont (City)
Document Type	Commercial/Business Outreach
Document Title	"Automotive Washing Guidelines"
Author	Union Sanitary District
Abstract	This brochure offers BMPs for washing vehicles. This flyer is aimed at businesses.
Contact	Forest L. Frasieur City of Fremont Urban Runoff Clean Water Program P.O. Box 5006 Fremont, CA 94537-5006 (510) 494-4700

Name of Agency	Gardena (City)
Document Type	Commercial/Business Outreach
Document Title	"Solutions to Pollution, Automotive Industry Tips"
Author	City of Gardena
Abstract	Flyer targets automotive industry and provides instruction on proper site maintenance and legal disposal practices. Differentiates between storm drain and sanitary sewer. Flyer is being distributed through Gardena's business licensing process and is included in any segmented mailing undertaken by the Business License Division.
Contact	Lynn Sakamoto City of Gardena 1700 W. 162nd St. Gardena, CA 90247 (310) 217-9663

Name of Agency	Gardena (City)
Document Type	Commercial/Business Outreach
Document Title	"Solutions to Pollution, Construction Industry Tips"
Author	City of Gardena
Abstract	Handout targets construction industry and provides instruction on proper site maintenance and legal disposal practices. Differentiates between storm drain and sanitary sewer. Flyer is being distributed through Gardena's business licensing process and is included in any segmented mailing undertaken by the Business License Division.
Contact	Lynn Sakamoto City of Gardena 1700 W. 162nd St. Gardena, CA 90247 (310) 217-9663

Name of Agency	Gardena (City)
Document Type	Commercial/Business Outreach
Document Title	"Solutions to Pollution, Commercial/Industrial Tips"
Author	City of Gardena
Abstract	Handout targets general commercial/industrial firms and provides instruction on proper site maintenance and legal disposal practices. Differentiates between storm drain and sanitary sewer. Flyer is being distributed through Gardena's business licensing process and is included in any segmented mailing undertaken by the Business License Division.
Contact	Lynn Sakamoto City of Gardena 1700 W. 162nd St. Gardena, CA 90247 (310) 217-9663

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Name of Agency	Gardena (City)
Document Type	Commercial/Business Outreach
Document Title	"Solutions to Pollution, Restaurant Industry Tips"
Author	City of Gardena
Abstract	Handout targets restaurant industry. Provides instruction on proper site maintenance and legal disposal practices. Differentiates between storm drain and sanitary sewer. Flyer is being distributed through Gardena's business licensing process and is included in any segmented mailing undertaken by the Business License Division.
Contact	Lynn Sakamoto City of Gardena 1700 W. 162nd St. Gardena, CA 90247 (310) 217-9663

Name of Agency	The Lindsay Museum
Document Type	Commercial/Business Outreach
Document Title	Are You Polluting Our Water?/oil (seal)
Author	The Lindsay Museum
Abstract	8½" x 11" point of sale flyer to be distributed in stores, open (folds to 4½" x 11") full color brochure in English explaining six easy steps to take that prevent storm drain pollution by automotive products including oil.
Contact	Jennifer Kaiser The Lindsay Museum 1931 First Avenue Walnut Creek, CA 94596 (510) 935-1978 ext. 26

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Landscaping, Gardening and Pest Control"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Roadwork and Paving"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

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Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Painting"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"General Construction & Site Supervision"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Home Repair & Remodeling"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Horse Owners and Equine Industry"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

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Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Heavy Equipment & Earthmoving Activities"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
	City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Fresh Concrete and Mortar Application"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Automotive Maintenance and Car Care"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Food Service Industry"
Author	City of Los Angeles/PS Enterprises
Abstract	8½" x 11" 2-fold desk top publishing piece using line-art. Designed for outreach to industry and outlines BMPs. English, Spanish, Chinese, Vietnamese and Korean.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

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Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	"Good Cleaning Practices for a Cleaner Ocean" Poster
Author	City of Los Angeles
Abstract	19" x 14" color BMPs poster developed for the Restaurant/Food Industry. English/Spanish.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Los Angeles (City)
Document Type	Commercial/Business Outreach
Document Title	Ocean Safe Coalition Package
Author	City of Los Angeles
Abstract	Grass roots organizing materials designed to solicit membership into the Ocean Safe Coalition (OSC). The OSC is a group of environmental groups, community groups, businesses, media outlets and public agencies with the goal of using in-kind services to spread the word about stormwater pollution. There are no dues or fees. OSC members give of their individual skills and receive the benefit of the expertise other members have.
Contact	Chuck Ellis City of Los Angeles, Stormwater Management Division 650 S. Spring St., Suite 700 Los Angeles, CA 90014 (213) 847-5206

Name of Agency	Palo Alto (City-Regional Water Quality Control Plant, for five communities)
Document Type	Commercial/Business Outreach
Document Title	"Laboratories: Best Management Practices for Water Quality Protection"
Author	City of Palo Alto
Abstract	12-page, (5½" x 8½") 3-color brochure with BMPs for research labs. Illustrated with line drawings from the associated poster. Available as a PageMaker or Microsoft word file (unillustrated).
Contact	Palo Alto Regional Water Quality Control Plant Suzanne Healy 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598 or Janet Cox 952 Cowper Street Palo Alto, CA 94301 (415) 321-3070

Name of Agency	Palo Alto (City-Regional Water Quality Control Plant, for five communities)
Document Type	Commercial/Business Outreach
Document Title	"Checklist of Laboratory Best Management Practices"
Author	City of Palo Alto
Abstract	8½" x 11", printed on one side, checklist of BMPs from brochure.
Contact	Palo Alto Regional Water Quality Control Plant Suzanne Healy 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598 or Janet Cox 952 Cowper Street Palo Alto, CA 94301 (415) 321-3070

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Name of Agency	Palo Alto (City-Regional Water Quality Control Plant, for five communities)
Document Type	Commercial/Business Outreach
Document Title	"Machine Shops: Best Management Practices for Water Quality Protection"
Abstract	20-page (5½" x 8½") brochure with BMPs for machine shops. Illustrated with engravings of antique machining tools. Available as a PageMaker or Microsoft word file (unillustrated).
Contact	Palo Alto Regional Water Quality Control Plant Suzanne Healy 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598 or Janet Cox 952 Cowper Street Palo Alto, CA 94301 (415) 321-3070

Name of Agency	Palo Alto (City-Regional Water Quality Control Plant, for five communities)
Document Type	Commercial/Business Outreach
Document Title	"Best Management Practices for Cooling Water Systems"
Author	City of Palo Alto
Abstract	12-page (5½" x 8½") brochure, with BMPs for cooling towers and other systems. Includes monitoring schedule and diagnostic chart.
Contact	Palo Alto Regional Water Quality Control Plant Stephanie Maldonado 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598

Name of Agency	City of Palo Alto Bay Protection Programs: the Palo Alto Storm Drain Program and the Regional Water Quality Control Plant, operated by the City of Palo Alto for five neighboring communities
Document Type	Commercial/Business Outreach
Document Title	"Be a Part of the Team! Keep the Bay CLEAN!: Water Quality Protection Guidelines for Food Handling Facilities"
Abstract	A 12-page brochure (2 colors inside, 3-color cover, 5½" x 8½") detailing BMPs for food handling facilities such as restaurants, grocery stores, delis, bakeries, etc. Includes "Checklist for Water Quality Protection".
Contact	Palo Alto Regional Water Quality Control Plant Leo Sarmiento 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598

Name of Agency	City of Palo Alto Recycling Program, Storm Drain Program, and Household Hazardous Waste Program
Document Type	Commercial/Business Outreach
Document Title	"Apartment and Condominium Complexes: Pollution Prevention and Waste Reduction Programs"
Abstract	12-page brochure, 3 colors, 5½" x 8½" with target audience: Apartment complex owners and managers. Describes the City's environmental programs available to apartment operators and tenants; stresses importance of storm drain protection.
Contact	Palo Alto Regional Water Quality Control Plant Janet Cox 952 Cowper Street Palo Alto, CA 94301 (415) 321-3070

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Name of Agency	Palo Alto (City - Regional Water Quality Control Plant, for five communities)
Document Type	Commercial/Business Outreach
Document Title	"Best Management Practices for Hospitals and Medical Facilities"
Abstract	Comprehensive BMPs for a wide range of hospital/medical facility functions.
Contact	Palo Alto Regional Water Quality Control Plant Ken Torke 2501 Embarcadero Way Palo Alto, CA 94303 (415) 329-2598

Name of Agency	Regional Water Quality Control Board (Santa Ana Region)
Document Type	Commercial/Business Outreach
Document Title	"Question & Answer Document for the GISP"
Author	Regional Water Quality Control Board Staff (Santa Ana Region)
Abstract	13-pages, 26 questions/answers for business/industry regarding compliance with the GISP.
Contact	Regional Water Quality Control Board (Santa Ana Region) Stormwater Program 2010 Iowa Avenue, Suite 100 Riverside, CA 92507 (909) 782-4130

Name of Agency	Richmond (City)
Document Type	Commercial/Business Outreach
Document Title	Industrial Stormwater Permit Compliance Guidelines
Author	CH2M Hill
Abstract	Provides an overview of stormwater regulations and information on necessary components for creating a Stormwater Pollution Prevention Plan for industry.
Contact	City of Richmond 2566 Barrett Ave. Richmond, CA 94804 (510) 231-3060

Name of Agency	Riverside (County-Flood Control)
Document Type	Commercial/Business Outreach
Document Title	"The Construction NPDES General Permit"
Author	Riverside County Flood Control
Abstract	3-panel brochure explaining how to apply for the permit.
Contact	Jason Christie, Senior Civil Engineer Riverside County Flood Control 1995 Market Street Riverside, CA 92501 (909) 275-1273

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Name of Agency	Riverside County Flood Control
Document Type	Commercial/Business Outreach
Document Title	"You May Need a Stormwater Permit"
Author	Riverside County Flood Control
Abstract	2-panel brochure/mailer informing businesses about General Permit for Industrial Activities. Contains information on EPA categories and how/where to obtain a General Permit and NOI.
Contact	Jason Christie, Senior Civil Engineer Riverside County Flood Control 1995 Market Street Riverside, CA 92501 (909) 275-1273

Name of Agency	San Dimas (City)
Document Type	Commercial/Business Outreach
Document Title	"A Friendly Reminder"
Author	City of San Dimas
Abstract	Modeled after the County's "reminder" notice. It is printed in English/Spanish. Our maintenance crews have received basic NPDES training and issue this notice whenever they observe a resident who is in violation. Major problems or repeated violators are referred to our code enforcement officer immediately.
Contact	Rosemarie Peterson City of San Dimas, Public Works Department 245 East Bonita Ave. San Dimas, CA 91773 (909) 394-6244

Name of Agency	San Dimas (City)
Document Type	Commercial/Business Outreach
Document Title	"BMPs for Automotive Maintenance and Car Care Businesses"
Author	City of San Dimas
Abstract	Notice was mailed with a cover letter to related businesses which were recently inspected for compliance with industrial waste regulations. The notice will be mailed to all related businesses with their annual business license renewal notification.
Contact	Rosemarie Peterson City of San Dimas, Public Works Department 245 East Bonita Ave. San Dimas, CA 91773 (909) 394-6244

Name of Agency	San Dimas (City)
Document Type	Commercial/Business Outreach
Document Title	"BMPs for Restaurants and Related Businesses"
Author	City of San Dimas
Abstract	Notice was mailed with a cover letter to related businesses which were recently inspected for compliance with industrial waste regulations. The notice will be mailed to all related businesses with their annual business license renewal notification.
Contact	Rosemarie Peterson City of San Dimas, Public Works Department 245 East Bonita Ave. San Dimas, CA 91773 (909) 394-6244

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Name of Agency	San Francisco Water Pollution Prevention Program
Document Type	Commercial/Business Outreach
Document Title	"The Green Wrench Guide"
Author	San Francisco Water Pollution Prevention Program
Abstract	Pollution prevention tips for auto repair and body shops describes the proper guidelines vehicle fluid removal, engine and parts cleaning, vehicle exterior washing, body repair and painting, good housekeeping, storage, spill control, recycling, treatment and education and training.
Contact	Paula Kehoe San Francisco Water Pollution Prevention Program Department of Public Works 3801 3rd Street, Suite 600 San Francisco, CA 94124 (415) 695-7317

Name of Agency	San Francisco Water Pollution Prevention Program
Document Type	Commercial/Business Outreach
Document Title	"Help Paint the Town Green"
Author	San Francisco Water Pollution Prevention Program
Abstract	Pollution Prevention Tips for Painting Contractors that discusses proper techniques for paint removal, brush cleaning and paint product disposal.
Contact	Paula Kehoe San Francisco Water Pollution Prevention Program Department of Public Works 3801 3rd Street, Suite 600 San Francisco, CA 94124 (415) 695-7317

Name of Agency	San Francisco Water Pollution Prevention Program
Document Type	Commercial/Business Outreach
Document Title	"The Bay is in the Balance"
Author	City of Palo Alto
Abstract	Poster with BMPs for laboratory practices and water quality protection.
Contact	Paula Kehoe San Francisco Water Pollution Prevention Program Department of Public Works 3801 3rd Street, Suite 600 San Francisco, CA 94124 (415) 695-7317

Name of Agency	San Francisco Water Pollution Prevention Program
Document Type	Commercial/Business Outreach
Document Title	"R_x for a Healthy Environment"
Author	San Francisco Water Pollution Prevention Program
Abstract	Explains pollution prevention opportunities for hospitals and medical office buildings.
Contact	Paula Kehoe San Francisco Water Pollution Prevention Program Department of Public Works 3801 3rd Street, Suite 600 San Francisco, CA 94124 (415) 695-7317

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Name of Agency	San Francisco Water Pollution Prevention Program
Document Type	Commercial/Business Outreach
Document Title	"Clean Image"
Author	San Francisco Water Pollution Prevention Program
Abstract	Explains pollution prevention opportunities for printing and photoprocessing operations.
Contact	Paula Kehoe San Francisco Water Pollution Prevention Program Department of Public Works 3801 3rd Street, Suite 600 San Francisco, CA 94124 (415) 695-7317

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Commercial/Business Outreach
Document Title	"Best Management Practices for Industrial Storm Water Pollution Control"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Illustrated guide for industry on keeping storm water from coming into contact with potential pollutants. Also contains guidance on complying with the County's General Permit for Industry. 20 pages.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Commercial/Business Outreach
Document Title	"Industrial Storm Water Pollution Control Compliance"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Three-ring binder for industry regarding federal, state and local regulatory requirements and information resources. Contains a sample storm water pollution prevention plan, EPA regulations, the industrial permit and the Industrial BMPs manual (see above). Available to local industry for $25.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Commercial/Business Outreach
Document Title	"Blueprint for a Clean Bay"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Illustrated guide for construction industries that contains guidance on complying with the state NPDES permit. Seven tri-fold pamphlets also available: "General Construction and Site Supervision", "Earth Moving Activities", "Roadwork and Paving", "Heavy Equipment Operation", "Fresh Concrete and Mortar Application", "Landscape, Gardening and Pool Maintenance", "Painting and Application of Solvents and Adhesives".
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

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Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Commercial/Business Outreach
Document Title	"Best Management Practices for Automotive-Related Industries"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Illustrated guide for auto industries on keeping storm water from coming into contact with potential pollutants. Contains some guidance on complying with local permit. 16 pages.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Commercial/Business Outreach
Document Title	"Mobile Cleaners BMPs" July 1994 draft
Author	Santa Clara Valley Nonpoint Source Pollution Control Program in conjunction with the Cleaning Equipment Trade Association, the San Jose/Santa Clara Water Follution Control Plant, the Palo Alto Regional Water Quality Control Plant, and the Sunnyvale Water Pollution Control Plant; and coordinated with the Alameda County Urban Runoff/Clean Water Program and Regional Water Quality Control Board staff.
Abstract	Eight-page report summarizing detailed BMPs for sidewalk/plaza cleaners, fleet cleaners, building washers, grocery cart cleaners, mobile auto detailers, restaurant cleaners.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Monica (City)
Document Type	Commercial/Business Outreach
Document Title	"Clean It Right!" Restaurant BMPs Poster
Author	Gary Welling, Pretreatment Coordinator
Abstract	17" x 11" full color laminated poster providing basic information on runoff pollution and a list of ten BMPs for restaurants/food industry. English/Spanish.
Contact	Billi Romain, Stormwater Coordinator City of Santa Monica Utilities Division 1212 5th Street, 3rd Floor Santa Monica, CA 90401 (310) 458-8286

Name of Agency	Santa Monica (City)
Document Type	Commercial/Business Outreach
Document Title	"Protect Santa Monica Bay!" Auto Service BMPs Poster
Author	Gary Welling, Pretreatment Coordinator
Abstract	17" x 11" full color laminated poster providing basic information on runoff pollution and a list of ten BMPs for the automotive industry. English/Spanish.
Contact	Billi Romain, Stormwater Coordinator City of Santa Monica Utilities Division 1212 5th Street, 3rd Floor Santa Monica, CA 90401 (310) 458-8286

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Name of Agency	City of Sunnyvale/Water Pollution Control Plant/Environmental Division/Public Education
Document Type	Commercial/Business Outreach
Document Title	Hazardous Materials, Hazardous Waste, Who Regulates What?
Author	Santa Clara County Pollution Prevention Program
Abstract	A six-panel tri-fold quick reference guide listing agencies that may regulate businesses in the Sunnyvale area.
Contact	Sunnyvale Water Pollution Control Plant - Public Education P.O. Box 3707 Sunnyvale, CA 94088-3707 (408) 730-7717

Name of Agency	City of Sunnyvale/Water Pollution Control Plant/Environmental Division/Public Education
Document Type	Commercial/Business Outreach
Document Title	General Best Management Practices Handbook
Author	City of Sunnyvale Industrial Pretreatment Program
Abstract	This BMPs handbook explains how one can reduce wastes and other substances.
Contact	Sunnyvale Water Pollution Control Plant - Public Education P.O. Box 3707 Sunnyvale, CA 94088-3707 (408) 730-7717

Name of Agency	City of Sunnyvale/Water Pollution Control Plant/Environmental Division/Public Education
Document Type	Commercial/Business Outreach
Document Title	Automotive Best Management Practices Handbook
Author	City of Sunnyvale Industrial Waste Pretreatment Program
Abstract	This handbook explains how one can operate their shop to reduce the amounts of antifreeze, heavy metals, oil wastes and other substances one generates as wastes.
Contact	Sunnyvale Water Pollution Control Plant - Public Education P.O. Box 3707 Sunnyvale, CA 94088-3707 (408) 730-7717

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1/9/97

R0035252

MANUALS/REPORTS/GUIDES

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Report
Document Title	"Developing a Volunteer Storm Drain Stenciling Program"
Author	Alameda Countywide Clean Water Program
Abstract	History and success of various stenciling programs with materials and techniques to use when developing a volunteer program.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Manual
Document Title	"Alameda Countywide Clean Water Program Reference Manual"
Author	Alameda Countywide Clean Water Program
Abstract	Manual used to help acquaint persons answering member agencies' information telephones with the Clean Water Program and prepare them to receive calls from the public. A great tool for workshops.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Alameda Countywide Clean Water Program
Document Type	Manual/Guide
Document Title	"Implementation Manual: San Leandro Creek Watershed Awareness Program 1993-1994"
Author	San Francisco Estuary Institute
Abstract	This manual explains how/why the San Leandro Creek Watershed Program was developed. The manual breaks down the processes involved in the development of a successful program.
Contact	Sharon Gosselin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94544 (510) 670-6547

Name of Agency	Environmental Health Coalition (Environmental Group)
Document Type	Manual
Document Title	"How to Create a Storm Water Pollution Prevention Campaign"
Author	Clean Bay Campaign Environmental Health Coalition
Abstract	A resource manual for a municipality, community group, neighborhood association, or other group interested in educating the public about stormwater pollution prevention. Also includes black line masters for watershed protection calendar, a watershed guide, and a final evaluation of the multifaceted Cholias Watershed Protection Project.
Contact	Clean Bay Campaign Environmental Health Coalition 1717 Kettner, Suite 100 San Diego, CA 92101 (619) 235-0281

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Name of Agency	Manhattan Beach (City)
Document Type	Guide
Document Title	"A Guide for the Automotive Industry"
Author	City of Manhattan Beach
Abstract	BMPs guide with hotline phone numbers. Contains information on how to become an Ocean Safe Enterprise member. Provides information/definitions about storm water run-off.
Contact	City of Manhattan Beach, Ocean Safe Campaign Coordinator 3621 Bell Avenue Manhattan Beach, CA 90266 (310) 545-5621, ext. 424

Name of Agency	Manhattan Beach (City)
Document Type	Guide
Document Title	"A Guide for the Restaurant Industry"
Author	City of Manhattan Beach
Abstract	5¾" x 8" insert for Ocean Safe brochure - "A Guide for the Restaurant Industry". An introduction to the Ocean Safe Program and what the restaurant industry can do to reduce and eliminate storm drain pollution.
Contact	City of Manhattan Beach, Ocean Safe Campaign Coordinator 3621 Bell Avenue Manhattan Beach, CA 90266 (310) 545-5621, ext. 424

Name of Agency	Manhattan Beach (City)
Document Type	Brochure
Document Title	"A Guide for the Construction Industry"
Author	City of Manhattan Beach
Abstract	5¾" x 8" insert for Ocean Safe brochure - "A Guide for the Construction Industry". An introduction to the Ocean Safe Program and what the construction industry can do to reduce and eliminate storm drain pollution.
Contact	City of Manhattan Beach, Ocean Safe Campaign Coordinator 3621 Bell Avenue Manhattan Beach, CA 90266 (310) 545-5621, ext. 424

Name of Agency	Manhattan Beach (City)
Document Type	Manual
Document Title	"Best Management Practices for Storm Water and Industrial Sanitary Sewer Pollution Control"
Author	City of Manhattan Beach
Abstract	BMPs for storm water and industrial sanitary sewer pollution control.
Contact	City of Manhattan Beach, Ocean Safe Campaign Coordinator 3621 Bell Avenue Manhattan Beach, CA 90266 (310) 545-5621, ext. 424

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Name of Agency	Orange (County- Development Services, NPDES Section)
Document Type	Report
Document Title	"Water Quality Management Plan for Gasoline Service Station with Convenience Market, Car Wash & Lube Bay Facilities"
Author	Marti Guerra Serizawa, Planner
Abstract	The model is to be used as a guide when preparing a WQMP. Preparing a WQMP is a condition of approval for development, or significant redevelopment in the County.
Contact	Marti Guerra Serizawa County of Orange, Development Services, NPDES Section 300 N. Flower St., Room 210 Santa Ana, CA 92702 (714) 834-3526

Name of Agency	Palo Alto (City - Regional Water Quality Control Plant)
Document Type	Report
Document Title	"Clean Bay Plan 1995"
Author	Palo Alto Regional Water Quality Control Plant
Abstract	Comprehensive report on all aspects of the RWQCP's source control and metals discharge reduction programs.
Contact	Palo Alto Regional Water Quality Control Plant Kelly Moran 952 Cowper Street Palo Alto, CA 94301 (415) 329-2598

Name of Agency	Richmond (City)
Document Type	Manual
Document Title	Commercial and Industrial Stormwater Inspection and Control Program
Author	CH2M Hill
Abstract	Training manual for industrial pretreatment provides Federal, State, and local stormwater regulations; Regulations of State and City permitted industries; additional resource information for assisting inspectors with Stormwater Pollution Prevention Plans and facility inspections; Sample materials, i.e., Permit Application, Inspection Checklist, etc.
Contact	City of Richmond 2566 MacDonald Ave. Richmond, CA 94804 (510) 231-3060

Name of Agency	Sacramento County Water Resources Division
Document Type	Manual
Author	Sacramento County Water Resources Division
Abstract	Procedures manual for daily activities of field screening for illicit connections to the storm drain system, including safety supplies, gathering data, and collecting samples.
Contact	Sean McMillin Sacramento County Water Resources 827 Seventh Street, Room 301 Sacramento, CA 95814 (916) 440-6851

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Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Manual, poster, tri-folds
Document Title	"Good Practices to Protect our Creeks and Bay - Guidelines for Restaurants, Grocery Stores, Delicatessens, Cafeterias, Bakeries"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	8½" x 11", 16-page, color manual, 1' x 4', color, double-sided, UV-coated poster (showing the manual's illustrations); tri-folded fact sheet in English, Spanish, Vietnamese and Chinese, folded in back pocket of manual for restaurant manager to copy for employee training. All available on disk.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Manual
Document Title	"Construction Storm Water Pollution Control Compliance" binder
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	This three-ring binder for construction industry includes information on federal, state, and local regulatory requirements and information sources. Contains a sample storm water pollution prevention plan, the construction BMPs manual, the construction permit, and materials from the program's workshops. Available to construction industry at $15 a copy.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Guide
Document Title	"Methods for Conducting Illicit Connection Programs" - August 1990
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	26-page guide for cities to implement an illicit connection identification program. Includes description of several I.D. techniques, including dye testing, smoke testing, TV drain line surveys, visual observation and review and validation of industrial piping schematics.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Manual
Document Title	"Draft Manual of Practice Identification of Illicit Connections" - September, 1990
Author	U.S. EPA Permits Division (EN 336)
Abstract	100-page guide for implementing an illicit connection identification and elimination program. Includes description of several identification techniques; chemical and physical properties of typical spills; typical industry-specific discharges; on-site industrial investigation; field survey techniques; and cost information of necessary equipment.
Contact	U.S. EPA Region IX 75 Hawthorne Street San Francisco, CA 94105-3901 (415) 744-2011

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Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Manual
Document Title	"Manual for the Investigation and Elimination of Illegal Dumping"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	40-page booklet (5½" x 8½"); Guide for permit holders to implement an illegal dumping investigation and elimination program. Provides step-by-step procedures for the investigation of illegal dumping incidents to storm sewers and watercourses. Provides guidance on sample collection, preservation and analysis; completion of chain-of-custody forms and proper steps to take to ensure that evidence produced is admissible in court. Provides guidance for safety of field personnel.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Report
Document Title	"Prohibited Discharge Matrix"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Matrix summarizes the typical stormwater discharges that are prohibited in the District. Includes alternative disposal options for residential and commercial.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	Santa Clara Valley Nonpoint Source Pollution Control Program
Document Type	Report
Document Title	"Walsh Avenue Pilot Inspection Program"
Author	Santa Clara Valley Nonpoint Source Pollution Control Program
Abstract	Report on pilot project that focused on a small-business industrial community. Inspections, monitoring, concentrated educational effort in the targeted area.
Contact	Christy Adams Santa Clara Valley Nonpoint Source Pollution Control Program 5750 Almaden Expressway San Jose, CA 95118 (408) 927-0710

Name of Agency	City of Sunnyvale/Water Pollution Control Plant/Environmental Division/Public Education
Document Title	"Clean and Green"
Author	Annie Berthold-Bond and illustrations by Andrea Eberbach
Abstract	A 5-page magazine article about hard-working, homemade cleansers that are good for you and the environment.
Contact	Sunnyvale Water Pollution Control Plant - Public Education P.O. Box 3707 Sunnyvale, CA 94088-3707 (408) 730-7717

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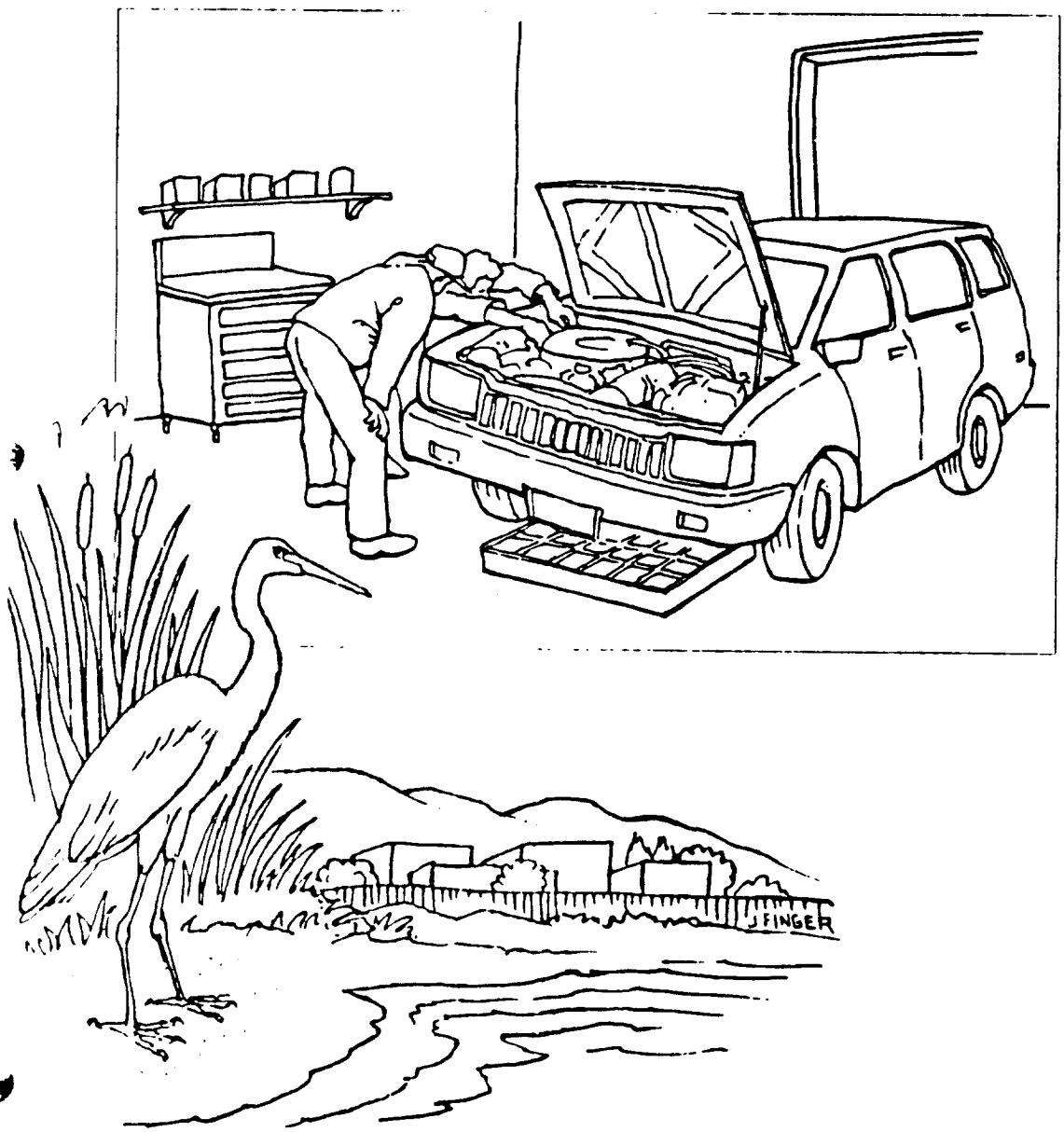
R0035257

Your Shop Can Make a Difference!

What vehicle service shops can do to protect water quality in the Bay and Delta



PRODUCED AND DISTRIBUTED BY BAY AREA WASTEWATER TREATMENT PLANTS AND STORMWATER MANAGEMENT AGENCIES

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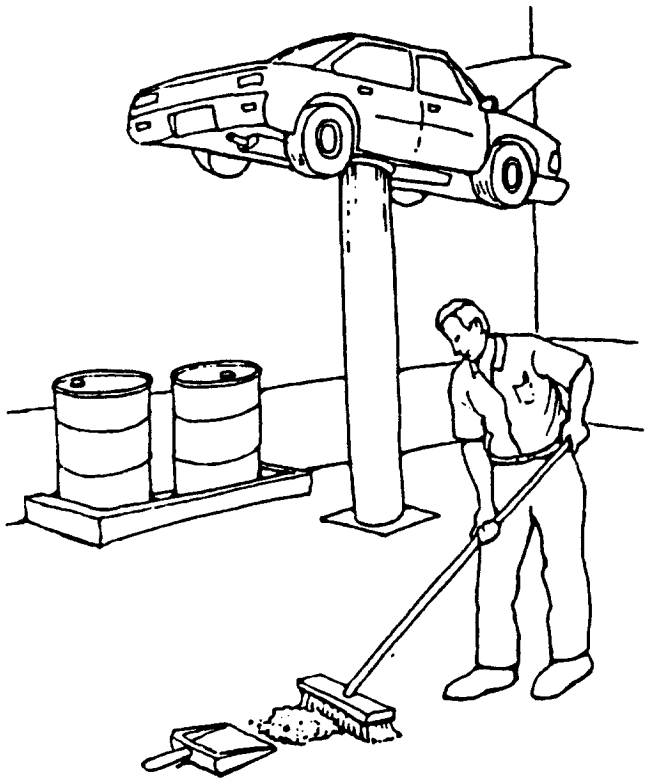
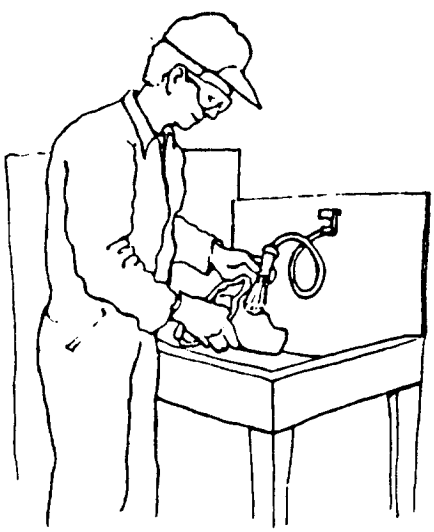
Vehicle service shops can help protect water quality in important ways when employees follow the guidelines for shop practices and maintenance in this booklet.

These practices focus on both storm drains and sewer systems. Outside your shop, storm drains carry runoff from streets, gutters, and parking lots directly to local creeks and the Bay and Delta with no wastewater treatment. Inside, most drains carry waste into a sanitary sewer and on to the local wastewater treatment plant, where motor oils, metals, and vehicle fluids can also cause problems—and still end up in the Bay or Delta.





When metals, oils, or other vehicle fluids reach a creek or the Bay, they threaten both water quality and wildlife in our waterways. Fortunately, there are many things you can do to make sure this doesn't happen.

We hope you will join with us and businesses throughout the Bay Area as we work together to safeguard the health of San Francisco Bay and the Delta.

Be sure to call your local wastewater treatment plant or stormwater management agency if you have any questions about the contents of this booklet, or if you need to obtain approval for a particular waste discharge.

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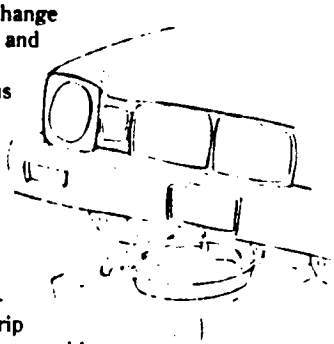
Service-Related Activities

Changing Oil and Other Fluids

Waste oil, antifreeze, and other vehicle fluids contain toxic chemicals and heavy metals from wear and tear of engine parts.

- Whenever possible, change vehicle fluids indoors and only on floors constructed of non-porous materials. Avoid working over asphalt and dirt floors—surfaces that absorb vehicle fluids.



- If vehicle fluids must be removed outdoors, always use a drip pan. Prevent spills from reaching the street or storm drain by working over an absorbent mat and covering nearby storm drains, or working in a bermed area. If necessary, you can use absorbent socks to create a bermed area.

- When draining fluids into a drain pan, place a larger drip pan (e.g., 3' x 4') under the primary drain pan to catch any spilled fluids.

- Transfer fluids drained from vehicles to a designated waste storage area as soon as possible. Drain pans and other open containers of fluids should not be left unattended unless they are covered and within secondary containment.

- Store waste containers of antifreeze and oil within secondary containment. Antifreeze and waste oil should be stored separately and recycled, or disposed of as hazardous waste.

- Never pour vehicle fluids or other hazardous wastes into sinks, toilets, floor drains, outside storm drains, or in the garbage. These substances should be kept in designated storage areas until recycled or safe disposal.

- Drain fluids from leaking or wrecked vehicles as soon as possible, to avoid leaks and spills.

Another Good Idea

- Consider using a quarter barrel, vacuum pump, or drain pan with built-in pump to transfer fluids.

Cleaning Engines and Parts, and Flushing Radiators

Solvents are hazardous to employees and can ignite in sewers.

- Eliminate discharges from these operations to the sanitary sewer and storm drains. Use a licensed service to haul and recycle or dispose of wastes.

- Designate specific areas or service bays for engine, parts, or radiator cleaning. Do not wash or rinse parts outdoors.

- Use self-contained sinks and tanks when working with solvents. Keep sinks and tanks covered when not in use.

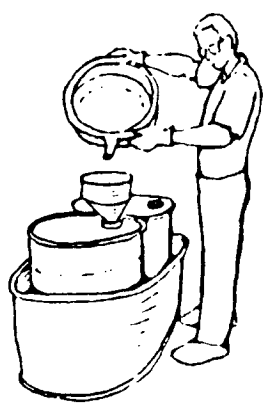
- Inspect degreasing solvent sinks regularly for leaks, and make necessary repairs immediately.

- Avoid soldering over drip tanks. Sweep up drippings and recycle or dispose as hazardous waste.

- Rinse and drain parts over the solvent sink or tank, so that solvents will not drip or spill onto the floor. Use drip boards or pans to catch excess solutions and divert them back to a sink or tank.

- Allow parts to dry over the hot tank. If rinsing is required, rinse over the tank as well.

- Collect and reuse parts cleaning solvents and water used in flushing and testing radiators. When reuse is no longer possible, these solutions may be hazardous wastes, and must be disposed of properly.



- Never discharge cleaning solutions used for engines or parts into the sewer system without adequate treatment. Most facilities have these solutions hauled off-site as hazardous waste because of the permits necessary for on-site treatment.

- Rinsewater may only be discharged to the sanitary sewer with adequate treatment and approval of the sewage treatment plant.

- Never discharge wastewater from steam cleaning, or engine/parts cleaning to a street, gutter, or storm drain.

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er Good Ideas

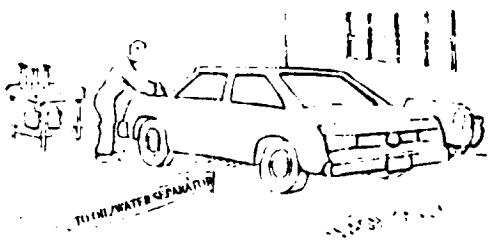
- Sweep or use a vacuum to clean up dust and debris from scraping or bead blasting radiators.
- Use static tanks for rinsing to reduce the volume of discharged rinsewater.
- Use counter-current rinsing to reduce water usage and rinsewater discharges.

Washing Cars and Other Vehicles

Even biodegradable soaps can be toxic when they reach a creek or waterbody.

Regular Activity

- If car washing is a central activity of your business, the most desirable option is to treat and recycle the wash water.



- Designate a vehicle washing area and wash cars and trucks only in that area. This "wash pad" should be bermed or protected from storm drains and should drain to an oil/water separator before discharging to the sewer.
- Cover an outside wash pad or minimize the area of an uncovered pad to reduce the amount of rainwater reaching the sewer. Consult your local sewage treatment plant for guidance.
- Minimize the use of acid-based wheel cleaners. These products may require additional treatment (beyond oil/water separation) before discharge to the sewer.

Occasional Activity

- Even biodegradable soap is toxic to fish and wildlife! Whenever possible, take vehicles to a commercial car wash.
- If soap is used in washing, the wash water must be collected and discharged, preferably with treatment, to the sanitary sewer. This water cannot be discharged to a storm drain.
- Never rinse off spray-on acid-based wheel cleaners where rinse water may flow to a street, gutter, or storm drain.

Washing New Vehicles

- If cleaning the exterior of new vehicles with water only, the discharged water may go to the storm drain directly.
- Always protect the stormdrains from solvents, used to remove protective coatings from new cars. Discharges of these solvents to the sanitary sewer must receive adequate treatment and approval of the sewage treatment plant.

Body Repair and Painting

Solvents, thinners, paints, and sanding wastes all cause problems for both the sanitary sewer and the storm drains.

- Whenever possible, conduct all body repair and painting work indoors or under cover.
- When receiving damaged vehicles, inspect for leaks. Use drip pans if necessary.
- When cleaning auto body parts before painting, minimize use of hose-off degreasers. Brush off loose debris and use rags to wipe down parts.
- Use dry cleanup methods, such as vacuuming or sweeping, to clean up dust from sanding metal or body filler. Debris from wet sanding can be allowed to dry overnight on the shop floor, then swept and vacuumed. Liquid from wet sanding should not be discharged to the storm drain.
- Minimize waste paint and thinner by carefully calculating paint needs based on surface area and using the proper sprayer cup size.
- Do not use water to control overspray or dust in the paint booth unless you collect this wastewater. This water should be treated before discharge into the sewer system.
- Clean spray guns in a self-contained cleaner. Recycle the cleaning solution when it becomes too dirty to use. Never discharge cleaning waste to the sewer or storm drain.

Other Good Ideas

- Use sanding tools equipped with a vacuum to pick up debris and dust.
- Reduce waste by using low-volume paint mixing equipment and high-efficiency painting tools.

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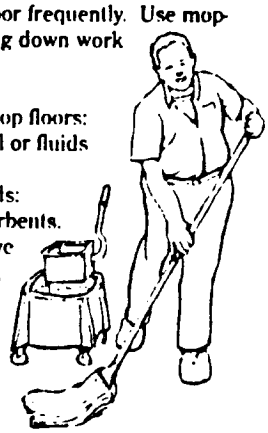
Facility Maintenance and Management

Keeping a Clean Shop

Good housekeeping practices minimize liability, reduce costs, and make it easier to detect spills and potential problems.

- Use drip pans under leaking vehicles to capture fluids.
- Sweep or vacuum the shop floor frequently. Use mopping as an alternative to hosing down work areas.
- If mopping is used to clean shop floors:
  1. Spot clean any spilled oil or fluids using absorbents or rags.
  2. Use dry cleanup methods: Sweep the floor using absorbents.
  3. After steps 1 and 2 above (if mopping is still needed), mop and discharge mop water to the sanitary sewer.



- Do not pour mop water into the parking lot, street, gutter, or storm drain.
- Remove unnecessary hoses to discourage washing down floors and outside paved areas.
- Regularly sweep parking lots and areas around your facility instead of washing them down with water.
- Clean fuel dispensing areas with absorbent instead of water.
- Collect all metal filings, dust, and paint chips from grinding, shaving, and sanding, and dispose of the waste properly. Never discharge these wastes to the storm drain or sanitary sewer.
- Collect all dust from brake pads separately and dispose of the waste properly. Never discharge these wastes to the storm drain or sanitary sewer.
- Send rags to an industrial laundry.

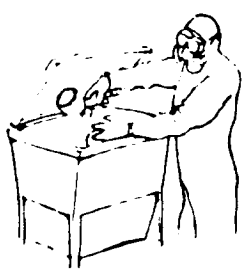
Another Good Idea

- Consider using an oleophilic mop (picks up oil and not water) to reduce the volume of waste liquids you collect and reduce your cost for disposal.

Storage

Appropriate storage protects your shop from hazardous spills. Consult you local hazardous waste agency for details.

- Store hazardous materials and wastes where they are protected from rain and in a way that prevents spills from reaching the sanitary sewer or storm drain.
- Keep lids on waste barrels and containers, and store them indoors or under cover to reduce exposure to rain.
- All hazardous wastes must be labeled according to hazardous waste regulations. Consult the Fire Department or your local hazardous waste agency for details.
- Keep wastes separate to increase your waste recycling/disposal options and to reduce your costs.
- Never mix waste oil with fuel, antifreeze, or chlorinated solvents. Consult your hazardous waste hauler for details.
- Double-contain all bulk fluids to prevent accidental discharges to the sewer and storm drain. Call the Fire Department for details.
- Keep storage areas clean and dry. Conduct regular inspections so that leaks and spills are detected as soon as possible.
- Carefully transfer fluids from drip pans or collection devices to designated waste storage areas, as soon as possible.
- When receiving vehicles to be parted or scavenged, park them on a paved surface and immediately drain and collect gasoline and other fluids properly.
- Drain all fluids from components, such as engine blocks, which you may store for reuse or reclamation. Keep these components under cover and on a drip pan or sealed floor.
- Store batteries securely to avoid breakage and acid spills during earthquakes. Shelving should be secured to the wall. Store used batteries indoors and in plastic trays to contain potential leaks. Recycle old batteries.



Spill Control

Spills cause safety hazards for employees and can spread if not cleaned up immediately.

- The best spill control is prevention!
- Minimize the distance between waste collection points and storage areas.

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Contain and cover all solid and liquid wastes—especially during transfer.

- Purchase and maintain the proper absorbent materials for containment and cleanup of different spills, and make sure they are easily accessible anywhere in the shop. Saturated absorbents generally must be disposed of as hazardous waste.

- Clean up spills immediately and completely. Spills are not considered cleaned up until the absorbent is picked up.

- Cover nearby downstream storm drains when transferring fuel from tank truck to fuel tank.

- Seal or remove floor drains to prevent accidental discharge to the sewer system.

- The air/water supply area at gas stations is vulnerable to fluid spills and radiator boil-over. Inspect this area daily and clean up spills immediately.

Recycling/Treatment

Recycling and properly treating wastes protects the environment and saves you money.

- Recycle solvents, paints, oil filters, antifreeze, motor oil, batteries, and lubricants.

- Set up a system (separate, well-labeled containers in a convenient location) to make it easy for employees to separate wastes and to recycle.

- Choose treatment systems that are adequately sized and easy to maintain and repair.

- Properly maintain and service all pretreatment equipment, including sumps, separators, and grease traps to ensure proper functioning. Follow manufacturer's maintenance instructions and consider using a licensed service to conduct maintenance on a regular basis.

- Frequently inspect equipment for malfunctioning parts, leaks, and the accumulation of pollutants such as oil and grease. Since pretreatment equipment is supposed to remove pollutants, a lack of accumulation may be a sign of a malfunction.

- Retain only a licensed service to haul away and dispose of wastes.

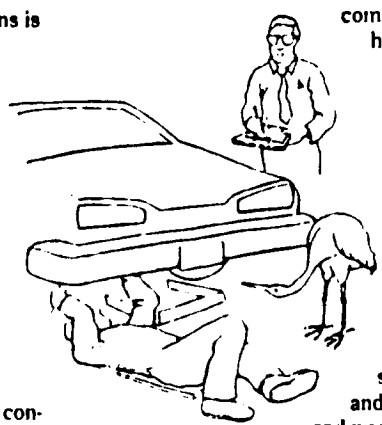
Another Good Idea

- Install self-contained, zero-discharge treatment systems that recycle wastewater.

Purchasing

Purchasing decisions have a direct and long-term impact on the products used and disposed of by your shop. Make pollution prevention easier and reduce costs and liability by controlling the types and amounts of products purchased.

- Ask your supplier for information on less toxic chemical cleaners and other products. There are alternatives to chlorinated solvents; chlorofluorocarbons; and 1,1,1, trichloroethane (TCA).



- Ask your supplier for information on the composition of brake pads. Recent studies have shown that brake dust washed off streets by rain may be the single biggest contributor of copper, a major pollutant, to the Bay. Your awareness and understanding of this problem and the available alternatives will help us come up with solutions in the future.

- Minimize inventory by purchasing only as much product as you will need in the foreseeable future. This will reduce your storage space needs, inventory tracking costs, and liability for storing hazardous materials and waste.

Education and Training

Your success in following these guidelines depends on an effective training program.

- Train all employees upon hiring—and annually thereafter—on personal safety, chemical management, and proper methods for handling and disposing of hazardous waste. Make sure that all employees understand appropriate disposal routes for different types of wastewater.

- Post instructional/informational signs around your shop for customers and employees. Put signs above all sinks prohibiting discharges of vehicle fluids and wastes. Put signs on faucets (hose bibbs) reminding employees and customers to conserve water and not to use water to clean up spills.

- Label drains both inside and outside your shop to indicate whether they flow to an oil/water separator, directly to the sewer, or to a storm drain.

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If you have any questions, or if you think you need to obtain approval for a particular waste discharge, please call your local wastewater treatment plant or stormwater management agency listed below:

ALAMEDA COUNTY
Stormwater
Alameda Countywide
Clean Water Program
(510) 670-5543

Wastewater Treatment
City of Hayward
(510) 881-7969
City of Livermore
(510) 373-5230
City of San Leandro
(510) 577-3434
Dublin San Ramon Services District
(510) 846-4565
East Bay Municipal Utility District
(510) 287-1651
Oro Loma Sanitary District
(510) 276-4700
Union Sanitary District
(510) 790-0100

CONTRA COSTA COUNTY
Stormwater
Contra Costa Clean Water Program
(510) 313-2364

Wastewater Treatment
Central Contra Costa Sanitary District
(510) 229-7288
City of Hercules
(510) 799-8242
City of Pinole
(510) 724-8963
City of Richmond
(510) 412-2014
Rodeo Sanitation District
(510) 799-2970
Delta Diablo Sanitation District
(510) 778-4040
Dublin San Ramon Services District
(510) 846-4565
Mt. View Sanitary District
(510) 228-5635
West County Wastewater District
(510) 237-6603

MARIN COUNTY
Stormwater
Marin County Stormwater Pollution
Prevention Program
(415) 485-3363

Wastewater Treatment
Central Marin Sanitation Agency
(415) 459-1455
Las Gallinas Valley Sanitary District
(415) 472-1734
Marin County Sanitary District #5
(415) 435-1501
Novato Sanitary District
(415) 892-1694
Sausalito-Marin City
Sanitary District
(415) 332-0244
Sewerage Agency of
Southern Marin
(415) 388-2402

NAPA COUNTY
Wastewater Treatment
City of Calistoga
(707) 942-2828
City of St. Helena
(707) 963-2741
Napa Sanitation District
(707) 258-6024
Town of Yountville
(707) 944-2988

SAN FRANCISCO COUNTY
Stormwater
Department of Public Works, BERM
(415) 695-7310

Wastewater Treatment
Department of Public Works, BERM
(415) 695-73105

SAN MATEO COUNTY
Stormwater
San Mateo Countywide Stormwater
Pollution Prevention Program
(415) 363-4708

Wastewater Treatment
City of Burlingame
(415) 342-3727
City of Millbrae
(415) 259-2388
City of Pacifica
(415) 738-7348
City of San Mateo
(415) 377-4694
City of South San Francisco
(415) 877-5979
North San Mateo County
Sanitation District
(415) 991-8200
Sewer Authority Mid-Coastside
(415) 726-0124
South county covered by
South Bayside System Authority
(415) 594-8411, ext. 141

SANTA CLARA COUNTY
Stormwater
Santa Clara Valley Nonpoint Source
Pollution Control Program
(800) 794-2482

Wastewater Treatment
City of Sunnyvale Water
Pollution Control Plant
(408) 730-7260
Palo Alto Regional Water Quality
Control Plant
(415) 329-2598
San Jose/Santa Clara Water
Pollution Control Plant
(408) 945-5307

SOLANO COUNTY
Stormwater
Fairfield-Suisun Urban Runoff
Management Program
(707) 429-8930
Vallejo Sanitation and
Flood Control District
(707) 644-8949, ext. 281

Wastewater Treatment
City of Benicia
(707) 746-1098
Fairfield-Suisun Sewer District
(707) 429-8930
Vallejo Sanitation and
Flood Control District
(707) 644-8949, ext. 281

SONOMA COUNTY
Wastewater Treatment
City of Petaluma
(707) 762-5892
Sonoma Valley County
Sanitation District
(707) 938-4052

Printed on Recycled Paper

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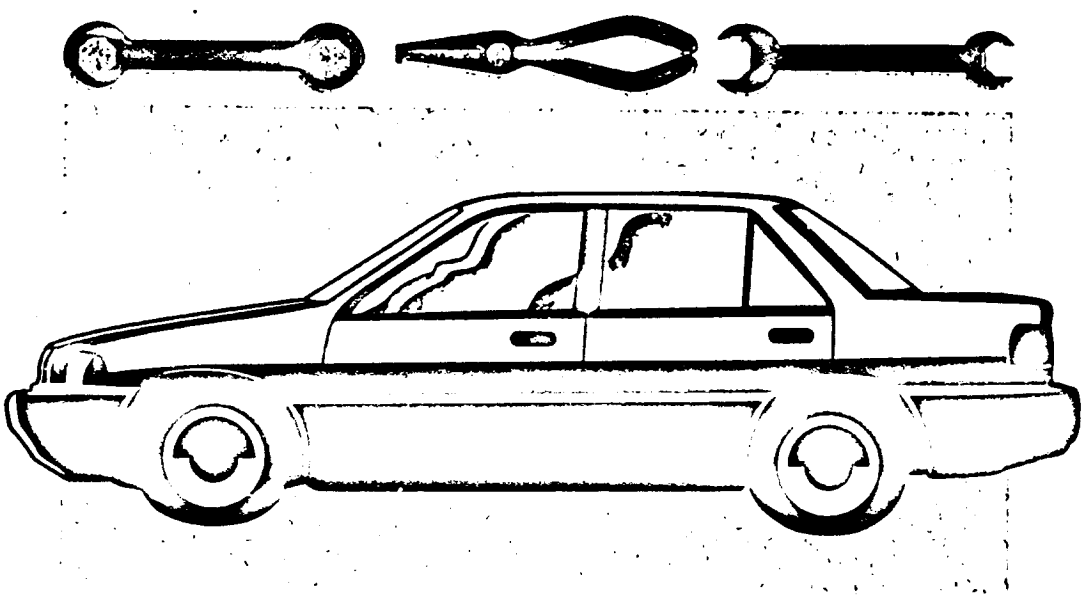
1929
R0035264

Auto Repair Shops

Pollution Prevention Facts



City of Los Angeles

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Auto Repair Shops Pollution Prevention Facts

Do it right. Practice pollution prevention in your business and save money $$$, ensure employee health and safety, and protect the environment and your community. Remember, with pollution prevention you can reduce work hazards and liability, while saving money and maintaining compliance with local air, water, and hazardous waste regulations.

Keep Your Shop in Tune

When your shop is in tune and running smoothly, you generate less wastes. This brochure is intended to help keep metals, oils, grease and other pollutants from entering the sewer and storm drain and harming the environment. It also serves as guidance on pollution prevention and waste management practices for the automotive repair industry. The following recommended practices aim to help you comply with sewer discharge regulations. Local requirements may vary, so it is your responsibility to be aware of and comply with all applicable waste regulations.

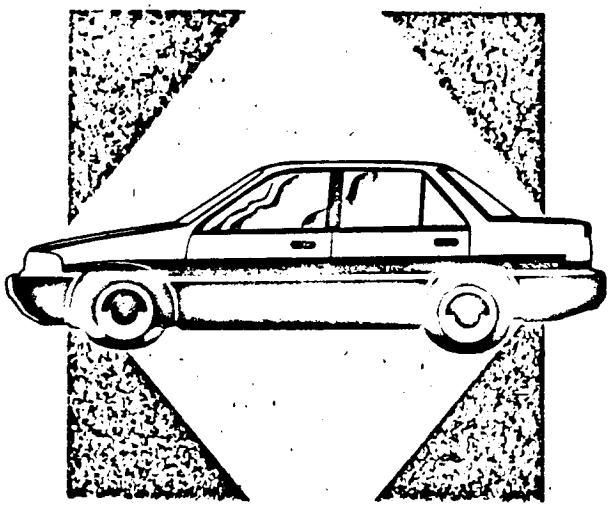
Benefits of Pollution Prevention

Substantial costs are associated with raw materials purchase, energy use, waste disposal, and compliance with federal, state, and local regulations. Handling and disposing of hazardous materials and wastes can also affect employee health and safety and environmental liability. By preventing pollution at the source, it will be easier for you to comply with regulations while reducing your costs. Pollution prevention can:

- Improve operations and efficiency,
- Reduce hazardous materials use,
- Reduce raw material use and costs,
- Minimize waste disposal and permitting costs,
- Help comply with regulations,
- Reduce liability and associated costs, and
- Maintain and enhance a positive image within your community.

What is Pollution Prevention ?

Pollution prevention is source reduction or the prevention of waste at the source, before it is generated. There are simple things you can do in your shop to practices pollution prevention, such as:



- substitute detergent-based solutions for caustic solutions when cleaning;
- substitute water-based cleaners for solvent cleaners;
- remove parts slowly after immersion in solvent solution to prevent spillage;
- pre-rinse parts before using the hot tank or jet washer.

Recycling or reuse activities turn a waste into a usable material. Simple pollution prevention practices you can perform at your shop include to:

- contact an oil recycler to collect used oil for recycling;
- arrange for spent battery collection and recycling;
- arrange for spent antifreeze collection and recycling;
- recycle spent solvents.

Recommended Practices to Reduce Wastes and Save $$

General Cleaning Minimize the use of water to clean floors. Avoid cleaning with a wet mop or by hosing down the entire floor. Use a damp mop and/or wet-vac for routine cleaning. Contract with an industrial laundry to collect dirty rags and provide clean ones. Laundries will not accept saturated or heavily contaminated rags. Avoid using paper towels.

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Segregate Wastes If you mix a hazardous waste with non-hazardous materials, the total mixture becomes hazardous, increasing the amount of hazardous waste that requires special handling. Segregate different wastes to expand your recycling options.

Control, Cover, Contain and Label Materials Use materials on a first-in, first-out basis to avoid discarding 'expired' chemicals. Designate one person to manage raw materials to ensure proper inventory control. Segregate and store materials in an area protected from heavy traffic, dust, dirt, heat, and rainwater. Install adequate berms and containment to properly manage any accidental spills. Properly label all containers as to their content, chemical purchase date and when storage of wastes began.

Used Oil Filters Used oil filters need not be handled as hazardous waste if they meet special handling requirements (call the agencies listed for more information). Oil filters should be drained into a waste oil bin, crushed to recover additional oil, stored in leak proof containers, and delivered to a recycling facility. Recycle oil and antifreeze. Some waste oil and fluid recyclers will also pick up oil filters. Purchase recycled oil and lubricants.

Acid or Caustic Solutions Ensure that the shop's wastewater does not exceed the City of Los Angeles' local discharge limits, particularly the pH limit of 5.5-11. Solutions with very high or very low pH usually contain metals and must be disposed of as hazardous waste.

Spills Seal floor drains to reduce the possibility of spills & leaks from entering the sewer. You must prevent spills from going into the floor drains or outside to the gutter/storm sewer. Use absorbents to clean small spills or leaks. For larger spills, use absorbent "snakes" as temporary berms to contain liquid while it is cleaned up. The absorbents must then be stored and manifested as a hazardous waste. Install spill containment or dikes around tanks to contain the volume of the largest tank.

Fluid Replacement Use drip pans under vehicle to minimize need to wash floor. Combine used transmission and brake fluids for cost effective recycling. Recover freon/refrigerants from air conditioners using an air tight machine. Reusing freon on-site is less costly than sending it to an off-site recycler.

Parts Replacement Recycle used batteries and tires with a contract recycler. Reclaim and refurbish parts such as alternators, water pumps, and carburetors. Send parts to a rebuilder or auto dismantler who can reuse or recycle them.

Radiator/Parts Repair For flushing radiators, recycle rinse water, use a high pressure hose with low flow rate, use a rinse tank or series of two still-rinse tanks instead of flushing.

Replace hot caustic tanks with mechanical agitation to eliminate hazardous waste sludge, or at a minimum replace caustic with non-hazardous detergents and remove solids from the bottom of the tank to extend bath life. Also collect solids from the test tanks and dispose of them as a hazardous waste. Use water from flushing as makeup for the hot rinse or test tanks. Do not solder over test tanks. Never discharge tank solutions to the sewer or storm drain, the spent solution will harm the environment and not meet City standards.

Cleaning Parts Substitute less toxic detergent-based cleaners for caustic solutions and water-based cleaners for solvents. Clean parts at a centralized station such that solvents and residues stay in one area. Install drip pans, drain boards, and drying racks in a way that directs drips back into the fluid holding tank for reuse. Implement two-stage parts cleaning - use dirty solvent first then virgin solvent for final cleaning. Segregate different cleaning operations. Zero discharge can be accomplished by installing:

- Self-contained, recirculating petroleum solvent sinks that recycle liquid back into a storage drum and use less harmful solvents. Use a service to pickup spent solvent and deliver fresh solution.

- Parts washers with filters to remove contaminants can extend solution life. Many of these washers use hot water and detergents instead of hazardous fluids. Keep lids closed on parts washers or solvent sinks when not in use to reduce air emissions. Operating costs average $50/month (in 1995).

Metal Grinding and Polishing Capture metal filings produced by grinding or machining. Enclose the unit as much as possible and keep a bin under your lathe or grinder to catch the filings. Filings from asbestos brake shoes and asbestos dust should be captured in a separate, enclosed container and must be handled as a hazardous waste. Avoid contaminating other metal filings with asbestos, which can not be sent to ordinary scrap dealers. Dust from brake pads contains a significant amount of copper which enters the storm drains. Whenever possible, ask your supplier or manufacturer for non-metallic or low copper content alternatives.

Body Repair Consider using alternative water-based or high-solids paints. Use high volume/low pressure or electrostatic spray equipment to maximize transfer efficiency. Use mechanical stripping techniques to remove paint from body parts. Savings in chemical stripper purchase and disposal costs should offset the increase in labor time required for mechanical stripping. Recycle leftover paint by giving it to customers or donating it to community organizations or schools.

Close the Loop and Be a Zero Discharger If your dry cleanup and recycling efforts are successful, you can seal your

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floor drains and become a zero discharger. Even a decrease in water discharged to the sewer may reduce your sewer surcharge fees. Being a zero discharger will ultimately save money and resources.

However, if you must discharge to the sewer, make sure that you comply with the City's discharge standards. Never put vehicle fluids, cleaning solutions, paints, acids or other wastes down the sewer or storm drain. If your wastewater does not meet City limits, you may need to change your processes or treat the wastewater before discharging.

Train Employees Making Pollution Prevention changes requires understanding and commitment from managers and employees. The techniques described should be implemented with a plan to train and involve staff. Utilize incentives to encourage employees to identify other P2 techniques. All employees should accept and practice waste reduction.

Marketing Promote your use of environmentally friendly products and your reuse and recycling activities to your customers. Many of your customers will appreciate and be interested in your pollution prevention efforts. Educate your customers on the importance of proper vehicle maintenance to reduce leakage of oil and other fluids which are washed to the ocean by rainwater.

Stay Informed Sources of information are local regulatory agencies, trade associations, waste haulers, chemical or equipment vendors, chambers of commerce, business assistance centers, energy and water suppliers, and informational workshops.

Steps to Pollution Prevention

1. Commit!!!
2. Assess operations, material used, and wastes generated.
3. Determine how material usage and waste generation can be eliminated or reduced.
4. Implement pollution prevention techniques.
5. Monitor and evaluate effectiveness of each pollution prevention technique.

Where to Find Help

Pollution Prevention Section, Industrial Waste Management Division (IWMD), Bureau of Sanitation, City of Los Angeles. The IWMD requires all businesses in the City of Los Angeles who discharge non-domestic wastewater to the sewer, to obtain an Industrial Wastewater Permit. City staff inspect and take wastewater samples at your facility to verify compliance with City standards. IWMD can provide free technical assistance on pollution prevention opportunities which can help you comply and save money. Call (213) 237-0806.

CAL EPA, Department of Toxic Substances Control (DTSC). The DTSC can provide information on storage, accumulation, transportation and treatment of hazardous wastes. DTSC also has material regarding pollution prevention, potential sources of funding, and permitting requirements. Call (818) 551-2830, (310) 590-4958 or (916) 322-3670.

Hazardous and Toxic Materials Office (HTM), Environmental Affairs Department, City of Los Angeles. HTM provides Los Angeles businesses with on-site technical environmental assistance, pollution prevention training and workshops, access to a vendor database and a technical library. Call (213) 580-1079.

Produced by the City of Los Angeles, Department of Public Works, Bureau of Sanitation, Industrial Waste Management Division • June 1995

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For More Information...

Questions regarding this notice may be directed to:

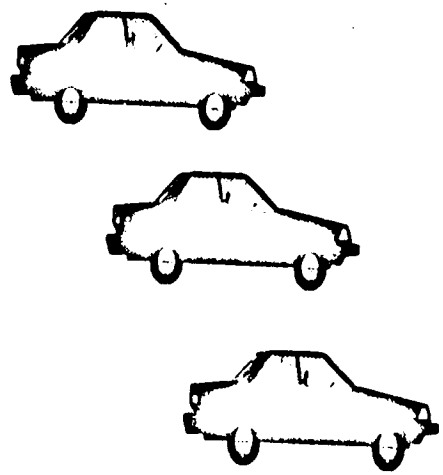
The Orange County Environmental Management Agency's Stormwater Section at (714) 567-6371

or Pavlova Vitale of the Santa Ana Regional Water Quality Control Board at (909) 782-4130

ORANGE COUNTY • STORMWATER • PROGRAM

Orange County Stormwater Program
10852 Douglass Road
Anaheim, California 92806

Mobile Detailing and the Water Quality Act



This flyer has been prepared at the request of the mobile detailing industry to provide direction with regard to compliance with the federal Water Quality Act of 1987.

R0035269

THE WATER QUALITY ACT: Controlling Storm Drain Pollution

Under the federal Water Quality Act of 1987, the County and cities of Orange County are obligated to control the discharge of pollutants into storm drain systems. Specifically, National Pollutant Discharge Elimination System (NPDES) Permits issued by the state in 1990 pursuant to the Act prohibit the public agencies of Orange County from accepting, with few exceptions, non-stormwater discharges into these systems.

According to EPA, exceptions to local regulation include water line flushing, landscape irrigation water, water from potable water sources, foundation drains, air conditioning condensation, irrigation water, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, dechlorinated swimming pool discharges, street wash runoff and fire fighting runoff.

The County's NPDES Permits prohibit, with few exceptions, non-stormwater discharges into the storm drain system

---

Mobile Detailing Procedures

Since commercial vehicle washing, including mobile detailing, is not exempted, the following procedures should be adopted by individuals performing this service:

1. When cleaning engines and/or vehicles using chemical additives such as soaps, solvents or degreasers:

   a. Service must be performed at a facility that has the equipment to properly process the contaminated wastewater runoff, or

   b. Service must be performed using a leak-proof ground cover device that will catch and contain all contaminated wastewater runoff for later disposal in a manner that complies with all city, county, state and federal codes.

2. When engine cleaning is not involved, the service may be performed using only deionized water, purified water, and/or tap water with no additives for wash and rinse purposes. This water may then be discharged to the storm drain systems provided there is no visible evidence of chemical contamination such as foams, odors, discoloration, etc.

   When chemical products must be used to perform this type of service, they must be used on a spot basis and wiped off prior to rinsing.

3. Equipment, such as ground cover devices, shall be regularly inspected and maintained to ensure proper and effective functioning.

Before you allow anything to go into the gutter or storm drain, stop and think!

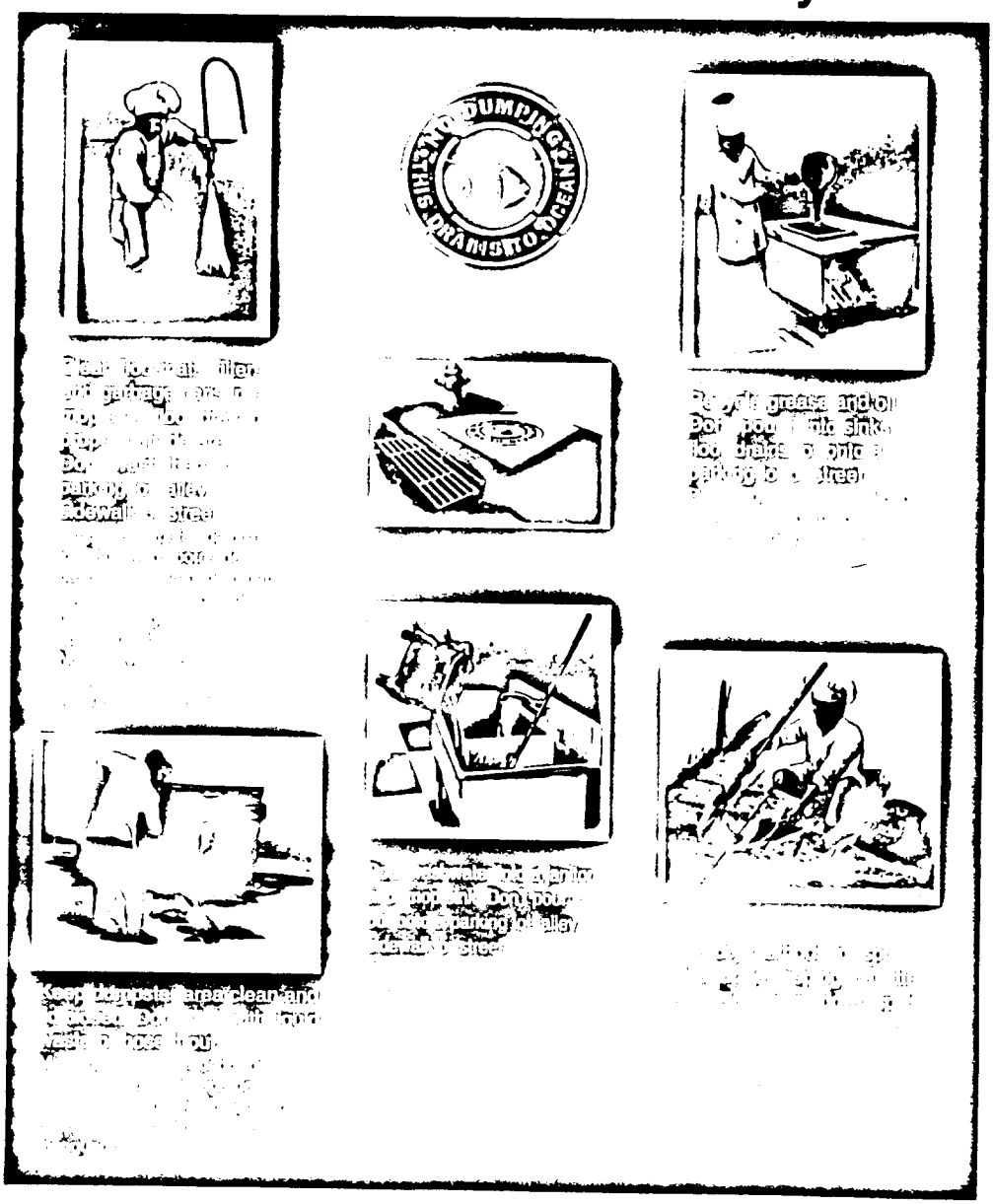
Storm drains go directly to channels and creeks, through wetlands and to the ocean.

R0035270

POST IN CLEANUP/WORK AREA

Good Cleaning Practices

Food & Restaurant Industry



For A Cleaner Ocean

To report illegal dumping
(Para reportar descargo ilegalmente)

1-800-303-0003

MAKE THE CONNECTION

R0035271

VOL 12 1936

THE CITY OF MANHATTAN BEACH
OCEAN SAFE CAMPAIGN
ENTERPRISE PLEDGE

THE MAYOR AND CITY COUNCIL OF MANHATTAN BEACH ARE PROUD TO ANNOUNCE THAT *Orville & Wilbur's Restaurant* HAS PLEDGED TO PARTICIPATE IN THE CITY'S OCEAN SAFE CAMPAIGN AS AN OCEAN SAFE ENTERPRISE. THE PURPOSE OF THIS CAMPAIGN IS TO USE COMMUNITY EDUCATION TO REDUCE THE AMOUNT OF CONTAMINANTS THAT ENTER THE OCEAN AND BEACHES VIA THE STORM DRAIN SYSTEM. THIS ESTABLISHMENT IS COMMITTED TO OBSERVING ALL OF THE OCEAN SAFE RESTAURANT OPERATION AND MAINTENANCE PRACTICES AS LISTED BELOW:

- PROPER DISPOSAL OF FOOD PARTICLES AND DRAINAGE OF DISH WATER DOWN UTILITY SINKS OR FLOOR DRAINS,
- PROPER DISPOSAL OF GREASE, FOOD AND OTHER WASTE IN APPROPRIATE TRASH RECEPTACLES,
- PROPER CLEANING OF FLOOR MATS, OFF SITE IF NECESSARY,
- DISPOSAL OF ENTRY-WAY AND SIDEWALK SWEEPINGS IN TRASH RECEPTACLES,
- MAXIMUM RECYCLING OF GLASS, CARDBOARD, PLASTIC AND METALS.

FULFILLMENT OF THIS PLEDGE ENTITLES *Orville & Wilbur's Restaurant* TO DISPLAY THE OCEAN SAFE ENTERPRISE SYMBOL IN THIS RESTAURANT AND ON ANY OTHER PUBLISHED OR PRINTED MATERIALS PROMOTING THIS BUSINESS.

THE OWNERS, OPERATORS AND MANAGERS OF THIS ESTABLISHMENT ARE PROUD TO DO THEIR PART IN MAKING MANHATTAN BEACH AN OCEAN SAFE COMMUNITY.

SIGNATURE DATE

SIGNATURE DATE

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R0035272

OCEAN SAFE PRACTICES FOR RESTAURANTS

The purpose of this form is to provide the restaurant owners and operators with information about how to eliminate discharge of waste water into the storm drain system. Please take a few minutes to fill out this checklist so that the needs of your facility can be properly assessed.

1. Employee training at your establishment includes education about the proper cleaning of floor mats, the correct disposal of food particles and waste water, and the disposal of entry-way and sidewalk sweepings into trash receptacles.
   N/A (initial)

2. Kitchen and bar floor mats are cleaned within the premises and not outside the building in streets, alleyways or sidewalks.
   N/A (initial)

3. A mop sink is available inside the facility that may be used to clean floor mats, mops and receive waste water.
   N/A (initial)

4. If there are no mop sinks or floor drains in the facility, mats are cleaned by a janitorial service off the restaurant site.
   N/A (initial)

5. Glass, cardboard, paper, plastic and metal are collected at the restaurant for recycling.
   N/A (initial)

6. All trash cans, trash bins and other trash receptacles have covers and are tightly sealed.
   N/A (initial)

7. The areas surrounding trash receptacles are maintained and cleaned daily.
   N/A (initial)

8. Grease traps and grease interceptors are maintained and cleaned out on a regular basis.
   N/A (initial)

(signature)

1-3-94
(date)

After you have completed this checklist, please contact one of our representatives so that a site visit and discussion of this form can be arranged. Please call (310) 545-5621 extension 424.

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FRONT OF 8½ x 5½" CARD

HOW TO BE AN OCEAN SAFE ENTERPRISE

A GUIDE FOR THE RESTAURANT INDUSTRY

FOOD WASTE AND PARTICLES, GREASE, CLEANING SOLVENTS AND CHEMICALS, MOP WATER AND TRASH FROM RESTAURANT OPERATIONS FREQUENTLY MAKE THEIR WAY INTO THE MANHATTAN BEACH STORM DRAIN SYSTEM. THESE MATERIALS FLOW THROUGH THE STORM DRAIN SYSTEM DIRECTLY ONTO THE BEACH AND INTO SANTA MONICA BAY, MAKING THEM UNHEALTHY AND UNSAFE FOR PEOPLE AND MARINE LIFE.

WITH YOUR HELP, WE CAN MAKE MANHATTAN BEACH OCEAN SAFE. HERE IS WHAT YOU NEED TO KNOW TO MAKE YOUR RESTAURANT AN OCEAN SAFE ENTERPRISE.

- THE STORM DRAIN SYSTEM AND THE SEWER SYSTEM ARE SEPARATE SYSTEMS! EVERY CITY STREET, SIDEWALK AND ALLEY LEADS TO A STORM DRAIN. THE STORM DRAIN SYSTEM LEADS DIRECTLY TO THE BAY. EVERYTHING FLOWING THROUGH THE STORM DRAIN SYSTEM ENDS UP ON THE BEACH AND IN SANTA MONICA BAY WITHOUT BEING TREATED.
- THE SINKS, FLOOR DRAINS, BATHROOMS AND MOP SINKS IN YOUR RESTAURANT ARE CONNECTED TO THE SANITARY SEWER SYSTEM. WHAT FLOWS THROUGH THE SEWER SYSTEM IS TREATED TO REM[illegible] POLLUTANTS BEFORE [illegible] OCEAN. THE SANITA[illegible] SYSTEM IS THE PROPER AND LEGAL DISPOSAL OPTION FOR CONTAMINATED WATER, SMALL FOOD PARTICLES AND OTHER WASTE CREATED DURING RESTAURANT OPERATIONS.

BACK OF CARD

- OCEAN SAFE RESTAURANT CLEANING AND MAINTENANCE PRACTICES. • DON'T WASH KITCHEN MATS, GARBAGE CONTAINERS, GRILLS AND UTENSILS ANYWHERE THAT WASTE WATER CAN FLOW INTO THE STORM DRAINS. • POUR MOP AND WASH WATER INTO THE MOP SINK OR DOWN FLOOR DRAINS, NOT INTO ALLEYS, STREETS OR SIDEWALKS. • IF YOUR RESTAURANT IS NOT EQUIPPED WITH MOP SINKS AND FLOOR DRAINS, HAVE SUCH FACILITIES INSTALLED. • IF YOUR RESTAURANT CANNOT BE RETROFITTED, EMPLOY A CLEANING SERVICE THAT WILL REMOVE MATS FOR PROPER CLEANING OFF PREMISES. • TRAIN YOUR WORKERS AND LET THEM KNOW IT IS YOUR RESTAURANT POLICY TO FOLLOW OCEAN SAFE CLEANING AND DISPOSAL PRACTICES. GIVE THEM RECOGNITION FOR INNOVATIVE IDEAS ON HOW TO KEEP RESTAURANT WASTE OUT OF THE STORM DRAINS.

FOLLOWING OCEAN SAFE PRACTICES AT YOUR RESTAURANT WILL ALSO REDUCE WASTE THAT ATTRACTS RATS AND ROACHES.

REMEMBER! DUMPING ANY MATERIAL OTHER THAN CLEAR WATER INTO A STORM DRAIN IS A VIOLATION OF THE FEDERAL CLEAN WATER ACT AND CITY OF MANHATTAN BEACH ORDINANCES. YOUR RESTAURANT IS SUBJECT TO INSPECTION FOR VIOLATIONS.

IF YOU JOIN THE OCEAN SAFE ENTERPRISE CAMPAIGN, YOU WILL RECEIVE A SEAL OF RECOGNITION FROM THE CITY AND CITY RESIDENTS WILL BE ENCOURAGED TO PATRONIZE YOUR BUSINESS.

FOR MORE INFORMATION:

- HOW TO BECOME AN OCEAN SAFE ENTERPRISE: (310) 545-5621 EXT. 424
- HOUSEHOLD HAZARDOUS WASTE HOTLINE: (800) 552-5218
- USED-OIL COLLECTION CENTERS: (800) 553-2962
- TO REPORT ILLEGAL DUMPING OR A CLOGGED STORM DRAIN: (310) 545-5621 EXT. 380

1939

SANTA CLARA VALLEY
NONPOINT SOURCE
POLLUTION CONTROL PROGRAM

R0035275

Cleaning Equipment

Clean floor mats, filters, and garbage cans...

- Indoors, in a mop sink or near a floor drain.

OR

- Outside, within your designated cleaning area, where cleaning water will not flow to the street, the gutter, a storm drain or a creek.

- Pour washwater into the mop sink... never out the back door, or into a gutter, storm drain, or creek.

Spills

Use dry methods for spill cleanup.

- Don't hose down outside spills.
- Use rags or absorbents.
- Sweep up and dispose of absorbent to the trash.
- If necessary, mop the area with a minimum amount of water.

Grease and Oil

Handle and dispose of grease properly.

- Save used grease and oil for recycling in tallow bins or sealed containers.
- Never pour grease into a sink, floor drain, storm drain, or dumpster.
- Watch out for, and report to management, overflowing grease interceptors.

Dumpsters

Keep dumpster and loading dock areas clean.

- Control litter. Sweep up. Don't hose down.
- Keep dumpster lids closed to keep out rainwater.
- Keep dumpsters or the dumpster enclosure locked to prevent illegal dumping.
- Never place liquid waste or leaky garbage bags into a dumpster.
- Apply absorbent over any fluids spilled in the dumpster.
- Don't hose out dumpsters.
- Leaking dumpsters and compactors, and dumpsters that need to be cleaned out, should be reported to management and replaced by the dumpster leasing company.

R0035276

VOL 12

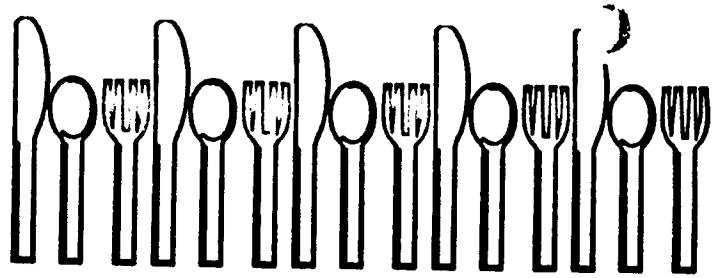
Food Service Establishments Can Help Prevent Pollution

Brochure produced by
Pollution Prevention Program
Source Control Division
Eastern Municipal Water District
(909) 928-3777 ext. 6203

July 93

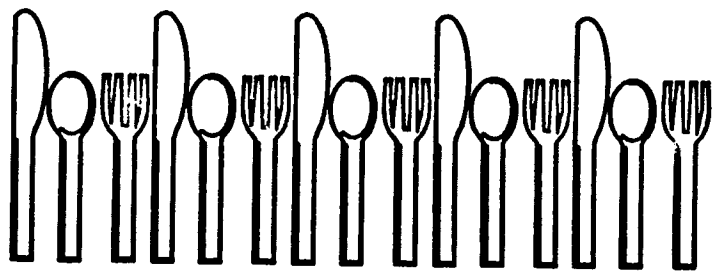
Printed on Recycled Paper

R0035277



Grease...

Help For the Food Service Establishment



Grease interceptor maintenance costs are escalating for food service establishments each year. Disposal costs may go up as much as 300% within two years.

These are ACTIONS you can take.

Contract with a reclaimer or processor to pick up waste grease.

Reduce the amount of solids entering the interceptor through garbage grinders.

Monitor your interceptor YOURSELF to decide when it needs pumping.

STRATEGY

Minimizing Grease and Solids Reaching the Interceptor

Reduce the amount of grease washing down the drain by scraping off trays and pans into waste grease cans.

Scrape grills and cooking services into a waste grease can.

Place baskets in drains to catch solids which can then be placed in the trash bin.

Look at the solids entering garbage grinders to evaluate the best method of disposal. Much of this material could be placed in trash bins and disposed in landfills.

Minimize spills of oil and grease on floors which when wet-mopped end up down the drain.

R0035278

GREASE INTERCEPTORS
HOW DO THEY WORK?

Grease interceptors are installed to protect the sewer lines from being blocked with grease or solid material.

Grease interceptors are usually a three chambered concrete tank-like structure buried in the ground outside the building. Many times a small concrete box is attached for sampling purposes. The top of each chamber should have a manhole opening to allow for cleaning by a liquid waste hauler.

Here's how interceptors work:

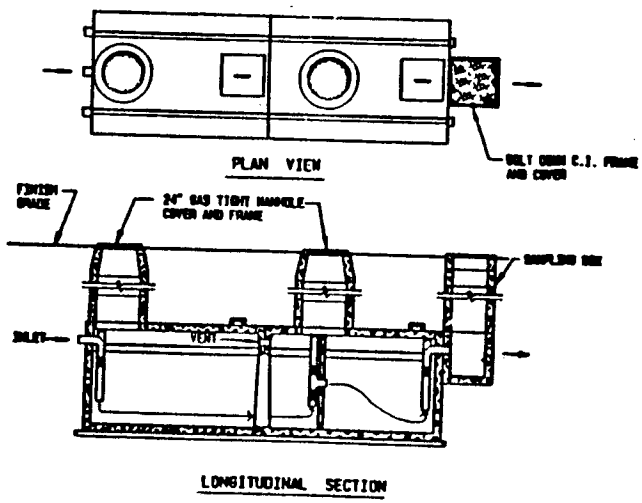
1. Wastewater containing solid matter and grease leaves the kitchen. (Restroom wastewater does not enter the interceptor.)

2. Wastewater flows through the interceptor following the arrows in the top diagram.

3. Most of the solids will settle to the bottom of the first chamber.

4. Since grease floats, a major amount will be retained at the top of the first chamber.

GREASE INTERCEPTOR



Standard Drawings of Grease Interceptors are available by calling
Eastern Municipal Water District
Source Control Division
at (909) 928-3777 ext 6262

5. Water travels through the bent pipe (called an elbow) into the second chamber. More of the solids and grease will separate from the water.

6. The final chamber should have very little grease and solids. An inspector may require you to have the interceptor pumped by a liquid waste hauler if the solids in the final chamber reach within 2 inches of the elbow or the grease is more than 12 inches thick or a sample of the discharge contains more oil and grease (of animal origin) than the limit of 500 mg/L.

7. In the two hours that wastewater should take to travel through the interceptor, most of the solids and grease will be retained. The retention can be affected by water temperature and cleaning products used.

8. Water exits the interceptor and mixes with the restroom flow in the sewer lateral.

R0035279

l od Service Establishments and the Liquid Waste Hauler

1. Ask the hauler for the location of the disposal site for the grease.

2. Ask the hauler whether the grease removed will be reclaimed.

3. Ask the hauler if the service provided includes complete pumping of the interceptor and sample box or just skimming of the grease layer.

4. Watch during the treatment and pumping process. Make sure you are receive the services for which you receive a bill.

5. Discuss with the hauler who is responsible for additional charges if the local authority requires the interceptor to be pumped between regularly scheduled maintenance events.

BACTERIAL ADDITIVES

Many sales representatives are knocking at the food service establishment's door selling what sometimes seems to be a

MIRACLE CURE!!!

Be careful before signing a contract. Ask what guarantees are provided.

Make sure that the additive is <u>not</u> an emulsifier, which just breaks the grease into parts which will float out into the sewer. Emulsifiers may be prohibited by your local agency.

No bacterial additive will <u>eliminate</u> the need for pumping the interceptor. It may increase the time between pumpings.

Ask the bacteria sales representative for the names of other local food service establishments that are using the product with success.

R0035280

CITY OF SAN JOSÉ, CALIFORNIA

4 NORTH SECOND STREET, SUITE 675
SAN JOSE, CALIFORNIA 95113
Phone Number (408) 277-5970
Fax Number (408) 277-3186

ENVIRONMENTAL
SERVICES DEPARTMENT
Environmental Enforcement Division

VOL 12

«DATE»

«FACILITY NAME»
«STREET #» «STREET NAME»
«CITY» «STATE» «ZIP»

SUBJECT: NPS FACILITY INSPECTION
SIC CODE: «SIC CODE»
FILE NUMBER: «FILE NUMBER»

Dear Facility Owner/Operator:

The City of San Jose is currently conducting a Non Point Source Facility Inspection Program in your area to locate sources of pollution running into local storm drains and to help business owners comply with new regulations prohibiting the discharge of anything besides rainwater into the public storm drain system. The storm drain system unlike sanitary sewers, are intended to conduct clean rainwater runoff. This water does not undergo any type of pre-treatment prior to entering our surface waterways; such as local creeks and ultimately the San Francisco Bay.

The type of pollution we are working to prevent is called non point source pollution. It is pollution washed by rain from streets, industrial/commercial areas and roofs. Included are materials which are deliberately dumped into gutters and storm drains. It is made up of many types of pollutants, including but not limited to: residual oil and grease, paint, solvents, waste wash-water, fertilizers, economic poisons, and particulates.

As required by the Regional Water Quality Control Board, the City of San Jose has participated in Non-Point Source monitoring studies over the past four years to find out how polluted our storm water is and what types of contaminants are present. The City of San Jose is required to determine where this pollution is coming from and to help business owners employ specific best management practices to prevent the pollution of storm water. Based on Standard Industrial Code (SIC) criteria set forth by the RWQCB your facility has been identified as requiring a need for inspection under this new program. The purpose of this audit will be to identify and document existing or potential sources of pollution which may enter the storm drain system.

The mandate to reduce Non-Point Source pollution and improve surface water quality will require a tremendous effort and in order to do so we need your assistance. Between now and July 1, 1995, Inspectors from this division will be coming to your facility to conduct a Non Point Source Inspection. If you were required to file a Notice of Intent (NOI) to be covered under the State's general storm water permit for industry, please prepare to have available your NOI and Storm Water Pollution Prevention Plan (SWPPP) for review. Other documents which may be of use during the inspection are plumbing schematics and a facility/site map. If you wish to schedule your facility inspection for a specific date or you think that your facility is exempt, please call the undersigned Inspector at (408) 277-5970.

We welcome any questions you may have and appreciate your cooperation.

Sincerely,

«INSPECTOR NAME»
Code Enforcement Inspector

cc: Richard Sun

1946

R0035281

Industrial Stormwater Management Survey Form

IT IS IMPORTANT THAT YOU COMPLETE THIS FORM AND MAIL BEFORE OCTOBER 11, 1991.

If your company operates more than one facility in Richmond, please copy this form ~~and fill one out for~~ each facility.

Part I. To Be Completed for All Facilities

1. Please peel off the mailing label from the envelope and attach it in the space below.

If any of the information on the label is incorrect, please correct it below:

Contact name _____

Company name _____

Mailing address _____

City _____ Zip code _____

2. What industrial activities are performed *at this facility?* Please circle all that apply.
   A. Manufacturing
   B. Trucking or substantial shipping operations
   C. Any process or service that involves the use of chemicals, solvents, or paints
   D. Vehicle maintenance, repair, and/or fueling
   E. Outdoor storage or handling of materials
   F. Other industrial activities (Please describe) _____
   G. This facility performs *none* of the above industrial operations.
3. Does this facility discharge *stormwater associated with* any of the above industrial activities, i.e. does stormwater come into contact with any of the above activities?

   Yes _____ No _____

   (If yes, please complete Section II of this survey form.)
4. Please give a brief description of the activities or services conducted at the facility. (For example, furniture manufacturing; freight transport; finishing or plating of products.)

   _____

   _____

   _____
5. Please give a brief description of any raw materials or finished products that are stored at the facility that may be exposed to stormwater.

   _____

   _____
6. If you know the facility's principal 4-digit Standard Industrial Classification (SIC) code, please provide it below. If your facility has more than one SIC code, please provide all that you know.

   _____

Part II. To Be Completed for All Facilities that Discharge Industrial Stormwater

Please have this form completed by the person responsible for stormwater pollution control compliance.

1. Contact Person's Name _____ Title _____

   Mailing Address _____

   Phone Number (____) _____ - _____

   Signature _____ Date _____
2. What is the facility's (or construction site's) *street location*, if different than the mailing address above? _____
3. Does this facility hold an NPDES Permit for *direct* discharge of wastewater to receiving waters?

   Yes _____ No _____ If yes, what is the permit number? _____

(Note that this is *not* the same as a permit for discharge to a municipal wastewater system.)

VOL 12

1947

R0035282

May 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

Industrial and Commercial Businesses

The ACURCWP *consists of the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, Union City, Unincorporated Alameda County, the Alameda County Flood Control & Water Conservation District, and the Alameda County Flood Control & Water Conservation District Zone 7.*

The Goal of the ACURCWP *is to control discharges of pollutants to municipal storm drain systems (and local creeks and the S.F. Bay) using Best Management Practices and effectively eliminate illegal discharges and connections.*

The Storm Drain System was built to collect and transport rain to prevent flooding in urban areas. Anything that flows or is discharged into the storm drain system goes directly into local creeks or San Francisco Bay without any treatment.

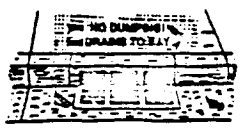
Best Management Practices (BMP) are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.

Illegal Discharges or Connections are non-storm water discharges to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Pollutants discharged to local creeks, lakes and San Francisco Bay during storms or through illegal dumping significantly contribute to water pollution and harm aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing their own practices, municipalities in Alameda county have launched a public education campaign and inspection program and are working with commercial and industrial businesses to identify and control pollutants.



Storm water runoff from industrial and commercial businesses is one of the major contributors to urban runoff pollution. Automotive fluids, paints, solvents, food wastes, grease, pesticides, herbicides, litter, cement and yard wastes are only some of the pollutants that get into the storm drain system.

All businesses can reduce or eliminate their contribution to storm water pollution by conducting common-sense Best Management Practices (BMPs) that require modest changes to routine operations or maintenance practices. The table on the reverse side of this page identifies activities by industrial and commercial businesses which contribute to urban runoff pollution and BMPs to control or eliminate these discharges. For more detailed BMP information, ask your local urban runoff representative for a copy of the *Best Management Practices for Industrial Storm Water Pollution Control* booklet.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

VOL 12

1948

R0035283

Best Management Practices

You can control pollutant discharges by conducting these BMPs. The objectives are to 1) keep pollutants from contacting rain, and 2) keep pollutants from being dumped or poured into the storm drains. The goal is "only rain in the storm drain."

Activities	Best Management Practices
Good Housekeeping Practices	• Keep work areas clean. • Sweep your lots and pick up litter regularly.
Process/Equipment Areas	• Identify all areas with outdoor equipment and storage of raw or waste materials that are exposed to storm water and have potential to discharge pollutants to the storm drain system. When possible, bring work process areas, equipment, and transfer stations inside a building or under a roof. • Inspect equipment and vehicles often for leaks. Follow preventive maintenance practices. • Contain leaks by using drip trays and splash guards around and under vehicles and process equipment. • Eliminate illegal connections to the storm drain system.
Washing	• All wash water with detergent must be collected and discharged to the sanitary sewer. • Wash equipment/vehicles in a designated and/or covered area where the wash water is collected to be recycled or discharged to the sanitary sewer. Contact your local wastewater treatment agency. • If wet cleaning is required for small spills, use a 3-step process; 1) soak up with rags, 2) use absorbents, and 3) mop and collect water to dispose of in sink or sanitary sewer drain. Contact your local wastewater treatment agency.
Storage*	• Store materials such as grease, paints, detergents, metals, and raw materials in appropriate, labeled containers. • Store stock-piled materials and equipment inside a building or "doghouse", under a roof, or covered with a tarp to prevent contact with rain. Contact your local hazardous materials/fire authorities and building department to determine if specific requirements on storage sheds apply. • Use secondary containment measures for liquids stored outside and for liquids stored inside near a storm drain.
Material Use/ Waste Disposal*	• Handle materials carefully to avoid spills. Immediately clean up any spills. • Establish a clean-up plan for minor and major spills, post it in the work area, and have clean-up kits in well-marked accessible locations. • Repair dumpters that leak and keep lids closed. • Properly dispose or recycle all wastes. Materials that cannot be recycled must be taken to an appropriate landfill or disposed of as hazardous waste. • When ordering materials, practice source reduction and minimize waste. Do not order more than can be used within the shelf life of the product.
Training	• Train and assign responsibility to specific employees on BMPs, good housekeeping practices, and what to do in the event of a spill. • Inform your customers of the proper methods for disposing of fluids and wastes on your property. • Label storm drain inlets, so that employees and customers do not dispose of waste there.

Some facilities will require structural BMPs if simpler operational ones described above are not adequate for keeping pollutant discharges from storm drains. Contact your local storm water representative for more information on structural BMPs.

*Hazardous Materials must comply with hazardous materials storage and disposal requirements.

VOL 12

1949

R0035284

January 1995

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

The ACURCWP *consists of the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, Union City, Alameda County, the Alameda County Public Works, and Zone 7 of Alameda County Public Works.*

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The Storm Drain System was built to collect and transport rain to prevent flooding in urban areas. Anything that flows or is discharged into the storm drain system goes directly into local creeks or San Francisco Bay without any treatment.

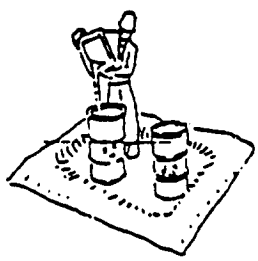
Best Management Practices (BMP) are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.

Illegal Discharges or Illicit Connections discharge non-storm water to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Outdoor Liquid Storage

Protect our creeks, lakes, and San Francisco Bay by properly managing liquids stored outdoors. Liquids spilled, poured, or dumped outdoors flow to the storm drain system. The storm drain system includes gutters, grated inlets, underground pipes, as well as channels creeks, and the Bay. *Anything that is discharged into the storm drain system flows to the Bay without any treatment.* Liquid materials are a particular concern because liquids which dissolve in water or float on the water surface are generally *toxic* to aquatic life. Remember, ONLY RAIN DOWN THE STORM DRAIN.



In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP). In addition to reviewing their own practices, municipalities in Alameda County have launched a public education and inspection program. Inspectors work with businesses, residents, and property owners to identify and control potential discharge of pollutants to the storm drain system.

The purpose of this flyer is to provide you with general guidelines for managing any liquid material you store outdoors. ***If you have any questions or need additional information, contact your local program representative at (510) 670-5543.***

VOL 12

1950

R0035285

Best Management Practices for Storage of Liquid Materials

Indoor Storage:

One way to keep rainwater from contacting liquid material is to move storage indoors. This also prevents any spills from accidentally flowing into the storm drains. Be sure to check with your local building, zoning, and fire department concerning indoor storage requirements. Also, hazardous materials must be stored in accordance with federal, state, and local requirements. Check with your local hazardous materials authority.

If you must store your liquid materials outdoors, you can significantly reduce your contribution to storm water pollution by applying best management practices, or *BMPs*, to your daily activities. BMPs related to outdoor liquid storage are described below.

Outdoor Storage:

- Regularly *inspect* liquid containers for cracks, corrosion or leaky seams.
- *Keep containers out* of pooled or standing water.
- Apply *caution and control* when transferring liquids to minimize the potential for a spill.
- Have *clean-up materials* easily accessible. Regularly train employees on spill clean-up procedures. Designate a spill clean-up coordinator.
- *Organize and arrange* containers so that they are accessible for inspection and/or clean up.
- *Keep a log* of when you apply BMPs. For example, write the name of the operator, the date and time the BMP was applied, and a description of the BMP in a spiral notebook. This helps you confirm to the inspector that you are minimizing the contaminants rain picks up on your site.
- As possible, practice *source reduction* by reducing the amount of materials stored on site at any one time.
- *Stencil* storm drain inlets with "No Dumping, Drains to Bay" message.
- *Store containers* so that if a leak or spill occurs, materials do not enter the storm drain system. One option is to place the containers in secondary containment. Secondary containment include oversize drums, secondary containment pallets, drum containers, etc. Any rain captured in secondary containment must be disposed of properly:

  - If the captured rainwater has not contacted the contents of the containers, the *uncontaminated* rain water can be discharged to the storm drains.

  - If there is potential that the rainwater is contaminated, the rainwater cannot be discharged to the storm drain. Contact your local storm water representative for more information and guidance on disposal alternatives specific for your site.

REFERENCE: ACURCWP Best Management Practices for Industrial Storm Water Pollution Control booklet.

VOL 12

1951

R0035286

January 1995

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

Finish the Pour Right

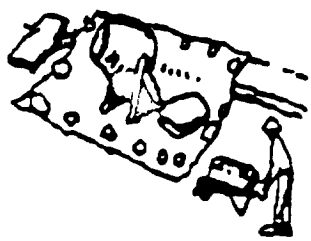
Guidelines for Small, "Week-end" Concrete Jobs

Protect our creeks, lakes, and San Francisco Bay by not placing concrete waste into inlets or gutters. **ONLY RAIN DOWN THE STORM DRAIN.**

The storm drain system includes gutters, grated inlets, underground pipes, as well as channels creeks, and the Bay. Anything that is discharged into the storm drain system flows to the Bay without any treatment.

Concrete wash waters contain sediments that coat stream beds and chemicals that harm fish and other wildlife. Concrete wastes block and back-up underground pipes.

How to properly dispose of concrete wastes:



- Remove all excess concrete from the chute by using a squeegy or similar tool.
- Place all excess concrete in a form, holder, box, or a designated washout area where it may be removed once it is hardened. You may need to make a number of smaller piles because solid concrete is very heavy. All concrete finishing tools and pumping hoses should also be cleaned in the washout area.
- Use the minimum amount of water to wash down the chute, finishing tools, and any other equipment.
- Remove the concrete sediment from the street, gutters, and area surrounding the washout area before it hardens.
- Dispose of concrete wash water properly. Two examples are described below.

  Preferred Practice to Dispose of Wash Water: Contain all washwater on soil, preferably in a bowl shaped area to prevent the wash water from flowing from the washout area.

  Alternate Practice: The following steps are illustrated on the back of this flyer.
  1. Find the storm drain immediately down stream from the designated washout area. Block the storm drain and dam an area to collect the washwater. One effective control method is to use sandbags. To properly install, first wet down the sand bags, then compact them tightly to one another and to the curb so that no silty water can flow through.
  2. Allow particles to settle and allow the water to evaporate.
  3. Remove any remaining concrete sediment.
  4. Discard the concrete particles to the trash or landfill.

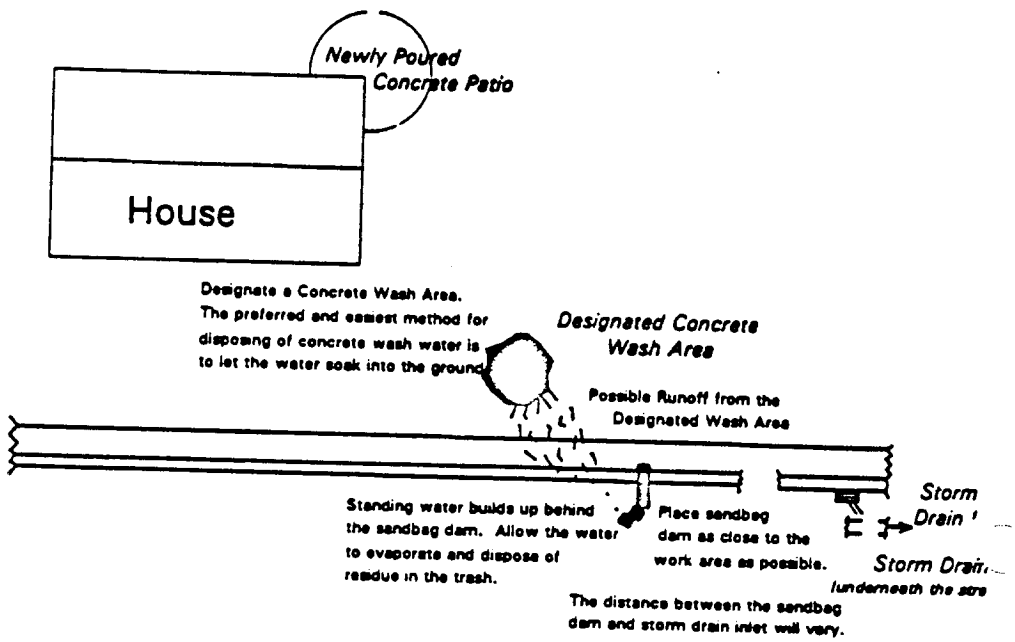
Please remember, IT IS ILLEGAL TO DISPOSE OF CONCRETE OR UNTREATED CONCRETE WASH WATERS IN THE STORM DRAIN SYSTEM. Also, DO NOT dispose of concrete in the sanitary sewer.

VOL 12

1952

R0035287

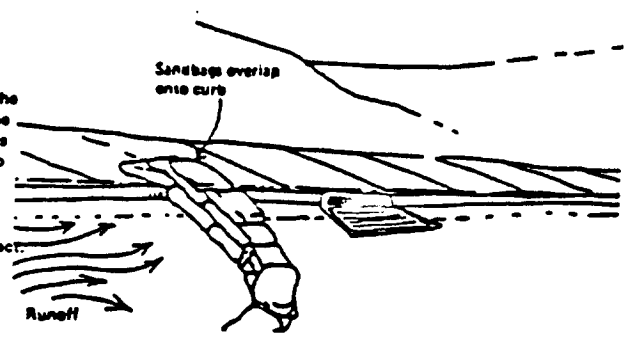
Typical Best Management Practice for keeping Concrete and Concrete Wash Water out of the Storm Drain System (Bird's Eye View):



Typical Sandbag Dam:

To properly install the sandbags, first wet down the bags. Compact the bags tightly to one another and to the curb and gutter, and overlap the bags so that all gaps are eliminated and no silty water can flow through.

A different number of sandbags than shown may be required for your project. Build the dam large enough so that all wash waters will be contained behind the dam.



VOL 12

1953

October 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

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The Storm Drain System was built to collect and transport rain to prevent flooding in urban areas. Anything that flows or is discharged into the storm drain system goes directly into local creeks or San Francisco Bay without any treatment.

Best Management Practices (BMP) are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.

Illegal Discharges or Illicit Connections discharge non-storm water to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Outdoor Storage of Dry Materials

Pollutants discharged to local creeks, lakes, and San Francisco Bay during storms or through illegal dumping significantly contribute to water pollution, and harm aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing their own practices, municipalities in Alameda County have launched a public education campaign and inspection program. Inspectors work with businesses to identify and control potential discharge of pollutants to the storm drain system.

Storm water runoff from outdoor materials storage areas contribute to urban runoff pollution. Sediment, metals, landscape waste, grease, automotive fluids, and concrete products are some of the pollutants that get into the storm drain system. Stock piles of galvanized metal products are concentrated sources of pollutants.

All businesses can significantly reduce their contribution to storm water pollution by applying Best Management Practices to their daily activities. BMPs related to outdoor storage of dry materials are identified on the reverse side of this page.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

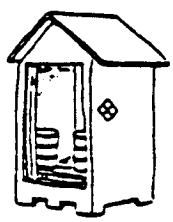
VOL 12

1954

R0035289

Best Management Practices for Outdoor Storage of Dry Materials*

- Keep rainfall from directly contacting dry materials stored outdoors. You can do this by doing any of the following: **



  - move storage indoors;
  - cover the outdoor areas with a roof;
  - move materials into a shed; or
  - cover the outdoor areas with plastic sheeting or a tarp, and secure with weighted tires or sand bags.

- Keep rain from running onto or through the storage area by storing on a mounded area, on a pallet, or in a bermed area.

- Sweep the area frequently; dispose of debris in the garbage.

- Keep dumpster areas free of litter and keep lids closed.

- Do not use the area for washing; wash water from cleaning operations must be discharged to the sanitary sewer. Contact the local wastewater treatment plant.

- Stencil storm drain inlets with "No Dumping, Drains to Bay" message.

* Hazardous Materials must be stored in accordance with federal, state, and local requirements.

** Check with local building, zoning, and fire departments concerning indoor storage requirements.

REFERENCE: ACURCWP Best Management Practices for Industrial Storm Water Pollution Control booklet, 1994.

VOL 12

1955

August 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

Parking Lots

The ACURCWP *consists of the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, Union City, Unincorporated Alameda County, the Alameda County Flood Control & Water Conservation District, and the Alameda County Flood Control & Water Conservation District Zone 7.*

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Best Management Practices (BMP) are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.

Illegal Discharges or Illicit Connections discharge non-storm water to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Pollutants discharged to local creeks, lakes, and San Francisco Bay during storms or through illegal dumping significantly contribute to water pollution, and harm aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing their own practices, municipalities in Alameda County have launched a public education campaign and inspection program. Inspectors work with businesses to identify and control potential discharge of pollutants to the storm drain system.

Storm water runoff from parking lots contribute to urban runoff pollution. Automotive fluids, food wastes, grease, pesticides, litter, and landscape wastes are only some of the pollutants that get into the storm drain system.

Owners and operators of parking lots can significantly reduce their contribution to storm water pollution by applying Best Management Practices (BMPs) to their daily activities. Some of these BMPs are identified on the reverse side of the page.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

VOL 12

1956

R0035291

Best Management Practices for Cleaning Parking Lots

- Sweep parking lots frequently; at least weekly, daily is preferable. Small areas can be swept with a broom; larger areas may need a vacuum truck or mechanical sweeper. Dispose of sweepings properly.
- Post signs to control litter and prevent patrons from working with automobile fluids in your parking lot (changing oil, adding transmission fluid, etc.). You could be liable for their mess on your property!
- Use absorbent material to clean up automotive fluids on the parking lot. Dispose of absorbent properly.*
- Pick up litter daily; dispose of debris in the garbage.
- Keep dumpster areas free of litter and lids closed.
- Wash water from all cleaning operations must be discharged to the sanitary sewer.
- If cleaning with water and detergent is needed, use a mobile washing unit that is self-contained; do not allow the wash water (whether or not it is soapy) to discharge to the storm drain system.
- If using a self-contained mobile cleaner is not feasible, collect the wash water and dispose in indoor sinks or drains for discharge to the sanitary sewer. Contact your local wastewater treatment agency for approval.

- Stencil storm drain inlets with "No Dumping, Drains to Bay" message.

*Hazardous Materials must comply with hazardous materials storage and disposal requirements.

REFERENCES: ACUWCWP Best Management Practices for Industrial Storm Water Pollution Control booklet

VOL 12

1957

R0035292

June 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

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Building Maintenance/ Remodeling

Pollutants discharged to local creeks, lakes and San Francisco Bay during storms or through illegal dumping significantly contribute to water pollution and harm aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing our own practices, municipalities in Alameda county have launched a public education campaign and inspection program. The ACURCWP is working with commercial and industrial businesses, as well as construction contractors and residents, to identify and control pollutants.

Construction sites, even small scale projects such as maintenance work or building remodeling, are sources of storm water pollution. Materials and wastes that are blown or washed into a storm drain, gutter, or street have a direct impact on local creeks and the Bay. As a contractor, supervisor of a construction site, permittee, owner, or facility operator, you are responsible for any environmental impact caused by the people working on your site.

All construction contractors can reduce or eliminate their contribution to storm water pollution by following Best Management Practices (BMPs). The table on the reverse side of this page identifies activities at construction sites that contribute to urban runoff pollution and alternatives (BMPs) to control or eliminate these discharges.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

VOL 12

1958

R0035293

Best Management Practices

You can control pollutant discharges by following these BMPs. The objectives are to 1) keep pollutants from contacting rain, and 2) keep pollutants from being dumped or poured into the storm drains. The goal is "only rain in the storm drain."

Activities	Best Management Practices
General Practices	• Store materials under cover, protected from rainfall and runoff. • Use tarps on the ground to collect fallen debris or splatters. • Secure bags of cement after they are opened. Keep wind-blown cement powder away from gutters, storm drains, and rainfall. • Pick up litter and other wastes daily from outside areas including storm drain inlet grates. • Avoid outdoor work during wet or windy weather.
Materials/Waste Handling*	• Order and mix only the amount of materials you will need. • Use recyclable materials whenever possible. • Dispose of all wastes properly. Recycle whenever possible. Dispose of small amounts of dry concrete, grout, and mortar in the trash. • Liquid residues from oil-based paints, thinners, solvents, glues, and cleaning fluids are hazardous wastes*. • Never bury waste materials. Never leave waste material in the street or gutter, nor near a creek or stream bed.
Spills	• Clean up leaks, drips and other spills immediately so that they do not contaminate soil or groundwater or leave residue on paved surfaces. • Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags), or dig up and remove contaminated soil.*
Washing/Cleanup	• Contain, collect, and filter washwater from concrete operations. Discharge washwater to the sanitary sewer. (Contact the your local wastewater treatment agency.) Dispose of filtered particles in trash. • Wash concrete mixers out in designated wash-out areas in your company's yard, where the water will flow into containment ponds or onto dirt. At the construction site, recycle washout by pumping back into mixers for reuse; recycle or properly dispose of concrete remaining in chute. Never dispose of washout into the street, storm drains, drainage ditches, or streams. • When stripping or cleaning building exteriors with high-pressure water, block storm drains. Collect the water for disposal to the sanitary sewer (contact your local wastewater treatment agency). • For water-based paints, first paint out brushes as much as possible and then rinse in a sink. Empty cans, rags, used brushes used with water-based paints can be disposed of in the trash. • For oil-based paints, first paint out brushes as much as possible, then filter and reuse thinners and solvents. Dispose of excess liquids and residue as hazardous waste.* • Never clean brushes or rinse paint containers into a street, gutter, storm drain, or stream.

*Hazardous Materials must comply with hazardous materials storage and disposal requirements.

REFERENCES:
ACURCWP Best Management Practices for Industrial Storm Water Pollution Control booklet
Santa Clara Valley Nonpoint Source Pollution Control Program 'General Construction and Site Supervision', 'Fresh Concrete and Mortar Applications', 'Painting and Applications of Solvents and Adhesives', flyers

VOL 12

1959

R0035294

April 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

The ACURCWP *consists of the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, Union City, Unincorporated Alameda County, the Alameda County Flood Control & Water Conservation District, and the Alameda County Flood Control & Water Conservation District Zone 7.*

The Goal of the ACURCWP *is to control discharges of pollutants to municipal storm drain systems (and local creeks and the S.F. Bay) using Best Management Practices and effectively eliminate illegal discharges and connections.*

*The **Storm Drain System** was built to collect and transport rain to prevent flooding in urban areas. Anything that flows or is discharged into the storm drain system goes directly into local creeks or San Francisco Bay without any treatment.*

***Best Management Practices (BMP)** are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.*

***Illegal Discharges or Illicit Connections** discharge non-storm water to municipal storm drain systems which contribute to water pollution.*

***Urban Runoff** is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.*

Good Housekeeping Practices

Pollutants discharged to local creeks, lakes, and San Francisco Bay during storms or through illegal dumping significantly contribute to water pollution, and harm aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing their own practices, municipalities in Alameda county have launched a public education campaign and inspection program. Inspectors work with commercial and industrial businesses to identify and control potential discharge of pollutants to the storm drain system.

Storm water runoff from industrial and commercial businesses is one of the major contributors to urban runoff pollution. Automotive fluids, paints, solvents, food wastes, grease, pesticides, herbicides, litter, cement and yard wastes are only some of the pollutants that get into the storm drain system.

All businesses can reduce or eliminate their contribution to storm water pollution by applying good housekeeping practices in their daily activities. The table on the reverse side of this page identifies some of these good housekeeping practices also called Best Management Practices, or BMPs.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

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Good Housekeeping ☞ Best Management Practices

You can control pollutant discharges by doing these BMPs. The following list describes some common-sense BMPs that require modest changes to routine operations or maintenance practices. The objectives are to 1) *keep pollutants from contacting rain* and 2) *keep pollutants from being dumped or poured into the storm drains*. The goal is "only rain in the storm drain."

Activities	Best Management Practices
Pavement Cleaning	• Sweep parking lots and other paved areas periodically to remove debris. Dispose of debris in the garbage. • If outdoor pavement cleaning with detergent is required, collect wash water and dispose in indoor sinks or drains for discharge to the sanitary sewer. Contact your local wastewater treatment agency.
Litter Control	• Provide an adequate number of trash receptacles for your customers and employees. This helps keep trash from overflowing receptacles. • Pick up litter and other wastes daily from outside areas including storm drain inlet grates.
Waste Disposal	• Inspect dumpsters and other waste containers periodically. Repair or replace leaky dumpsters and containers. • Cover dumpsters and other waste containers. • Never dispose of waste products in storm drain inlets. • Recycle wastes or dispose properly.
Materials Storage*	• Store materials such as grease, paints, detergents, metals, and raw materials in appropriate, labeled containers. • Make sure all outdoor storage containers have lids, and that the lids are adequately closed. • Store stock piled materials inside a building, under a roof, or covered with a tarp to prevent contact with rain.
Training	• Train employees regularly on good housekeeping practices. • Assign a person to be responsible for effective implementation of BMPs.
Equipment/Vehicle Cleaning	• Maintain equipment and vehicles regularly. Check for and fix leaks. • Use drip pans to collect leaks or spills during maintenance activities. • Wash equipment/vehicles in a designated and/or covered area where the wash water is collected to be recycled or discharged to the sanitary sewer. Contact your local wastewater treatment agency.

Some facilities will require structural control BMPs if simpler operational ones are not adequate for keeping pollutant discharges from the storm drains.

* Hazardous materials must comply with hazardous materials storage and disposal requirements.

REFERENCES:

California Industrial/Commercial Best Management Practices Handbook, March 1993

City of Richmond Storm Water Management Program "Your Business and the City of Richmond Partners in Protecting the Bay". 1993

Cities of Fremont, Newark, and Union City. "Sources Controls for Storm Water Pollution Prevention". October 1993

ACCWP "Restaurants" flyer. January 1994

ACCWP Best Management Practices for Industrial Storm Water Pollution Control. March 1994

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March 1994

Alameda County
Urban Runoff
Clean Water Program

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The Storm Drain System was built to collect and transport rain to prevent flooding in urban areas. Anything that flows or is discharged into the storm drain system goes directly into local creeks or San Francisco Bay without any treatment.

Best Management Practices (BMP) are methods and practices such as good housekeeping, spill prevention, or treatment measures to prevent or minimize pollutant discharges to municipal storm drain systems.

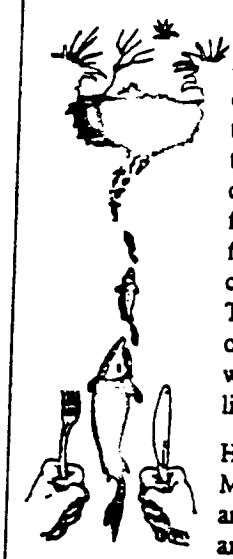
Illegal Discharges or Connections are non-storm water discharges to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Urban Runoff Pollution Prevention is Everybody's Business

The next time you're caught outside in the rain, take a look at what's running off the street, into gutters, and down storm drain inlets. Clean rainwater can quickly be transformed into an oily, cloudy mixture. You're looking at a major cause of water pollution in local creeks and the San Francisco Bay: urban runoff.

Courtesy City of Bellevue "Stream Team Guidebook"



The discharge of pollutants from urban runoff during storms is far greater than any other source. Over the course of each year, our community storm drains dump more lead, copper, zinc, and other toxic substances into the bay than sewage treatment plant and industrial discharges combined. Other types of pollutants found in storm water runoff include litter, food waste, automotive fluids, construction material, and yard waste. This pollution can harm fish, birds and other wildlife. It can degrade the whole web of life in the bay, including human life. We are part of the food chain too!

How do pollutants get into storm drains? Most are washed off streets, parking lots, and paved areas during storms. Others are deliberately drained or dumped into streets, gutters, and inlets. Some come from illicit connections to the storm drain system, or when materials are spilled because of careless storage and handling practices.

State and Federal agencies have mandated a clean up of urban runoff pollution. Alameda County municipalities have joined forces and formed the Alameda County Urban Runoff Clean Water Program (ACURCWP). The other side of this flyer describes specific ways that work activities cause storm water pollution. If you have additional questions concerning urban runoff, call the ACURCWP at 670-5543.

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Major Causes of Urban Runoff Pollution

What day-to-day activities cause urban runoff pollution? Here are some of the biggest causes:

- *Using automobiles.* Particles in auto exhaust contain toxic organics and heavy metals. Dripping motor oil and wear from brake linings and tires deposit pollutants on streets and highways.

- *Maintaining vehicles.* Vehicle maintenance results in drips and spills of oil, coolant and other fluids. When performed outdoors, these fluids soak into asphalt and concrete pavements until they are washed away with the next storm. Water from washing vehicles outdoors carries pollutants directly to the nearest storm drain.

- *Allowing drainage from the shop floor to flow outside.* Allowing process or clean-up water to drain out onto the street is an often-seen practice that transports pollutants to the storm drain.

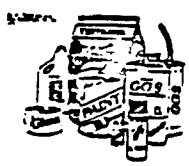
- *Cleaning tools or equipment outdoors.* Cleaning or rinsing containers, tools, floor mats or other items outdoors discharges pollutants such as chemicals, detergents, oils, etc.

- *Dumping wastes.* People looking for a "shortcut" to dispose of used oil, paint or other wastes dump them directly into storm drain inlets, causing pollution.

- *Landscaping and grounds maintenance.* Overuse, or indiscriminate use, of fertilizers and pesticides results in these materials running off landscaped areas into storm drains.

- *Allowing dumpster areas to become untidy.* Liquids that leak from dumpsters or garbage left outside the dumpster get washed away during a storm.

- *Building or remodeling facilities.* Disturbing soil and vegetation during construction greatly increases erosion; *sediment* is a pollutant. During construction, proper material handling and waste disposal is especially important because much of the work is performed outdoors.



Effects of urban runoff pollution

What are the consequences of these activities? The most immediate effects can be seen: many creeks have an oily sheen near storm drain outfalls, litter is left behind by receding waters after a storm, layers of oil-and-grease-laden sediments accumulate, dead animals are occasionally found on beaches.

But the most serious effects are more subtle. Some toxic substances affect critical life stages of certain organisms. Even if we do not usually see, or think about, these organisms (such as algae, or mussels) they are part of the food supply for other plants and animals, including fish and birds. Pollutants in the aquatic environment disrupt the food chain. Some toxins bioaccumulate, which means organisms further up the food chain will concentrate the toxins in their tissue. This is why the state health department has recommended restrictions on human consumption of some species of fish and birds found in the Bay. Other effects of urban runoff pollution include contamination of water supply sources and loss of recreational activities such as fishing, swimming, and boating.

People can still stop storm water pollution because people cause it. By making small changes in the way we live and work, we can reduce the pollution we produce.

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January 1994

Alameda County
Urban Runoff
Clean Water Program

A Consortium of Local Agencies

Restaurants

The ACURCWP *consists of the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, Union City, Unincorporated Alameda County, the Alameda County Flood Control & Water Conservation District, and the Alameda County Flood Control & Water Conservation District Zone 7.*

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Illegal Discharges or Connections are non-storm water discharges to municipal storm drain systems which contribute to water pollution.

Urban Runoff is rain and any other water that passes through and out of developed areas (streets, parking lots, roof tops, etc.) into the storm drain system and eventually to creeks and other waters.

Pollutants discharged to local creeks and S.F. Bay during storms or through illegal dumping significantly contribute to water pollution and toxicity to aquatic life. In response to recent Federal and State regulations and requirements, municipalities in Alameda County have joined to form the Alameda County Urban Runoff Clean Water Program (ACURCWP).

In addition to reviewing their own practices, municipalities in Alameda county have launched a public education campaign and inspection program and are working with commercial and industrial businesses to identify and control pollutants.

Based on a recent survey of retail food establishment inspectors in Alameda County, some restaurants have discharged washwater, grease and litter to municipal storm drain systems.

The table on the reverse side of this page identifies restaurant activities which contribute to urban runoff pollution and alternatives to control or eliminate these discharges.

If you have any questions concerning urban runoff, contact your program representatives at 670-5543.

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Suggested Best Management Practices

Activities	Best Management Practices
Pavement Cleaning	• Sweep parking lots and other paved areas periodically to remove debris. Dispose of sweeping in the garbage. • If outdoor pavement cleaning with detergent is required, collect washwater and dispose in indoor sinks or drains for discharge to the sanitary sewer. Contact your local wastewater treatment plant.
Equipment Cleaning (dumpsters, floor mats, exhaust filters, etc.)	• Discharge washwater to the sanitary sewer. Contact your local wastewater treatment plant. • If outdoor cleaning is required, collect washwater and dispose in indoor sinks or drains for discharge to the sanitary sewer. Contact your local wastewater treatment plant.
Spill Cleanup in Outdoor Areas	• Have spill containment kits ready in case of a spill and store kit in convenient locations. • Clean up any spills immediately using rags, cat litter, or any other type of absorbent in your spill kit. • If you must mop up a spill, dispose of mop/washwater in indoor sinks for discharge to the sanitary sewer.
Grease Handling and Disposal	• Store grease in separate, covered containers. Recycle grease or dispose at an appropriate landfill.
Waste Disposal	• Inspect dumpsters periodically. Have the leasing company repair or replace leaky dumpsters. • Cover dumpsters and other waste containers to prevent storm water from entering the container. • Never dispose of waste products, such as food wastes, to storm drains. • Use all paints, pesticides, cleaners, and other products or dispose as hazardous waste.
Litter Control	• Provide an adequate number of trash receptacles for your customers and employees. • Pick up litter and other wastes daily from outside areas including storm drain inlet grates.
Landscaping	• Minimize use of pesticides and fertilizers, and do not apply in wet weather. • Do not blow, rake, or sweep yard waste into the street or gutter. Compost yard waste or place in trash.
Training	• Train employees regularly on what to do in the event of a spill. • Designate a person responsible for effective implementation of BMPs. • Stencil inlets to discourage illegal dumping.

REFERENCES:
Alameda County Urban Runoff Clean Water Program, "Results of Survey of Retail Food Establishment Inspections," September 1992.
City of Bellevue Storm and Surface Water Utility, "Water Quality Protections for Food Businesses," March 1991.
City of Palo Alto, Food Handling Establishment Workgroup Best Management Practices, September 1993.

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Your Business and the City of Richmond Partners in Protecting the Bay

Steps You Can Take Now

Cover areas where potential pollutants are stored.

Pollutants such as trash, grease, paints, detergents and metals can come into contact with storm water or water from other sources and create polluted runoff. Keep these materials covered, labeled and stored in appropriate containers.

Seal leaking storage and dumpster containers.

Prevent substances like grease, liquids and food products from coming into contact with rainfall and entering the storm drains.

Prevent spills and leaks.

Maintain a regular inspection and repair schedule for vehicles and equipment. Take appropriate precautions in loading and unloading materials. Look for and correct any potential leaks or spills.

Develop plans to manage spills should they occur.

Clean any spills promptly, not allowing them to evaporate. Clean spills without water whenever possible. Rags, damp mops and dry absorbent materials are recommended for clean up. Dispose of any spill waste promptly.

Sweep parking lots and outdoor storage areas regularly.

Sweep these areas at least once per week to maintain a debris-free facility. Dispose of debris, do not sweep it into the gutter. Never hose off paved surfaces.

Landscape maintenance.

Pick up and properly dispose of waste, don't allow waste to be blown into the street gutter. Avoid over-irrigation and over-application of herbicides and pesticides that could create run-off to the storm drains.

Know your waste hauler's practices.

Avoid waste haulers that accept your payment and dump your waste illegally. You are liable for illegal dumping of your waste. Your waste should be disposed of at a landfill or other appropriate facility.

Recycle or dispose of fluids properly.

Many automotive fluids can be recycled, others must be disposed of as hazardous materials. For photo processors, treat spent chemicals on site to remove silver.

Wash vehicles and equipment in designated areas only.

Wash areas must be paved and filted to drain only to sanitary sewers. A commercial car wash may be an alternative if your facility is not properly equipped.

Label storm drain inlets.

Stenciling storm drains alerts employees and customers that no dumping is allowed. Contact Ray Ardoin at the City to arrange for stenciling of storm drains near your facility: (510) 231-3000.

Inspect storm drain inlets periodically.

Prevent accumulated pollutants from washing down storm drains on your property by periodically inspecting, removing and properly disposing of any debris.

Check for and correct illicit connections to storm drains.

Any discharged waste water must be carried by the sanitary sewer to a treatment plant, never by storm drains to waterways.

Educate customers and train employees to implement storm water management practices.

Post notices of appropriate practices, provide convenient disposal containers and train employees to implement these management practices.

Additional information.

The California Integrated Waste Management Board Recycling Hotline offers information on local recycling services: (800) 553-2962.

If you would like more information about the City of Richmond's Storm Water Management Program, please call Steve Linsley of the City of Richmond at (510) 231-3060.

Richmond Storm Water Management Program

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R0035301

STORMWATER BMPS FOR FOOD HANDLING FACILITIES

Food handling facilities such as restaurants, grocery stores, delicatessens, taverns and bakeries contribute pollutants to stormwater primarily through improper cleanup practices. Types of pollutants from food handling facilities include grease, oil, food particles and cleaning products. The best management practices (BMPs) that follow are to be implemented by the permittee:

SPILL PREVENTION AND CLEANUP

1. Identify which drains are connected to the sanitary sewer and which are connected to the storm drain system.
2. Block spills from entering a storm drain with absorbent pillows or rags. The drain can be temporarily sealed with plastic sheeting or a rubber mat.
3. Dry clean-up methods should be used whenever possible. Dry sweep spills first and use rags or granular absorbent (e.g., cat litter) to absorb the liquid.
4. Only use a minimum amount of water to wash or rinse the area. Dispose of the water in the sink. Do not use cleansers if working outside and there is a potential for rinsewater to flow to a storm drain.

EQUIPMENT CLEANING

1. Clean equipment (e.g., hood filters, floor mats, grills) indoors in a mop sink or floor area with a drain connected to the sanitary sewer.
2. If necessary, equipment may be cleaned outdoors if the area is covered and bermed to prevent spills to a storm drain. The bermed area must have a drain to the sanitary sewer.
3. Minimize the use of harsh cleaning products such as bleach and ammonia where accidental discharge to the storm drain is possible. Even "biodegradable" materials may be toxic to aquatic life.

GREASE HANDLING AND DISPOSAL

1. Recycle cooking oil, grease and meat fat by contracting with a recycler. Designated tallow bins or sealed containers should be used for storage before recycling. Never dispose of oily sauces, grease, cooking oil or meat fat into storm drains, sanitary sewer drains or dumpsters.
2. Inspect and clean all grease traps and interceptors regularly (skim smaller traps weekly and clean quarterly, larger traps and interceptors should be pumped quarterly). Waste grease should be disposed of properly by a waste grease hauler.

DUMPSTER AND RECEIVING AREAS

1. Dumpsters must have a lid and be leak-proof. Tallow bins must be tightly sealed.
2. Never dispose of liquids or leaking garbage bags into dumpsters or compactors. Apply absorbent to liquids spilled into dumpsters. Never hose out dumpsters or the receiving area. Dumpsters that leak or require cleaning should be replaced by the leasing company.
3. Control litter and spills around the dumpsters and receiving area.

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R0035302

STORMWATER BMPS FOR RESIDENTIAL PAINTERS

Residential painters contribute pollutants to stormwater primarily through improper paint application, cleanup and disposal practices. Types of pollutants from painters include overspray, waste paint and cleaning solvents. No paint or painting wastes should ever be discharged to the storm drain system. The best management practices (BMPs) that follow are to be implemented by the permittee:

SITE PREPARATION

1. Drop cloths should be used during all painting operations including scraping, sandblasting, spraying, brushing, mixing, and storage to prevent spills.
2. Exterior cleaning of buildings should be done with water only, or a mild soap if necessary. Prevent all wash water from entering storm drains and the street.
3. Scraping or sandblasting waste should be collected on tarps or dry swept, then properly disposed of (as hazardous waste if paints contain lead). Drop cloths covering landscaping, grass and bare soil will facilitate complete recovery of waste material.

PAINT APPLICATION

1. Use water base, non-metal base paints whenever possible
2. Minimize the amount of paint used by adjusting application rates to fit the job. Overspray contributes to air and stormwater pollution. As little as 30 percent of paint from airless sprayers reaches the target. Consider using other methods of application such as electrostatic spray systems, brushes, or rollers.
3. Mix only as much paint as needed for the job. Save off-color excess paint to use as base paint for other jobs.
4. Consider weather conditions before beginning spray operations. Winds increase the amount of overspray and cleanup necessary. Winds vary during the day depending on the time of year, adjust your schedule accordingly.

CLEANUP

1. Use water base (latex) paints whenever possible to limit the amount of solvents needed for cleanup.
2. Latex paint should be wiped out of brushes and sprayers and cleaned in a sink that drains to the sanitary sewer. Equipment should also be dry-wiped of oil base paint then cleaned in a solvent tank or other designated area indoors.
3. Spills of paint or solvent should be wiped up with rags. Large spills (>5 gallons) of paint or solvent onto soil should be reported immediately to the Fire Department.

STORAGE

1. All paint and solvent supplies must be stored indoors or under cover.
2. On the job site, during transport and in the shop all paint and solvent containers must be closed tightly to reduce evaporation to the atmosphere and prevent spills.

RECYCLING AND DISPOSAL

1. Thinners and solvents should be filtered for reuse.
2. A legally licensed service must be contracted to recycle or dispose of hazardous waste such as used shop rags, hazardous particulates, and waste paint and solvents.

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STORMWATER BMPS FOR LUMBER DEALERS

Lumber dealers, including lumber yards, woodworkers and cabinet builders, contribute pollutants to stormwater primarily through improper cleanup practices. Types of pollutants from lumber dealers include sawdust, wood scrap, glues and preservatives. The best management practices (BMPs) that follow are to be implemented by the permittee:

HOUSEKEEPING

1. Use dry cleaning methods whenever possible. Sweep all sawdust and wood scraps. Granular absorbent (e.g., cat litter) or rags should be used to clean up liquids.
2. Minimize the use of water during cleanup and never permit wash water or rinse water to enter the street or storm drains. Organic debris in waterways increases the biological oxygen demand (BOD) which lowers the oxygen available for aquatic life. Preservatives such as creosote are toxic to aquatic life and may leach out of sawdust.
3. Sawdust hoppers and vacuum systems should be maintained to maximize sawdust collection and prevent spillage.
4. Wood scraps and sawdust should be recycled. Segregate mill wastes to ensure proper and efficient recycling. Pressure treated wood and preserved wood contain toxic chemicals that must be handled appropriately. Untreated wood scrap and sawdust may be used for compost and landscaping, or reused as a fuel supplement for wood burning stoves or boilers.

EQUIPMENT CLEANING AND MAINTENANCE

1. Forklifts and other vehicles should be parked under cover and drip pans should be placed under each vehicle to prevent hydraulic fluid, oil and other liquids from draining to pavement.
2. Electric saws, planers, routers and hand tools should be cleaned with a minimum amount of solvent and cleanser. All cleaning of equipment should occur indoors and proper containment of solvents should be practiced. Absorbent pads or rags should be present whenever solvents are being used.

STORAGE AND DISPOSAL

1. Pressure treated and preserved wood should be stored under cover or inside to prevent toxins from leaching out of the wood and into the storm drain system. Do not accept wood if it is still wet with chemicals or not sufficiently air or kiln dried.
2. Solvents, lubricants, cleansers and other chemicals should be properly stored as hazardous materials in a sealed locker or double contained and under cover. The double containment requirement is 110% for one container; for multiple containers, 150% for the largest container or 110% for total gallonage.
3. Shop rags used for spill cleanup or equipment maintenance must be kept in a covered can marked "Flammable" and disposed of as hazardous waste by a contractor.
4. Material Safety Data Sheets (MSDSs) for all chemicals used on site, must be maintained on site, accessible to all employees and available to pretreatment personnel.

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STORMWATER BMPS FOR NURSERIES AND LANDSCAPERS

Nurseries and landscape contractors contribute pollutants to stormwater primarily through improper cleanup and disposal practices, and pesticide application. Types of pollutants from nurseries and landscapers include organic waste, and insecticides and herbicides. The best management practices (BMPs) that follow are to be implemented by the permittee:

INSTALLATION

1. Install native vegetation or low maintenance grasses and shrubs whenever possible to minimize water needs and mowing/trimming.

CHEMICAL APPLICATION

1. Minimize the use of insecticides, fertilizers and herbicides whenever possible.
2. Use up pesticides, rinse the containers, and use the rinsewater to apply to plants.
3. Never apply chemicals when rain or irrigation will wash chemicals from the target plants or area into the storm drain. Anticipate changes in the weather to prevent pollution.

MOWING AND TRIMMING

1. Clippings from mowing and trimming should be minimized by cutting less often and using a mulching mower on flat areas.
2. Clippings should be bagged or picked up from sloped surfaces and all pavement. Protect storm drain catch basins with a tarp before mowing. Mowing should not occur prior to large rain events.

IRRIGATION

1. Irrigation rates should be adjusted to minimize overspray and overwatering.

EQUIPMENT MAINTENANCE

1. Trucks, tractors, forklifts, gas-powered trimmers, mowers and pesticide sprayers should be well maintained to prevent leaks of hazardous materials.
2. Vehicles and equipment should be stored indoors or under cover. Equipment stored outside should have drip pans to minimize spills to the storm drain system.

STORAGE AND DISPOSAL

1. All hazardous materials (e.g., fertilizer, pesticides, fuel) and materials with the potential to flow into storm drains (e.g., clippings, fill, gravel) should be under cover. Liquids should be double-contained and absorbent materials should be available for potential spills.
2. Dispose of rinsed containers of pesticide and fertilizer as trash. Dispose of unused pesticides and fertilizer as hazardous waste through a licensed waste hauler.
3. Clippings should be collected for composting. Tree trimmings should be chipped and either reused in landscaping or recycled as compost.

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Attachment D

THE ENVIRONMENTAL EDGE

WINTER 1995

GOVERNMENT AND INDUSTRY IN PARTNERSHIP TO PROTECT OUR ENVIRONMENT

VOL 12

UNION SANITARY DISTRICT WELCOMES VAUGHN HENRIE

In September 1994, the District's Environmental Compliance Division welcomed Vaughn Henrie as supervisor of the Pretreatment Section. Vaughn's transfer from the District's Operations Department followed Gary Zanardi's retirement. Vaughn brings over 19 years of experience and knowledge in wastewater treatment and environmental compliance with him to his new position, and is a valuable addition to the Division.

Vaughn began his career at Union Sanitary District as a wastewater treatment plant operator. After nine months, he moved into the laboratory and worked as a laboratory analyst for six years. Then, wanting to get experience as an Industrial Waste Inspector, he moved into the Waste Source Control Division, as it was known then, and worked for four years as an inspector. For the next five-and-a-half years, Vaughn worked as a supervisor at the District's wastewater treatment plant. In the meantime, the Waste Source Control Division began to grow due to new regulatory programs and changed their name to Environmental Compliance Division. Vaughn's experience as an inspector allowed him to help Environmental Compliance when they were shorthanded. Because he has always enjoyed the environmental compliance field, he was pleased when the chance came to transfer back into Environmental Compliance as the Pretreatment Section Supervisor.

Vaughn has a diverse background: from plant operations and laboratory analyses to work with the pretreatment program as an inspector. He feels this experience helps him understand and relate to the various facets of the complex environmental regulation field. Vaughn enjoys a variety of outdoor activities and therefore has very strong feelings about protecting our environmental heritage. He looks forward to working with everyone in the Tri-Cities Area to achieve these goals. Vaughn's phone number is (510) 790-0100 extension 235.

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COUNTY ENVIRONMENTAL HEALTH OFFERS ONSITE ASSISTANCE

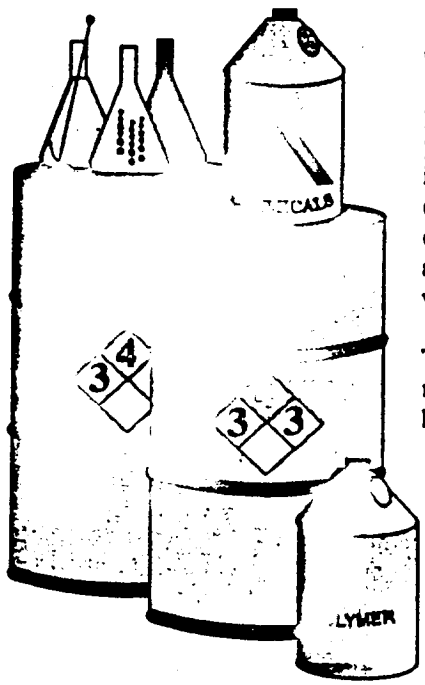
By: Paul M. Smith

Hazardous Materials Specialist
Alameda County Health Agency

Few business operators would consider ASKING a government inspector to spend extra time at their facility. Yet, a new approach developed by Alameda County Environmental Health Department is countering this way of thinking. Since 1991, the Department has performed over 150 onsite hazardous waste reduction assessments with small businesses. The aim is to identify strategies for businesses to cut hazardous waste while complying and saving money.

The convenience and site-specific nature of the assessment accounts for its appeal. Assessments are offered as an optional "add-on" to the hazardous waste compliance inspection. Auto repair, construction, photo processing, dry cleaning, printing, and metal-finishing businesses have been the primary recipients. The County is prepared to offer assistance to other industry types as well.

The assessment takes 30 minutes to an hour. During this time, the inspector and facility representative work as a team. Together, they identify processes and waste streams, then discuss possible waste reduction techniques that make sense for the business. The final product is one to five specific suggestions that are feasible for the business operator and are in compliance with the regulations. The business is under no obligation to implement any of the suggestions. Despite this, most past participants have implemented some, if not all, suggestions.



Most strategies identified through the assessment process are cheap and easy to implement, yet pay big waste reduction and compliance dividends. For example, many participants with maintenance shops initially used grease-sweep for waste oil clean-up. When other methods, like oil-absorbent pads, were identified and put into use, companies immediately began to see a drop in volume or complete elimination of contaminated absorbents as a hazardous waste stream.

To set up an onsite assessment, call your county hazardous waste inspector at (510) 670-6700 or Pamela Evans at (510) 670-6770.

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆

SAN JOSE GETS STATE PERMITTING OFFICE

The California Environmental Protection Agency (Cal/EPA) has opened its eighth office to assist local businesses in complying with state and local environmental permitting requirements. The office, which is currently located at 2220 Moorpark Avenue in San Jose, will be staffed by representatives of the Department of Toxic Substances Control, the Bay Area Air Quality Management District, the San Francisco Bay Regional Water Quality Control Board, and the Santa Clara County Department of Environ-

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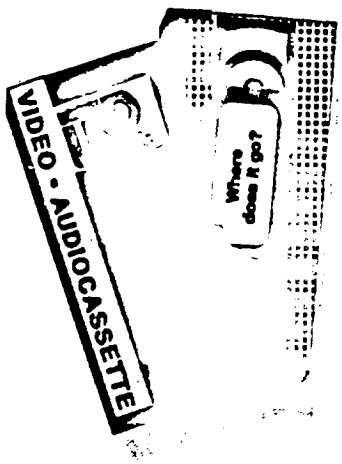
mental Health. This is the first such office in the Bay Area. The only other one in Northern California is located in Fresno. The office is scheduled to relocate next year to 1887 Monterey Highway. For more information, call (408) 299-6060

ENVIRONMENTAL VIDEOS TO LEND

The District has several environmental videos for loan to interested businesses, schools and other groups. The most recent addition to the video collection is "A Clear Solution", a Storm Water Pollution Prevention employee training video developed by EXCAL Visual Communications of Boulder, Colorado. The program includes a Trainer's Guide and reproducible training materials. The 24-minute video summarizes the Clean Water Act and the National Urban Runoff Program, discusses the goals of a Storm Water Pollution Prevention Plan, gives specific examples of possible storm water hazards and suggests appropriate Best Management Practices (BMPs).

Other available videos are:

Where Does it Go?
(12 minutes)
Kids talking to kids about what happens to water and pollutants that are discharged to the sanitary and storm drains.
Produced by Central Marin Sanitary District. Appropriate for children in grades 3-6.



H_2O TV
(12.5 minutes)
Explains the natural water cycle and how it is affected by industrial and urban life. Includes an explanation of primary, secondary, and advanced treatment plant process. Also includes some good aerial views of the Bay Area and the Palo Alto treatment plant.
Produced by the Palo Alto Regional Water Quality Control Plant and the SF Bay Pollution Prevention Group.

The Urban Runoff Story
(15 minutes)
Explains the sources of urban runoff and the different fates of water discharged to the storm drain vs. the sanitary sewer. Includes legislative background on the urban runoff program, a description of the Alameda County program, and suggestions on preventing urban runoff pollution. Produced by the Aquatic Habitat Institute for the Alameda County Urban Runoff Program.

IAC SPONSORS WORKSHOP

Union Sanitary District's Industrial Advisory Council (IAC) is sponsoring a one-day workshop on Tuesday, March 21, 1995 for the industries and commercial businesses in Southern Alameda County. The all-day workshop, which will be held at Choices in Fremont, will feature presentations that are designed to provide the attendees with guidance and practical information for meeting today's regulatory requirements. Speakers will include members of the IAC, USD staff, regulators, and representatives from industry.

An important part of the program is the willingness of the speakers from local industries to share the expertise and training techniques that they have successfully used to keep their firms in compliance with federal, state and local regulations. The workshop will also feature a presentation by Steve Hayashi, USD's General Manager, on the District's organizational change effort. This effort, which includes a greater outreach to industry and other users within the District, has been recognized this past year at several national conferences.
There is no charge for attending the workshop, which includes lunch. However, due to limited seating, early registration is strongly recommended.

See back cover for additional informatiom

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For additional information or to obtain registration materials, please call :

Adrianne Roletto
(510) 790-0100, extension 232.

Environmental Assistance for Local Business

A Conference for Industry by Industry

Tuesday March 21, 1995 8:30 a.m. – 4.00 p.m.

CHOICES OF FREMONT
5388 Farewell Place
Fremont, CA. 94536

Sponsored by: Union Sanitary District's Industrial Advisory Council

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆

Union Sanitary District
37532 Dusterberry Way
Fremont, CA 94537
Address Correction requested

AGENDA

- **8:30a.m. Registration & Coffee**
- **Opening Remarks**
  Thomas Handley, Fuji TruColor
- **Keynote Speaker**
  Stephen Hayashi, USD
- **Spill Reporting**
  Ken Slaman, Fremont Fire Dept.
  Dave Livingston, USD
- **Stormwater Management**
  Donna Wies, USD
  Dale Bowyer, RWQCB
  Jane Burns, Evergreen Oil
  Panel Discussion

Complimentary Lunch & Speaker
Dan Wilkowsky, Chair,
USD Board of Directors

- **Pollution Prevention/Waste Min.**
  Janet Burggraf, Seagate Magnetics
  Michael Planer, Read-Rite Corp.
- **Quality Assurance, Auditing, & Training**
  Stuart Rupp, NUMMI
- **Closing Remarks**
  Jerry Galleway, Inland Container

Printed on Recycled Paper

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Appendix K

Example Stormwater Inspection Data Forms

1) General Industrial and Commercial Business Inspection Forms and Checklists:

   - Alameda Countywide Clean Water Program
   - Solano County Environmental Management/Fairfield-Suisun Sewer District
   - City of San Jose
   - Fresno Metropolitan Flood Control District
   - City of Richmond

2) Automotive Industry Inspection Forms

   - City of Manhattan Beach

3) Restaurant/Food Handling Facility Inspection Forms

   - City of Manhattan Beach
   - Solano County Environmental Management/Fairfield-Suisun Sewer District
   - San Mateo Countywide Stormwater Pollution Prevention Program

4) Santa Clara Valley Nonpoint Source Inspection Notice and Facility Inspection Guidelines, February 1996

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Alameda Countywide
Clean Water Program

Standard Stormwater Facility Inspection Report Form

Municipality: _____

Date: _____

Reason for Inspection: ☐ First Inspection ☐ Routine Inspection ☐ Response to Complaint ☐ Facility has closed or Facility information has changed

NAME OF FACILITY		SITE ADDRESS	
CONTACT NAME	PHONE	BUSINESS TYPE/ACTIVITY	SIC

Is the property owner different than the facility owner? ☐ yes ☐ no If yes, complete the following:

NAME PHONE

MAILING ADDRESS

Is the facility covered under any other programs or permits? (Check all that apply.) ☐ None

☐ Air quality ☐ Hazmat business plan ☐ Underground storage tanks ☐ Sanitary sewer

☐ Fire department(hazmat storage) ☐ Hazmat waste generator ☐ Other _____ ☐ Aboveground storage tanks

Is the facility covered under a storm water permit? ☐ Does not need Coverage ☐ No, but may need to be (Refer to Regional Board)

☐ Individual ☐ General: Does the facility have a SWPPP? ☐ yes ☐ no

N/A = Not Applicable; PTNL = POTENTIAL for Pollutant Discharge: 1 = low potential, 2 = medium potential, 3 = high potential
ACTUAL Type of Discharge: BMP: 0 = BMPs are effective, 1 = BMPs are fairly/almost effective, 2 = BMPs are not effective, 3 = No BMPs are implemented
PEX = Pollutant Exposure, NSW = Non-Stormwater Discharge

AREAS OF ACTIVITY	N/A	PTNL	ACTUAL Type of Discharge			REMARKS: Describe recommendations, requirements, and time to implement. Check box if remark is a *requirement*.
			BMP	PEX	NSW	
A. Outdoor Process/Manufacturing Areas						☐
B. Outdoor Material Storage Areas						☐
C. Outdoor Waste Storage/Disposal Areas						☐
D. Outdoor Vehicle and Heavy Equipment Storage, Maintenance Areas						☐
E. Outdoor Parking Areas and Access Roads						☐
F. Outdoor Wash Areas						☐
G. Rooftop Equipment						☐
H. Outdoor Drainage from Indoor Areas						☐
I. Other (describe):						☐

ADDITIONAL COMMENTS/REMARKS

☐ See attached for more comments

FIRST Follow-up Inspection (Date & Findings)

SECOND Follow-up Inspection (Date & Findings)

PRIORITY FOR RE-INSPECTION: ☐ 1; First ☐ 2; Second ☐ 3; Third

ENFORCEMENT: ☐ None ☐ Verbal Notice ☐ Warning Notice ☐ Administrative Action ☐ Administrative Action w/Penalty ☐ Legal Action

Facility Representative Signature: _____ Date _____

Print Name of Facility Representative: _____ Inspector's Signature: _____

EOA, Inc. (F:\AL49-10.2\INSP RPT, February 1996)

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CITY OF SAN JOSE
ESD/ENVIRONMENTAL ENFORCEMENT DIVISION
NON POINT SOURCE FACILITY INSPECTION AUDIT FORM

..lity Name: _____

File No: _____

Inspection Date:

Inspection Type: (Please circle one) Initial/Follow-up Inspection 1 2 3 4 5

Sec.	Yes	Vio	GENERAL SWPPP INFORMATION
2-1	[ ]	[ ]	SWPPP on site.
2-2	[ ]	[ ]	Facility covered under NPDES stormwater permit.
2-3	[ ]	[ ]	NOI filed.
2-4	[ ]	[ ]	SWPPP identifies all potential pollutants.
2-5	[ ]	[ ]	Employee training program mentioned in SWPPP.
2-6	[ ]	[ ]	Spill prvention plans adequately covered.
2-7	[ ]	[ ]	(if not covered in HMMP) SWPPP includes signed statement of certification.
2-8	[ ]	[ ]	BMP'S identified.
2-9	[ ]	[ ]	SWPPP needs improvement

Sec.	Yes	Vio	MONITORING PROGRAM:
3-1	[ ]	[ ]	Storm water sampled.
3-2			Method: [ ]composite [ ]grab [ ]other
3-3			Frequency:
3-4			Last sampling date: _____
3-5			Parameters tested: [ ]oil/grease [ ]PH [ ]TSS [ ]conductivity [ ]metals [ ]other
3-6	[ ]	[ ]	Spill procedure for indoor and outdoor spills.
3-7	[ ]	[ ]	Outfalls or drainage troughs on site.

Sec.	Yes	SWPPP REVIEW CHECKLIST
4-1	[ ]	North arrow
4-2	[ ]	Property boundaries
4-3	[ ]	All adjacent streets
4-4	[ ]	Buildings
4-5	[ ]	Outside process/manufacturing areas.
4-6	[ ]	On site paved and unpaved.
4-7	[ ]	Property borders -paved/unpaved.
4-8	[ ]	Storm drain inlets;CB's, area drains.
4-9	[ ]	Sanitary sewer drains/labeling of Ind. waste & lines.
4-10	[ ]	Outdoor storage areas [ ]covered [ ]uncovered
4-11	[ ]	Discharge points to surface water ie;creeks, ponds,etc.
4-12	[ ]	Outdoor solid waste receptacles.
4-13	[ ]	Outdoor equipment storage.
4-14	[ ]	Parking areas.
4-15	[ ]	Fueling areas.
4-16	[ ]	Surface/subsurface water bodies.
4-17	[ ]	French drains/SWID
4-18	[ ]	Manholes(sanitary ,storm).

Sec.	Yes	Vio	BMP's
5-1	[ ]	[ ]	Established
5-2	[ ]	[ ]	Compliance
5-3	[ ]	[ ]	Illegal Plumbing/Illicit Connection
5-4	[ ]	[ ]	House keeping
5-5	[ ]	[ ]	Equipment/floor washing indoor

Sec.	Yes	Vio	OUTDOOR ACTIVITIES
6-1	[ ]	[ ]	Air compressors
6-2	[ ]	[ ]	Boiler
6-3	[ ]	[ ]	Clarifiers
6-4	[ ]	[ ]	Compactors /refuse bins
6-5	[ ]	[ ]	Construction Activities
6-6	[ ]	[ ]	Cooling Towers
6-7	[ ]	[ ]	Defrost Water
6-8	[ ]	[ ]	Dewatering wells
6-9	[ ]	[ ]	Dust, process residues
6-10	[ ]	[ ]	Equipment Cleaning (indoor/outdoor)
6-11	[ ]	[ ]	Equipment storage yard
6-12	[ ]	[ ]	Erosion/Soil/Gravel
6-13	[ ]	[ ]	Exterior floor washing
6-14	[ ]	[ ]	Floor mat washing(restaurants)
6-15	[ ]	[ ]	French drains /SWID
6-16	[ ]	[ ]	Grease interceptors/Tallow container
6-17	[ ]	[ ]	Industrial waste-pretreatment facilities
6-18	[ ]	[ ]	Irrigation runoff
6-19	[ ]	[ ]	Litter Control
6-20	[ ]	[ ]	Non hazardous substance-storage/handling
6-21	[ ]	[ ]	Pesticide/herbicide application
6-22	[ ]	[ ]	Pools/Fountains
6-23	[ ]	[ ]	Railroad spur drains
6-24	[ ]	[ ]	Reverse osmosis system/D.I.
6-25	[ ]	[ ]	Roof (air scrubbers)
6-26	[ ]	[ ]	Roof (leaking equipment)/Other
6-27	[ ]	[ ]	Shipping/receiving/dock
6-28	[ ]	[ ]	Steam cleaners/Pressure washers
6-29	[ ]	[ ]	Stockpiles
6-30	[ ]	[ ]	Sumps and Pumps
6-31	[ ]	[ ]	Transformers
6-32	[ ]	[ ]	Vehicle cleaning/Maintenance
6-33	[ ]	[ ]	Outdoor Storage
6-34	[ ]	[ ]	Recycle Bins
6-35	[ ]	[ ]	other:

NPS PLEASE RETURN COMPLETED YELLOW COPY TO: Nonpoint Source Microprocessing

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Solano County Environmental Management/Fairfield-Suisun Sewer District
Storm Water Pollution Control
Standard Industrial and Commercial Inspection Checklist

Date: _____
Facility Name: _____
Facility Address: _____
Contact Person: _____ Telephone No.: _____
Type of Business: _____ SIC Code: _____
Time to Perform Storm Water Portion of Inspection: _____ hours
Describe outreach/educational information provided by inspector:
[ ] General Brochure [ ] Industrial Brochure [ ] Verbal
[ ] Other (describe): _____

Is establishment in compliance with storm water requirements? ——> [ ] Yes [ ] No
(If no, please complete information below)

- Is the facility required to have an Industrial Storm Water Permit? [ ] Yes [ ] No
- Does the facility have an Industrial Storm Water Permit? [ ] Yes [ ] No
- Does the facility have a Storm Water Pollution Prevention Plan? [ ] Yes [ ] No
- Are follow-up activities required? [ ] Yes [ ] No
  If yes, level of response required: [ ] Immediate [ ] As time permits

- For each activity area, check the numerical code best describing the potential discharge level to the storm drains and the letter code best describing the potential discharge type found.

Activity Area	Discharge Level				Discharge Type			
Check as Appropriate ——>	0	1	2	3	A	B	C	D
Outdoor Materials Storage Areas								
Process Equipment Drains/Floor Drains								
Waste Disposal Areas								
Rooftop Equipment								
Parking Areas and Access Roads								
Repair and Maintenance Areas								
Vehicle/Equipment Wash Areas								
Other Area:								

Potential Discharge Level
0 - Not applicable for facility
1 - Little potential for pollutant discharge to storm drains
2 - Some potential for pollutant discharge to storm drains
3 - Great potential for pollutant discharge to storm drains

Potential Discharge Type
A - Illicit connection
B - Where drain discharges unknown
C - Area and/or material exposed to rain
D - Other (specify in comment section)

Comments and conclusions:

_____
_____
_____
_____
_____
_____
_____

Signature: _____

Inspection Form for Industries/Revised: February 9, 1996

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INSPECTION CHECKLIST FOR POTENTIAL CISWICP PARTICIPANTS

Facility _____ Date _____ Inspector _____

Inspect the facility for the following BMPs and indicate the presence and effectiveness of the BMPs. Take notes that will be useful for your review of the facilities required to submit a SWPPP. BMPs that are frequently found to be appropriate are noted.

BMPs	In Place?	Effective?	Notes
Waste Handling & Disposal -dumpsters covered or sealed -haz waste stored/disposed properly			
Outdoor Storage -all pollutants covered or contained			
Washdown Procedures -outdoor washdown eliminated/contained			
Housekeeping -outdoor areas swept weekly -drains clear of debris			
Vehicle Maintenance -drip pans outdoors -cleaning areas drain to sanitary sewer			
Storm Water Control and Discharge Structures -note location(s) -note adequate maintenance			
Loading/Unloading -note potential for spills to storm water			
Potential Soil Erosion -sediments minimized to storm water			
Spill Prevention and Control -absorbent available -pavement stains removed			
Employee/Tenant Education -all receive info on storm water protection			

☐ Facility not required to submit SWPPP. All mandatory BMPs in place and effective

☐ Facility required to submit SWPPP. One or more mandatory BMPs are missing or ineffective.
SWPPP must be received by Public Works no later than _____ (30 days after this inspection)

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File No. 510.1714

STORM WATER QUALITY MANAGEMENT INSPECTION REPORT

Fresno Metropolitan Flood Control District
Storm Water Quality Management Program
5469 E. Olive, Fresno, CA 93727
(209) 456-3292

Date of Inspection: _____

Inspector: _____

Facility Name: _____

Site Address: _____ Drainage Area: _____

Mailing Address: _____

Owner/Operator: _____ SIC: _____

Business Type or Activity: _____

Federally regulated NPDES storm water site

- ☐ YES Mandatory
- ☐ YES Storm water exposed to industrial processes
- ☐ NO

- ☐ Has filed an NOI
- ☐ Has a SWPPP
- ☐ SWPPP is being implemented

Type of Inspection: ☐ Routine ☐ Reinspection ☐ Complaint

Comments or Identified Problems:

_____

Corrective Actions:

_____

Corrective actions must be implemented within _____ days.

☐ Reinspection Necessary. Reinspect After _____

Owner/Operator Signature _____ Date: _____

Inspector's Signature _____ Date: _____

Clean Storm Water

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CITY HALL 1400 HIGHLAND AVENUE MANHATTAN BEACH, CALIFORNIA 90266
TELEPHONE (310) 545-5621 FAX (310) 545-5234

OCEAN SAFE PRACTICES FOR THE AUTOMOTIVE INDUSTRY

The purpose of this form is to provide automotive-industry owners and operators with information on how to reduce discharge of wastewater and polluted storm water run-off to the storm drain system. Please complete this checklist so the needs of your facility can be properly assessed. The following items can be done by following the recommendations in the Best Management Practices for Automotive-Related Businesses booklet.

1. Employee training and education at your establishment should include the following:
   - education about proper maintenance of equipment and tools;
   - disposal of hazardous materials and waste water;
   - recycling procedures;
   - facility sweeping and cleaning procedures;
   - maintenance of oil and water clarifiers; and
   - enforcement (i.e., regulations & penalties). _____ (initial)

2. The proper maintenance and cleaning of tools & equipment: Equipment is maintained to prolong its life span. Tools are cleaned in a centralized area where fluids are contained and properly disposed of. _____ (initial)

3. Proper disposal of hazardous materials & waste water: Use of containers to collect the hazardous materials on-site. Use of a utility sink to dispose of all waste water. _____ (initial)

4. Debris inside and outside the facility is swept up and properly disposed of in a trash or recycling receptacle. The area surrounding the receptacle(s) is maintained daily. Receptacles have covers which are always closed. _____ (initial)

5. Recycling: glass, cardboard, paper, plastic & metals are collected in separqate receptacles at the facility and are regularly collected for recycling. _____ (initial)

6. Utility sinks, floor drains, and oil/water clarifiers (if applicable) are maintained and cleaned out regularly. _____ (initial)

7. Informational meetings are held to inform employees of regulations and penalties at the local, State, and Federal levels. _____ (initial)

Establishment/Location: _____

_____

Sign: _____ Date: _____

FIRE DEPARTMENT ADDRESS: 400 15TH STREET, MANHATTAN BEACH, CA 90266 FAX (310) 545-8925
POLICE DEPARTMENT ADDRESS: 420 15TH STREET, MANHATTAN BEACH, CA 90266 FAX (310) 545-7707
PUBLIC SERVICES DEPARTMENT ADDRESS: 3621 BELL AVENUE, MANHATTAN BEACH, CA 90266 FAX (310) 546-1752

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OCEAN SAFE PRACTICES FOR RESTAURANTS

The purpose of this form is to provide the restaurant owners and operators with information about how to eliminate discharge of waste water into the storm drain system. Please take a few minutes to fill out this checklist so that the needs of your facility can be properly assessed.

1. Employee training at your establishment includes education about the proper cleaning of floor mats, the correct disposal of food particles and waste water, and the disposal of entry-way and sidewalk sweepings into trash receptacles.

   Cx (initial)

2. Kitchen and bar floor mats are cleaned within the premises and not outside the building in streets, alleyways or sidewalks.

   Cx (initial)

3. A mop sink is available inside the facility that may be used to clean floor mats, mops and receive waste water.

   _____ (initial)

4. If there are no mop sinks or floor drains in the facility, mats are cleaned by a janitorial service off the restaurant site.

   Cx (initial)

5. Glass, cardboard, paper, plastic and metal are collected at the restaurant for recycling.

   Cx (initial)

6. All trash cans, trash bins and other trash receptacles have covers and are tightly sealed.

   Cx (initial)

7. The areas surrounding trash receptacles are maintained and cleaned daily.

   Cx (initial)

8. Grease traps and grease interceptors are maintained and cleaned out on a regular basis.

   Cx (initial)

(signature)

4/13/94
(date)

After you have completed this checklist, please contact one of our representatives so that a site visit and discussion of this form can be arranged. Please call (310) 545-5621 extension 424.

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Solano County Environmental Management/Fairfield-Suisun URMP
Storm Water Pollution Control

Food Handling Establishment Inspection Checklist

Date: _____

Establishment Name: _____

Establishment Address: _____

Contact Person: _____ **Telephone No.:** _____

Is establishment in compliance with storm water requirements? ——> [ ] Yes [ ] No
(If no, please complete information below)

General:

Time to Perform Entire Inspection: _____ minutes
Time to Perform Storm Water Portion of Inspection: _____ minutes
Are follow-up activities required? ——> [ ] Yes [ ] No
If yes, level of response required: [ ] Immediate [ ] As time permits
Outreach/educational information provided by inspector:
[ ] General Brochure [ ] Food Handling Brochure [ ] Verbal
[ ] Other (describe): _____

Areas:

Outdoor Trash Disposal Areas:

Dumpsters covered ——> [ ] Yes [ ] No
Dumpster sealed (no signs of leakage) ——> [ ] Yes [ ] No
Dumpster enclosure clean, drains to the sanitary sewer ——> [ ] Yes [ ] No
All trash stored in dumpster (no paint cans, furniture, etc.) ——> [ ] Yes [ ] No
Tallow recycled ——> [ ] Yes [ ] No
Tallow bin located away from storm drains ——> [ ] Yes [ ] No
Tallow bin clean, covered, in good repair, and serviced regularly --> [ ] Yes [ ] No
Date of last service: ——> _____

Other Areas:

Sanitary sewer grease interceptor installed ——> [ ] Yes [ ] No
Sanitary sewer grease interceptor regularly maintained ——> [ ] Yes [ ] No
Date of last maintenance: ——> _____
Only air conditioner condensate drains from roof top equipment --> [ ] Yes [ ] No
Mop sinks drain to sanitary sewer ——> [ ] Yes [ ] No

Other: _____

Activities:

Cleaning:

Washwater from floor mat cleaning goes to sanitary sewer ——> [ ] Yes [ ] No
Washwater from screen/baffle filter cleaning goes to sanitary sewer [ ] Yes [ ] No
Washwater from floor cleaning goes to sanitary sewer ——> [ ] Yes [ ] No
Washwater from other cleaning goes to sanitary sewer ——> [ ] Yes [ ] No

Parking Lot Maintenance:

Parking lot is routinely swept ——> [ ] Yes [ ] No
Litter is routinely picked up ——> [ ] Yes [ ] No
Exterior litter cans are regularly dumped when full ——> [ ] Yes [ ] No
Spills are cleaned up and disposed in trash (not hosed down) ——> [ ] Yes [ ] No

Other: _____

Comments and conclusions (use back of page):

Inspector's Name: _____

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SAN MATEO COUNTYWIDE STORMWATER POLLUTION PREVENTION PROGRAM
10 Twin Dolphin Drive, Suite 200, Redwood City, CA 94063

Retail Food Facility Stormwater Inspection

Conducted by: San Mateo County Environmental Health Services Division, 590 Hamilton St., Redwood City, CA 94063 tel: 363-4305

ATE:_____ INSPECTOR NAME: _____

YPE OF INSPECTION: Routine ☐ Illicit Discharge Investigation ☐ Complaint ☐ Follow-up ☐

ACILITY NAME:_____ Phone#:_____

ACILITY ADDRESS:_____ CITY:_____

ONTACT PERSON:_____ TITLE:_____

OVERNMENTAL JURISDICTION: Incorporated ☐ Unincorporated ☐

- **BEST MANAGEMENT PRACTICES (BMPs):**

1. Are BMPs utilized at this facility? Yes ☐ No ☐
2. Is there a SPILL CLEAN-UP PLAN that includes procedures for different types of spills? Yes ☐ No ☐
3. Are all outside garbage containers covered & leak-proof? Yes ☐ No ☐
4. Are outside grease storage containers covered & leak-proof? Yes ☐ No ☐
5. Is all equipment cleaning done in an area that drains to a sanitary sewer? Yes ☐ No ☐
6. Are there indications of illicit discharge into stormdrains? Yes ☐ No ☐

- **ILLICIT DISCHARGE(s) OBSERVED?** Yes ☐ No ☐

Describe:_____

_____

_____

EVALUATION: For each area of activity, indicate a numerical code to describe the level of potential discharge to the storm drains and a letter code to describe the type of potential discharge, using the following chart:

evel of potential discharge (LPD):
- not applicable for facility
- little potential for discharge to storm drains
- some potential for discharge to storm drains
- great potential for discharge to storm drains

ype of potential discharge (TPD):
- illicit connection
- destination of drain unknown
- material exposed to storm water
- other: _____

AREAS OF ACTIVITY:	LPD	TPD
Outdoor material storage	___	___
Waste storage/handling/disposal	___	___
Rooftop equipment & ventilation discharge	___	___
Vehicle & heavy equipment storage	___	___
Repair and maintenance	___	___
Parking and access roads	___	___
Other:_____	___	___
AVERAGE OF LPD's	___	

- **DO THE EXISTING OPERATIONAL PRACTICES OF THIS FACILITY EFFECTIVELY REDUCE THE POTENTIAL DISCHARGE TO THE STORM SEWER SYSTEM TO THE MAXIMUM EXTENT PRACTICABLE?** YES ☐ NO ☐

- **CORRECTIVE ACTIONS REQUIRED TO BE TAKEN:**

_____

_____

_____

- **FOLLOW-UP ACTIVITY:** None ☐ Reinspection ☐ Referral to: sanitary district ☐ building dept. ☐

- **OUTREACH MATERIAL DISTRIBUTED:** STOPPP Brochure ☐ Best Management Practices (BMPs) ☐

_____

Received by Signature Printed Name Title Date

A Program of the City/County Association of Governments (C/CAG)

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R0035320

Santa Clara Valley
NPS Inspection Notice

Facility Name:	Inspection Date\Time:
Address:	Sic:
Contact Person:	Business License:
Telephone:	Inspector:

Item #	Section #	Location/Description	Violation Yes	Violation No
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

NOI has been submitted Yes ☐ No ☐ N/A ☐ | SWMP & SWPPP are availible Yes ☐ No ☐ N/A ☐

Comments/Recomendations/Referrals

☐ NO VIOLATIONS OBSERVED FOR THIS INSPECTION.

You are hereby notified to correct, or submit plans to correct, the violation(s) noted above within_____ hours/days from the date of service of this notice. Your cooperation is appreciated. Prompt correction will avoid the neccesity for legal remedies.

Inspector:_____ Received By:_____
Signature

Reinspections:___/___/___ ____ ___/___/___ ____ ___/___/___ ____ Violations Corrected/Referred: _____
Date and Initials Date and Initials Date and Initials Date and Initial

* - See reverse for section descriptions

Distribution: Original to Occupant, Copy to File

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Sections & Descriptions

Section 2

Indoor Activities

2-1. Floor cleaning water improperly disposed.
2-2. Equipment cleaning wastewater improperly disposed.
2-3. Mfg. residues, spills, leaks properly cleaned.

Section 3

Outdoor Activities

3-1. Vehicle and equipment fueling (tank farm).
3-2. Vehicle and equipment washing: mats, filters, screens.
3-3. Vehicle and equipment maintenance and repair.
3-4. Storage and handling of raw materials, products and by-products.
3-5. Waste storage, handling and disposal (i.e., Hazardous Materials).
3-6. General construction activities/erosion.
3-7. Pavement cleaning or power washing (steam).
3-8. Scrap yards/Equipment/Vehicle storage.
3-9. Process residues.
3-10. General housekeeping.
3-11. Irrigation and landscape maintenance.

Section 4

Equipment

4-1. Air Compressors.
4-2. Air conditioning, chillers, refrigeration.
4-3. Air scrubbers.
4-4. Basement parking lots (sumps).
4-5. Boilers.
4-6. Catch basin/Drop inlet condition.
4-7. Compactors/Dumpsters.
4-8. Cooling tower blow down.
4-9. Emergency shower drains.
4-10. Filter back flushing.
4-11. Floor sinks/drains.
4-12. Grease interceptors/Tallow bin.
4-13. Groundwater treatment discharge.
4-14. Groundwater dewatering devices.
4-15. Loading/Unloading.
4-16. Parking lot.
4-17. Ponds/Fountains
4-18. Roof (vent)/Other roof equipment.
4-19. R.O./D.I. units.

Abbreviations/Definitions

NOI -Notice of intent for the coverage under the States NPDES General Permit for dischargers of storm water associated with industrial activity in the Santa Clara County to the South San Francisco Bay(Order No. 92-011, NPDES No. CAG612001) which is submitted to the California Regional Water Quality Control Board S.F. Bay Region.
AOC - Area of Concern .
SWPPP - Storm Water Pollution Prevention Plan
NPDES - National Pollutant Discharge Elimination System
BMP - Best Management Practices
SIC - Standard Industrial Classifications Code
IC - Illicit or unpermitted connection
Mandatory Industries - A permit is required in any case
Conditional Industries - A permit is required only if materials, Machinery, or Products are exposed to stormwater.
Non-regulated - Those industries which were not identified by the Federal Storm Water Regulations/EPA Categories which are subject to storm water runoff.
SWMP - Storm Water Monitor Plan.

Agency Phone Numbers
RWQCB (510) 286-1255
SCVWD (408) 265-2600
Calif. Dept. of Fish & Game
(408) 649-2370

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12-8-95

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FACILITY INSPECTION GUIDELINES
STATEMENT OF PURPOSE

The attached guidelines were developed to act as a guidance document in giving broader scope and definition to the Santa Clara Valley Inspection Notice developed by members of the Santa Clara Valley NPS Industrial/Commercial Subcommittee.
The guidelines are designed to give public agency inspectors specific guidance in correlation with the individual sections printed on the back side of the notice. The guidelines were developed to aid in the training of inspectors and to foster consistency in inspection procedures/protocol throughout the program.
Since Inspections may be conducted by different agencies(NPS, POTW,Haz. Mat./Waste),it is recommended that where inspectors are responsible for compliance with other program requirements, they should incorporate the use of the NPS inspection notice and guidelines into their inspection procedures.

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NPS FACILITY INSPECTION GUIDELINES

(for use with SCV-NPS inspection notice)

FEB. 1996

Section 1. General Information

Section	What To Look For	Recommended Control Measures	Reference Materials
1.1 NOI	>If required,Ask if a Notice of Intent (NOI) for coverage under General Permit has been submitted. >Make visual verification of NOI.	If NOI has not been filed, but is required, advise facility to contact RWQCB.	Available at RWQCB SCV NPS-Program Storm Water Handbook Com./Ind. Inspector Workshop Handbook Calif. Storm Water BMP Industrial Handbook
1.2 SWPPP& SWMP	>If NOI has been submitted,make visual verification of Storm Water Pollution Prevention Plan (SWPPP). >Also, make visual verification of Storm Water Monitoring Plan (SWMP).	If SWPPP and SWMP are required but not on site, advise facility to contact the RWQCB regarding NPDES requirements.	Same as above
**	PLEASE NOTE THAT THE ABOVE SECTION REFERS TO THE PRE PRINTED ITEMS ON THE FRONT OF INSPECTION NOTICE BELOW ITEM # 15.		

Section 2. Indoor Activities

Section	What To Look For	Recommended Control Measures	Reference Materials
2.1 Floor Cleaning	>Verify where all floor cleaning water, wax, and unused stripper are disposed. Make visual inspection at all janitorial floor drains and sinks. Inspect outdoor drains and surfaces for signs of improper disposal of waste liquids.e.g.,stains.	Explain to the facility representative that all janitorial and maintenance staff should be advised to properly dispose of all unused product and wastewater's either to the sanitary sewer (within local POTW discharge limits), or hauled away. Discharges could be regulated under H&S, F&G, UFC, HMSO, SDO, or local municipal codes.	SCV NPS-Program Carpet cleaning BMP CETA Mobile Washer BMP

Section	What To Look For	Recommended Control Measures	Reference Materials
2.1 cont.	>Verify that waste liquids from automated floor cleaning equipment holding tanks are discharged to the sanitary sewer.	Same	
2.2 Indoor Equip. Cleaning	>Determine how indoor machinery,products, and equipment are cleaned. >Verify where waste water from equipment cleaning is discharged.	Discharge to sanitary (within local POTW discharge limits) or recycle. If indoor equipment is taken outdoors to be washed, refer to 3.2. Consult with POTW or managed as Haz. waste (consult with local Haz. Waste Compliance Agency).	
2.3 Indoor Mfg. Residues Spills	>Ask facility contact how all interior spills and leaks are cleaned and disposed of.Look for any evidence of past spills/stains on interior floor especially near exits/doorways. >Verify that absorbent or spill control materials are readily available. >Check to see if there are any manufacturing or process residues or dust present near any exterior doorways or openings where they can be tracked out, such as residues from grinding equipment, sawing equipment, washing tubs.	Proper disposal depending on type of substance. If Haz. Waste refer to local Haz. Waste Compliance Agency. Appropriate absorbent materials shall be kept readily accessible and designated employees should be trained on proper spill response techniques. Consult with local Haz. Waste Agency for proper disposal of spent absorbent. Relocate machinery. Install protective boom, dike or trough. Improve housekeeping.	Machine Shop BMP SCV NPS-Program Vehicle Service Facility BMP
IC	>Investigate any suspicious interior floor drains and verify which sewer they connect to. Note that floor sinks and drains in older buildings may have formerly been located outdoors but are currently located indoors due to past remodeling.	Review plumbing schematics if available. If necessary, ask operator to. conduct a dye test to verify connection. All interior floor drains and sumps should be plumbed to the sanitary sewer or closed loop treatment system.	
	CSJ/CEA 2/ 6/96 INSLIST 3		

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Section 3 Outdoor Activities

Section	What To Look For	Recommended Control Measures	Reference Materials
3.1 Veh.& Equip. Fuel Dispensing Areas	>Determine if there are fuel tank(s) on site. >Determine whether or not fuel dispensing equipment is exposed to storm water. Verify the dewatering procedures for the secondary containment areas which surround fuel tank farms or other fuel storage equipment. >Check to see if fueling or the transfer of any chemical from one vessel to another is done near a storm drain. >Look for any residual fuel on any part of the fuel dispensing equipment, surrounding pavement, or in adjacent storm drains. >Check to see if absorbent materials are readily available, especially near fueling stations.(if applicable).	Some items in this section are the responsibility of the local Hazardous Materials or fire prevention agency. Refer to appropriate enforcement agencies as needed.Discharges could be regulated under F&G, HMSO, UFC, or local municipal codes. Effect a method to protect all adjacent storm drains in the event of a spill. Keep absorbent material and booms readily at hand. Booms can be strategically placed inside storm drains to help absorb small volume spills(if it does not present a flood hazard). A special check valve may be installed, consult with Building Dept. Consult with local Haz. Waste compliance agency regarding proper disposal of spent absorbent.	
3.2 Veh.& Equip. washing	>Verify that floor mats and equipment screens/filters are not washed where discharge could reach a storm drain (this is common in restaurants).	See below.	SCV-NPS-Program Restaurant BMP CETA mobile washers BMP SCV- NPS Vehicle service BMP

Section	What To Look For	Recommended Control Measures	Reference Materials
3.2 Con't.	>Verify if a pressure washer is used to wash vehicles or equipment. >Determine if vehicles are washed at site and where rinse water is disposed to.	All vehicles and equipment rinse water should be discharged into an approved sanitary sewer drain. All waste water resulting from power washing of contaminated surfaces may be subject to some type of pre-treatment prior to entering the sanitary sewer. Consult with local POTW. Recycle wash water in a closed loop system.	
3.3 Veh.& Equip. Maint.	>Determine if vehicles are maintained at site, and if there are any associated impacts to any outdoor areas. >If applicable,Inspect all outdoor drains and suspicious indoor drains in the vehicle maintenance area. >Verify if specialized equipment is maintained on site (i.e. forklifts, 5th wheels,etc.).	If leaks or drips occur under vehicles ask facility to place drip pans under them. Conduct dye test to verify proper connection. Insure that wash water used to clean specialized equipment is not disposed to the storm drain directly or indirectly.	SCV-NPS Veh. Service facilities BMP BAASMA City of SV Veh. Service BMP
3.4 Material storage	>Determine if any raw materials and their by-products are exposed to rain water. >Determine if any (non-hazardous)raw materials and their by products are transferred in such a manner as to cause impact to the storm drain. >Also determine if raw material/by products are transferred from one package to another in or adjacent to any storm drains.	Store loose materials under cover or in bermed areas if possible. Place protective covers or similar devices over storm drains and increase housekeeping in these areas.	
3.5 Waste Storage	>Verify if facility stores or disposes of hazardous materials, hazardous wastes, or any other substances at the site. >Verify if rain water can enter any double-contained areas, and how these areas are drained once rain water comes into contact with these materials.	In cases where hazardous materials or haz.waste storage pose a threat to the storm drain, consult with your local Hazardous Materials/ Waste enforcement agency. Consult with Haz. Mat. and POTW.	

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Section	What To Look For	Recommended Control Measures	Reference Materials
3.5 cont.	>Determine whether or not the transfer of hazardous materials, waste, or non-hazardous substances may potentially impact the storm drain. >Determine if there are any storm drains adjacent to any storage areas.	If non- hazardous substances are involved, general housekeeping measures should be implemented.Protect storm drain by relocating substance to a covered area, berming or covering substance or installing an approved protective device at storm drain inlets. If Haz. Waste refer to appropriate agency. Ask facility contact to effect a method to monitor and protect storm drain inlet from accidental discharge.	
3.6 Con-struction Activities	>Determine whether or not there are on-going or future construction activities planned at the site and whether contractors are advised or required to protect the storm sewer from accidental discharge. >If construction activities are current, determine if there is a potential for soil to erode into the storm drain by rain or landscape irrigation run-off. >Verify that construction workers are not washing tools, and/or equipment adjacent to any storm drains. >Verify that construction materials are not being disposed to the storm drain directly or indirectly. >Ask facility rep. if construction contractors are aware of storm drain protection measures applicable to their trade (i.e. concrete cutters).	Where applicable, facility shall be responsible to advise or require contractors to protect storm drains. Advise facility that if 5 acres or more are disturbed a general construction permit (NPDES) is required. Install filter fabrics in combination with swales or berms to protect storm drain inlets. Erosion control techniques. Incorporate storm control verbage into future contracts and/or provide training programs. Construction debris and materials such as paint, mineral spirits, drywall compounds, adhesives, and other solvents should be properly disposed of. If haz. waste refer to appropriate agencies.	Available at RWQCB Calif. storm water BMP Construction handbook. SCV-NPS Construction BMP Erosion and Sediment control Measures, ABAG

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Section	What To Look For	Recommended Control Measures	Reference Materials
3.7 Power washing	>Determine if facility power washes pavement or any other exterior hard surfaces. >Determine how exterior walls, structures, silos, tanks are washed and where wash water is disposed of. >Ask facility rep if there are any power or steam cleaning units at the site.	Provide for adequate protection of the storm drain system. Consult listed BMP'S for additional info.	CETA mobile washers BMP Outdoor cleaning BMP, NBAPPA
3.8 outdoor equipment storage	>Inspect all scrap yards, vehicle storage lots or areas where retired/surplus equipment is stored. Determine where storm drains are in relation to these areas.	Cover oily and soiled equipment with a leak proof cover. Drain all automotive related fluids prior to storage and dispose of properly. Drip pans can be placed under leaking equipment.	
3-9 Process residues	>Determine if any manufacturing process which creates any type of residue is done outdoors and whether this residue can impact the storm drain. >Inspect outdoor process areas. >Inspect any outdoor equipment, eg, grinders, saws, paint spraying, ect.	Improve housekeeping or relocate process to a covered location. Protect adjacent storm drains. Relocate equipment to covered location or isolate adjacent storm drain inlets.Refer any airborne nuisances to BAAQMD.	
3.10 Gen. House-keeping	>Determine the general overall condition of the facility. Is housekeeping done on a regular basis? Are there accumulations of debris , refuse, or litter present?	Make necessary recommendations to effect an improved general housekeeping policy. The policy should address the frequency and scope of housekeeping.	
3.11 Irrigation & Landscape	>Determine if landscape contractors are properly disposing of lawn clippings and other vegetative wastes. >Inspect storm drains for vegetative wastes.	Have facility rep. contact the landscaping contractor to improve general housekeeping and to provide temporary protection of all impacted storm drain inlets while conducting landscape activities.	

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Section	What To Look For	Recommended Control Measures	Reference Materials
3.11 Con't.	>Inspect paving around landscaping to see if sprinklers are overwatering and causing undue erosion and run-off of associated chemicals.	Have facility Rep. adjust irrigation timers or sprinkler heads.	
	>Check to see if pesticides, herbicides or fertilizers are applied to the landscaping ; identify how much and how often.	Refer all pesticide/herbicide application problems to the S.C. County Ag. Dept.	
	>Verify that landscape equipment is washed properly and away from paved areas or storm drain.	Filter and discharge to sanitary sewer within POTW limits.	

Section 4. Equipment

Section	What To Look For	Recommended Control Measures	Reference Materials
4.1 Air compressor	>Inspect any air compressor units which are exposed to storm water for residual grease on the tank or motor surface.	Relocate compressor to a covered location. Repair oil leaks.	SCV-NPS Industrial BMP
	>Inspect area beneath air compressors bleed line and determine if any oily substance is being released which could impact the storm drain.	Place a catch pan below the bleed - off valve and dispose of any waste from pan on a regular basis.	
4.2 HVAC Chillers Refrig.	>Determine if air conditioning units (generally found on roof) and chillers have a condensate line which is plumbed to a roof storm drain.	For existing buildings, non-contaminated discharge can go to the storm drain. For new development or building remodels, the discharge will go to sanitary. Consult with local planning/building Dept.	Same as above
	>Determine if air conditioning and chiller units are treated with descaling or anti-algae agent.	Facility representative is responsible to direct HVAC contractor to properly dispose of all flushing agent residues and by pass condensate line while flushing unit.	

Section	What To Look For	Recommended Control Measures	Reference Materials
4.2 Con't.	> Determine if the HVAC condenser tubes are annually flushed with any type of chemical by a servicing contractor and how waste water is disposed of. Also verify if any of the units are annually power washed. >If larger refrigeration units exist, verify where defrost water or condensate is discharged. >Determine if condensate from any unit comes into contact with pollutants when discharged. >Determine how the chiller's waste compressor oil is disposed of.(Note, that some units can hold 40 to 50 gallons of oil and oil must be changed annually.	The runoff from the tube cleaning must be captured and properly disposed of. Have facility rep. follow proper proceduces for power wash rinse water disposal as provided in the CETA BMP's. Facility representative is responsible to ensure that defrost water does not come into contact with any pollutants directly or indirectly. Same. Contact local Haz. Waste enforcement agency regarding the proper disposal of used oil.	
4.3 Air scrubbers	>Determine if air scrubbers are allowing particulate to be deposited on any surface which will eventually come into contact with rain. >Inspect wet scrubbers discharge point.	Advise facility representative to repair air scrubbers and remove existing debris. If feasible, A protective catch pan may be placed around scrubber. Refer any fall out violations/issues to BAAQMD. Wet scrubbers must discharge to the sanitary sewer.	SCV-NPS Industrial BMP
4.4 Basement sumps	>If facility has a basement parking lot, verify if rain water drains to the storm drain. Inspect bottom of storm sump drain and ask how it is cleaned. >Find out if floors are power washed--if so, how is the waste water discharged.	Advise facility representative that only rain water can be pumped into the storm drain. Any debris surrounding or inside the sump should be removed and incorporate this practice into the regular maintenance schedule. A screen mesh or filter fabric may be installed on the sump grate to assist in protecting sump from particulate debris as long as it will not cause a flood hazard. Consult appropriate agency regarding the proper disposal of sump debris.	CETA Mobile washers guidelines

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Section	What To Look For	Recommended Control Measures	Reference Materials
4.4 Con't.	>Determine if automotive fluid spills and/or drips are cleaned with absorbent. >Determine if anyone washes cars in the basement parking lot. This should include mobile auto detailers.	Advise Facility rep. that all floor cleaning contractors must protect storm drain system from accidental discharge.	
4.5 Boilers	>Determine if boiler blow-down line or tank drain line is located adjacent to any storm water inlet or channel, directly or indirectly. >Determine if boiler is treated with scaler or algaecide and if any leakage is present. >Determine if boiler vents to the roof, and if so, will this vapor recondense on roof and make contact with stormwater run-off.	All treated boiler discharge must be discharged to the sanitary sewer or recycled / reused in an approved closed loop system. Discharge from boiler chemical additives may meet hazardous waste criteria. If so, refer to local haz. waste compliance agency for proper storage and disposal. Advise facility rep. to repair condensate pipe and redirect flow to sanitary sewer.	
4.6 C/B condition	>Inspect all catch basins and drop inlets for debris or other foreign material and have facility clean or remove debris properly.	Advise facility rep. to clean impacted catch basins on a regular maintenance schedule. Attaching a protective devices such as a screen or filter fabric may be an option as long as it does not create a flood or safety hazard. Identify all storm drains with stencil. "Do Not Dump Flows to Bay"	
4.7 Refuse dumpster & compactor	>Determine if dumpster lids are closed when dumpster is not in use. Verify if dumpster is stored near a storm drain inlet or channel and look for any leaks. >If the dumpster is an open-top/roll-off bin, or recycle bin, determine if it is covered.If the container fills with rain water, determine how rain water is discharged. >Verify that plugs are installed on dumpsters and are not leaking.	Have facility keep lids closed when not in use or exchange bin if it has no lids. Relocate dumpsters and bins away from storm drains.Repair any leaking dumpsters. Have contaminated rain water discharged to sanitary sewer if it is within POTW limits. Consult with POTW. Install plugs or exchange dumpsters.	SCV-NPS Rest.BMP

Section	What To Look For	Recommended Control Measures	Reference Materials
4.7 Con'L	>Verify that compactor leachate or associated hydraulic fluid does not leak into or adjacent to any storm drain or the pavement. >Determine if refuse hauler dumps or empties dumpsters or bins near a storm drain.	Protect storm drain. Repair compactor. Leaked material can be absorbed and absorbent placed in compactor. Liquid can also go to sanitary sewer.	
4.8 Cooling Towers	>Determine if cooling tower's blow down or tank drain lines can directly or indirectly impact the storm sewer (some towers are located on the roof). >Determine if cooling towers are treated with chemicals and if chemicals are stored adjacent to any storm drains. >Determine if cooling towers areannually power washed with detergent and/or muriatic . acid and where this dischage goes.	All cooling tower discharges must be directed to the sanitary sewer. Refer any chemical storage problems to local Haz. Mat. enforcement agency.Also contact POTW. Contact local Haz. Waste Enforcemnet agency for proper disposal of waste acid wash and local POTW if only detergent is used.	
4.9 Emg. Shwr.	>Verify that outdoor emergency showers do not discharge to the storm sewer.	Consult with POTW . Prevent contaminated water from entering the storm drain.	
4.10 Filter Backflush	>Determine if any outdoor equipment filters are back-flushed or back-washed at the site, including filters for pools and fountains (diatom. earth) . >Check to see if any filters from equipment are re-used and washed at the site.Determine how is filter medium disposed of?	Redirect discharge to sanitary sewer or collect and dispose of solids into refuse container. For commercial and institutional swimming pool facilities, refer filter medium disposal issues to S.C.Co. Health Dept. Consumer Protection Div.	

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Section	What To Look For	Recommended Control Measures	Reference Materials
4.11 Floor sinks/drains	>Look for any outdoor industrial floor sinks/drains which may be non-original installations or illicit connections. >Investigate all suspicious exterior surface drains or grated slot drains and verify ,if possible, which sewer they connect to(i.e, especially those drains which were formerly outdoors but are now indoors or under covered structures).	Replumb drains with proper building permits or seal drains if this will not cause a flood hazard. Review existing plumbing schematics or have dye tests conducted. NOTE: If facility is currently or was a fruit cannery, many of its'outdoor surface drains may be connected to the sanitary sewer.	
4.12 Grease Interceptor Tallow containers	>Inspect area around outdoor grease interceptor cover and verify if rain water can carry residual grease to the storm drain. >Determine if tallow containers are stored where they can come into contact with run-off. >Inspector outdoor tallow containers for residual grease in, on or around the container. >Ask facility rep. If outdoor grease interceptor has ever overflowed.	Advise facility rep.to clean immediate debris and continue this on a regular basis. Also clean the interceptor area after it is pumped by a septic hauler. Residual grease must be collected or washed back into the interceptor. Relocate tallow containers to a covered area. Replace or exchange bins and clean on a regular basis. Refer to POTW for inadequate maintenance. Protect storm drain relocate to a covered area. Refer to POTW for inadequate maintenance.	SCV-NPS Rest. BMP
4.13 Grnd. H2O Treatment Discharge	>Determine if groundwater is being treated at the site and where it is discharged. Verify there is an NPDES permit at the site for discharge.	Consult with RWQCB or SCVWD. If groundwater is being discharged to the storm drain ask if a NPDES permit has been issued. If it is discharged to the sanitary ask for POTW permit.	

Section	What To Look For	Recommended Control Measures	Reference Materials
4.14 Grnd. H2O Dewatering Devices	>Determine if any groundwater is being discharged from the site, and verify which sewer it connects to. > Review spill control plan if applicable. >Determine whether or not pumped water comes into contact with any pollutants before it is discharged.	Uncontaminated groundwater infiltration need not be prohibited unless they are identified by a public agencies or the RWQCB as sources of pollutants to receiving waters. Consult with SCVWD and RWQCB.	
4.15 Loading areas	>Inspect all loading dock drains for any potential pollutant. Inspect for truck fluid leaks. >Check if materials that could impact the storm drain are loaded or transferred at the dock. >Determine if docks are washed and the method of waste water disposal.	Have debris from catch basins removed on a regular basis. Protect loading dock CB from accidental spillage by placing absorbent booms or covers over drains or install valved inlet inserts(if safe and feasible). If materials are Hazardous advise local Haz. Mat. Enforcement agency. Have all dock wash water diverted to the sanitary sewer or use dry clean methods.	SCV-NPS Industrial BMP
4.16 Parking lot	>Inspect the facility's various parking lots, especially those associated with industrial and commercial activities, for any excessive vehicle fluid leaks or spills.	Have facility clean up spills with the three step method on a regular basis.(1) Sweep up particles.(2) Absorb with rags or absorbent. (3) Mop up area.	SCV-NPS Veh. Service BMP

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Section	What To Look For	Recommended Control Measures	Reference Materials
4.17 Ponds Fountains pools	>Determine if there are any ponds or decorative fountains at the site and if their overflow drains are connected to the storm drain directly or indirectly. >Determine if ponds or fountains are treated with copper-based algaecides(Shock) ,growth inhibitors, or other agents. Determine if pond or fountain filters are back flushed into any storm drain. (Diatom. earth)	Discharge to the sanitary sewer or reuse for irrigation, this includes all pool filter backwash and associated debris. Consult POTW.	Local Ordinance
4.18 Roof Vents & Equipment	>Inspect all roof vents, exhaust hoods ,roof storm drains and rain gutter down spouts for contaminants.Be aware of contaminants such as oil, grease, filter medium, paint dust, and organic debris as well. >Look for residual machinery process residues on roof (paper dust, saw dust, steam condensate). >Check for residual paint residue on the roof near the paint booth vent.Inspect wave solder roof vents or other similar roof vents which are associated with a hooded work station.	Excessively greasy roof vents should be cleaned on a regular basis especially during the wet season.If feasible, catchment pans or trays should also be installed at the base of these vents. Repair or have duct work properly sealed. Place protective devices around roof storm drains which will not create a hazardous conditon. Consult with local Hazardous Material or Waste enforcement agency as well as BAAQMD for control measures.Have any solids properly disposed of and have facility rep. repair unit and clean on a regular basis.	
4.19 R.O. & D.I.	>Verify that reverse osmosis units (RO) reject water is in no way impacting the storm drain. Also verify that Deionization units (DI) are back-flushed. Deionization units can be regenerated(ask if they are regenerated on or off site.Reverse osmosis membranes need to be cleaned; ask how they clean membranes).	Consult POTW for requirements. Divert reject water from R.O. unit to sanitary sewer. Divert D.I. Back flush water to the sanitary sewer.	CSJ/CEA 2/6/96 INSLIST 3

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Appendix L

Guidance On Evidence Collection And Sampling

1) Sampling Procedures and Guidelines (Los Angeles County Department of Public Works, Environmental Services Division)

2) Collection of Evidence - From "County Administered Cities Hazardous Materials Incident Investigation Guidance Document", Alameda County

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Samples shall only be taken when they may be done in a safe manner in compliance with the following:

1.1.0 EXPLOSIVE/FLAMMABLE DANGER - All potentially explosive or flammable confined spaces, manholes, sample boxes, tanks or other containers shall be tested for explosive hazard prior to removal of the container lid or attempting to secure a sample. Sampling/monitoring equipment shall not be placed in a potentially hazardous atmosphere unless specifically approved for such service.

1.2.0 FACILITY ACCESS - Samples shall be taken in such a manner as to not require entry into any confined space area or other areas that may be hazardous to health and safety. Personnel shall not attempt to secure samples that require reaching into any piece of machinery or equipment or that may require the person securing the sample to be placed into an unbalanced situation.

1.12 SAMPLE CONTAINERS - Samples shall be taken in appropriate containers supplied by the contract laboratory. Prior to transporting containers their caps/lids are to be securely tightened. Containers are at all times to be kept in an upright position and transported in a container so designed and constructed, that under conditions normally incident to transportation, there shall be no release to the environment. Stock containers are to be stored in a secured manner.

1.3.0 SAMPLE EQUIPMENT CLEANING AND DECONTAMINATION - In order to minimize the contamination of samples by the sampling equipment or through cross-contamination, all equipment must be thoroughly cleaned before their first use and also between samples. Under normal circumstances, cleaning sample equipment with a brush and a detergent solution, followed by thorough rinsing with clean water and drying should be sufficient to minimize cross-contamination.

Cleaning Procedure:

- Clean sample equipment with a brush and a detergent solution (were appropriate).
- Automated sample equipment is to be cleaned by pumping a solution of non-phosphate detergent through the pump assemble and associated tubing.
- Rinse equipment several times with tap water, dry.
- Store clean equipment (hoses, strainers, trowels, etc...) in clean polyethylene bags.
- Equipment which needs to be decontaminated is to be stored in polyethylene bags.

1.4.0 EQUIPMENT - All field equipment used for obtaining field measurements must be calibrated prior to and immediately after each investigation. Calibration records must be maintained in order to demonstrate the precision and accuracy of field measurements made with a particular instrument.

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Calibration records should include:

- A unique identification number assigned to the device, such as the factory serial number.
- The source and traceability of the standard(s) used for calibration.
- The name of the person performing the calibration, the date and notation as to whether it was a routine check or one required by malfunction.

Equipment calibration must be further supported by routine maintenance, as required by the individual types of equipment in use. Routine maintenance includes changing/charging batteries in portable meters and lubricating moving parts of sampling device with non-contamination materials.

Maintenance records must be kept similar to calibration records and must document the type of work done (routine checks, emergency repairs), the person performing the work, and the identity of the equipment.

1.5.0 QUALITY CONTROL - The sampling program includes specific quality control requirements to meet the data quality objectives. These objectives are usually met through the use of quality control samples such as replicates, spikes, and blanks.

1.5.1 EQUIPMENT BLANKS - Should represent 5% of the samples collected. Equipment blanks should be collected from all equipment cleaned in the field and reused, to detect any contamination not removed by or introduced by the cleaning procedures. For wastewater sampling, clean water is collected using the equipment in question and sent to the laboratory with the other samples for analysis. Distilled waster shall be passed through each equipment procedure used. All preservatives, used in the field should be included. Blanks are to be submitted in the same manner as other field samples, with no distinguishing labeling or markings. Documentation of blanks must be recorded on an inspectors report and attached to only this offices copy of the chain of custody.

1.6.0 DOCUMENTATION - Accountable field documents include items such as inspectors report, field data records, sample tags, graphs, chain-of-custody records and photographs. Each document must bear an identification number unique to the project (I-File Number whenever possible).

1.6.1 INSPECTORS REPORTS, FIELD DATA RECORDS - All pertinent factual information must be recorded in these Reports/Records from the time each individual is assigned to the inspection team until the inspections is completed. Entries must be dated, legible, and contain accurate and inclusive documentation of inspection activities. Reports/Records must contain only facts and observations. Language should be objective, factual, and free of personal opinions or other terminology which might prove inappropriate.

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1.6.2 PHOTOGRAPHS - Photographs are important in documenting the cause and effect relationship in the areas of environmental damage. Whenever samples are collected, photographs should be taken to verify the written description in Reports/Records. In all cases where a photograph is taken, the following information must be written in the Report/Records.

- Time, date, location, and, if appropriate, weather conditions;
- Complete description or identification of the subject in the photograph and reason why the photograph was taken;
- The sequential number of the photograph and file number; and
- Name of person taking photograph.

When the photographs are developed, the information recorded in the Report/Record should be transposed onto a Photographic Evidence lable and attached to the back of the photographs. Photographs and negatives are part of the project files and must be accounted for under document control procedures.

1.6.3 CHAIN-OF-CUSTODY - Sample chain-of-custody (COC) refers to all records maintained in the field and laboratory for sample identification, transmittal and receipt. When a sample is maintained under chain of custody the possession of the sample can be traced from collection until disposal. This procedure is necessary to insure that the sample or data derived from the sample is admissible as evidence in legal proceedings.

A sample is considered under custody if:

1) It is in your possession, or
2) It is in your view after being in your possession, or
3) It was in your possession and you locked it up, or
4) It is in a designated secure area.

In order to establish that sample is valid, it is also necessary to document the measures taken to prevent or detect tampering or loss of sample. Measures must also be taken to detect and prevent tampering and contamination to sampling equipment and the sample site. This is done by the use of evidence tape, locks, custody seals and documented observations.

Since it is not always possible to know in advance if a sample will be used as evidence, all samples are to be maintained under chain of custody. Use of standard operating procedures throughout the sampling process will contribute to the consistency and quality of the data produced.

All sample shipments are to be accompanied by a Chain-of-Custody Record. The original record will accompany the report and a copy will be retained by the laboratory, sampling team and sample control/courier. In general, as few people as possible should handle the samples; until transferred to the laboratory. Whenever replicate/split samples are offered to another agency or the facility, it

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must be noted on the custody form. The note indicates to whom the replicate samples are being offered and recipient. If the replicate/split is refused it must be noted.

1.6.4 CUSTODY SEAL - Custody seals are strips of printed tape that are used to demonstrate that no tampering has occurred. Seals are to be placed over all sample container caps/lids and sampling equipment while in use, if equipment is set-up outside of a secured sampling facility.

1.70 SAMPLING PROCEDURES - Appropriate personal protective equipment is to be worn during any sampling and equipment cleaning process. Sample or container lids/caps are to be kept in place until the container is used. Upon completion of sampling the container lid/cap is to be securely tightened, container rinse with tapwater, dry and properly labeled. Precautions should be taken of possible chemical reactions between preservatives and material being sampled.

1.8.0 SAMPLE IDENTIFICATION AND PACKAGING - All samples collected shall be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The sample label should be legibly written and completed with a waterproof ink. The label should be firmly attached to the sample container and should list the project number (I-File Number whenever possible); sample date and time; sample number; analysis required and type of preservative. All samples should be labeled, sealed, and refrigerated as soon as possible after collection. The sample number, date, time of collection, location, and signature of the sampler(s) should be recorded on the chain of custody.

1.9.0 TRANSPORTATION - Samples are to be delivered as soon as possible after collection. Unless prior arrangements have been made with the laboratory for pick-up, samples are to be delivered to the contract laboratory. Arrangements for laboratory pick-up of samples should be made with the laboratory 24-hours in advance, contact person is Jennie, Associated Laboratories (714) 771-6900. It is the responsibility of personnel conducting sampling to make arrangements of delivery or pick-up of samples and the return of any DPW monitoring equipment. Potentially incompatible samples shall not be transported in the same transport container. Transport containers shall not be transported in the passenger compartment of a vehicle where possible. Sample containers shall be packaged properly for shipment and transported in a container designed to prevent breakage or spillage during shipment.

2.0.0 EMERGENCY BODY/EYE FLUSH - Eyesaline Solution and Emergency Body Flush bottles are to be stored within each personal assigned Pelican Protector Case. Body/eye flush are to be used for emergency purposes only and are to be used in accordance with the manufacturer's instructions.

In case of emergency use employee's are to report industrial injuries to their supervisor immediately, pursuant to Safety Directive G101.

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OPERATIONAL GUIDELINES
pH Recorder

Recorders are to be operated in accordance with the manufacturer's operational manual.

Recorders are to be calibrated prior to and recorded on the attached Calibration/Maintenance Record.

Each chart paper recording shall bear an identification number unique to the project (I-File Number whenever possible); start/end time and dates; inspector's name.

The original chart paper recording is to be attached to this office's copy of the Chain-of-Custody Record.

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WP9/OG

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CALIBRATION/MAINTENANCE RECORD

pH RECORDER #_____

DPW ID #_____ MFG. SERIAL #_____

CALIBRATION		DATE	TIME	INSPECTOR NAME	COMMENTS
Routine	Malfunction				

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OPERATIONAL GUIDELINES
ISCO Portable Sampler

Portable samplers are to be operated in accordance with the manufacturer's operational manual.

All routine maintenance are to be recorded on the attached Maintenance Record.

JB:li
WP9/OG

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MAINTENANCE RECORD

ISCO PORTABLE SAMPLER #_____

DPW ID #_____ MFG. SERIAL #_____

CALIBRATION		DATE	TIME	INSPECTOR NAME	COMMENTS
Routine	Malfunction				

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LOS ANGELES DEPARTMENT OF PUBLIC WORKS
Waste Management Division
Mail Address: P.O. Box 1460, Alhambra, CA 91802-1460

SAMPLE AND CHAIN OF CUSTODY RECORD

Date _____ Page ____ of ____

PROJECT MANAGER

PHONE NUMBER

PROJECT NAME

TO BE COMPLETED BY LABORATORY

LAB NO.:

Samples Intact: YES ☐ NO ☐
County Seal(s) Intact: YES ☐ NO ☐
Sample: Ambient ☐ Cooled ☐ Frozen ☐

SAMPLERS (Signature)

SAMPLE NUMBER	SAMPLE LOCATION DESCRIPTION	DATE	TIME	SAMPLE TYPE				NO. OF CONTAINERS	PRESERVATION	TEST REQUIRED
				WATER		AIR	SOLID			
				COMP.	GRAB.					

Special Instructions:

SAMPLE COLLECTION INFORMATION

☐ Composite-timed _____ ml/_____ min. intervals
_____ intervals/_____ bottle.

☐ Composite-flow with _____ gallon intervals.

Composite Times:

Start _____ ☐ A.M. ☐ P.M. Date _____

End _____ ☐ A.M. ☐ P.M. Date _____

Sample split with facility ☐ YES ☐ NO

RELINQUISHED BY (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

38-0028 DPW (10/90)

DISTRIBUTION: WHITE: REPORT, CANARY: LAB, PINK: FIELD, GOLDENROD: SAMPLE CONTROL/COURIER

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COUNTY ADMINISTERED CITIES
HAZARDOUS MATERIALS
INCIDENT INVESTIGATION
GUIDANCE DOCUMENT

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Alameda County would like to acknowledge their assistance and thank the following people for their contributions in the preparation of this Guidance Document. Their input over several years transformed a concept into reality.

Senior District Attorney Gilbert Jensen, Alameda County D. A.

Senior District Attorney Margaret Ong, Alameda County D. A.

Lieutenant Phillip Fry, Alameda County District Attorney

Inspector Don Harris, Alameda County District Attorney

Inspector John Fredriksson, Alameda County District Attorney

Inspector Norm Healy, Alameda County District Attorney (Retired)

Director Rafat Shahid, Alameda County Environmental Health

Chief Edgar Howell, Alameda County Health/Hazardous Materials Unit

Battalion Chief Steve Faelz, Hayward Fire Department/Hazmat Unit

Detective Frank Daley, Hayward Police Department

Detective Steve Kirkland, Hayward Police Department

Sergeant Jan Riddell, Hayward Police Department (Retired)

Captain James Cooper, Oakland Police Department

Sergeant Alan Whitman, Oakland Police Department

Assistant Chief John Baker, Oakland Fire Department

Battalion Chief Ronald Campos, Oakland Fire Department

Inspector Donald Iverson, Oakland Fire Department

Inspector Randy Griffith, Livermore Fire Department

Inspector Rick Mueller, Pleasanton Fire Department

Hazmat Coordinator Danielle Stefani, City of Union City

Hazwaste Investigator Mitch Mueller, California Highway Patrol

Captain Dean Freeman, Fremont Fire Department

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Certification of Site as Safe

In emergency situations, the Incident Commander may declare an area unsafe for human entry. Only the Incident Commander, advised by the Health Department can declare such an area safe for re-entry. However, if the City Manager becomes the Incident Commander by declaring a state of emergency only the County Health Officer can declare the site safe to re-enter. Approval from the Incident Commander must be obtained for entry into an emergency scene.

COLLECTION OF EVIDENCE

It is very important that evidence which may lead to the prosecution of the guilty party be collected and preserved. However, safety should always be considered first. INVESTIGATORS SHOULD NEVER EXPOSE THEMSELVES TO AN UNKNOWN RISK TO COLLECT EVIDENCE. If in doubt about the nature and/or hazards of a material, do not approach it, stay upwind, and wait for County Hazmat or other technical experts to evaluate the situation. The sampling of hazardous materials is a special issue and is addressed on page 11. These investigations should be handled in a manner consistent with the investigation of any felony i.e. "chain of custody". "Paper trail" type evidence is extremely important in hazardous waste cases.

Safety Considerations

Never touch or breathe a chemical unnecessarily, no matter what it is, even something as "innocuous" as waste oil. Never allow chemicals to directly contact your skin or clothes - be especially aware of your hands and feet. Stay upwind. Never open containers unnecessarily. Be aware of surfaces which may be contaminated i.e. the ground, the outside of containers, etc. Employ the same precautions that you would use during the on-scene investigation of a drug lab. ***USE COMMON SENSE!!!***

Responsibility for Evidence

The lead investigatory agency is responsible for the collection and retention of evidence other than samples. Samples go to the County Health Department for analysis. This evidence may include but is not limited to:

- Hazardous Waste Manifests
- Bills of lading
- Memorandums/Notes
- All Labels and markings from containers (Photos of labels may be used if the labels can't be removed)
- Thorough listing of all drum identifiers including but not limited to manufacturer's name, address, batch or lot number, consignee, shipper, etc.
* Fingerprinting of containers (if appropriate and safe)
- Photographs of the entire crime scene
* Specialized evidence collection techniques such as casting, or

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photographing to scale, tire tracks and treads, "fuming" of paper evidence for latent fingerprints, videotaping, etc.

* In a criminal case if the local police department is not the lead investigative agency, these activities will need to be delegated to them.

SAMPLING

Sampling is a very important part of hazardous materials investigations, and is critical evidence for a successful prosecution. The Alameda County Health Care Agency has extensive sampling capabilities and will in most cases be the agency responsible for sampling. However, everyone involved in such investigations shall have a basic understanding of sampling.

Samples taken by the Fire or Police Departments should be turned over to County Hazmat or a State Certified Laboratory for analysis. It is the responsibility of the lead investigatory agency to obtain laboratory analysis results and maintain the "Chain of Custody". For results of laboratory analysis, contact the agency or laboratory to which the sample was submitted.

When to Sample

In order to establish and prove the fact that materials involved in a case meet the legal definition of "hazardous" it is often necessary to perform a chemical analysis of the materials e.g. whenever an incident involves a discharge of a suspected hazardous material to the ground, a stream, a storm sewer, a sanitary sewer, or the air, AND/OR whenever a material is suspected of causing damage to a person or property.

Sampling brings the sampler into close proximity and possibly direct contact with the material to be sampled. (See Safety Considerations on page 10, under Collection of Evidence.) The following rules should always be followed.

1) Unless specially trained and equipped DO NOT HANDLE unidentified materials.

2) Do not breath or touch <u>any</u> chemical, even one as apparently innocuous as waste oil. Always avoid breathing fumes, always stay upwind.

Split Samples

The party being investigated should always be given the opportunity to confirm the regulator's analysis results. This is done by "<u>splitting samples</u>". This means taking a sample, dividing it in two, keeping one half and giving the other to the interested party. The initial sample should be thoroughly mixed prior to being divided. All sample containers are to be sealed with an agency seal, and labelled with the sampler's name, date, and time taken.

Chain of Custody

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The regulator must be able to establish who had responsibility for, and access to, samples from the time they are taken to the time they are analyzed. This is done by using a Chain of Custody form (APPENDIX K). A Chain of Custody form must be used for all samples, and must accompany the sample at all times.

Sampling Kit

Because situations arise wherein the hazardous material involved may be present and available for sampling only for a short time (for example material poured into a storm drain or onto the soil), County Hazmat, the Police and Fire Departments have available for their designated hazardous materials personnel simple sampling kits. Again, these kits would only be utilized if the hazards of the materials are known and acceptable. The kits should include:

- PH paper
- VOA vials
- labels
- glass jars - quart size & pint size
- water-proof pens
- plastic ladle
- plastic spoon
- rubber gloves
- handiwipes
- plastic jars
- Chain of Custody Forms
- Eye Protection
- Ziplock plastic bags
- Paper bags
- Five gallon collapsible plastic container

STATEMENTS

A regulator acting in the course of his/her normal duties and responsibilities, and not as an agent of a law enforcement agency, does NOT have to give the "Miranda Warning" to the responsible party.

APPENDIX E contains directions for taking statements. Statement should be taped, videotaped, or written and signed by the witness. In most instances, tape recorded statements are best.

STATEMENTS ARE THE "HEART" OF ANY SUCCESSFUL CASE

Routine Inspection Incidents involving Fire Investigators:

- Cooperative owner, manager, or employee: summary of statement(s) made

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by responsible party may be included in inspection report

- Uncooperative owner, manager, or employee: if appropriate and reasonable, statement(s) should be taken from Witnesses

    - The witness may be a disgruntled employee or a person connected to the company

    - The statement should be written or typed, and signed by the witness

Incidents Involving Fire and Police Departments

This is typically a situation which involves an emergency response or major violations and necessitates processing as a crime scene when the scene is determined to be safe.

The police officer assigned to the preliminary investigation shall be responsible for obtaining statements from all percipient witnesses.

The police officer assigned to the preliminary investigation, due to his or her training and experience, shall decide if and when a Miranda warning is appropriate.

SPECIFIC SITUATIONS SECTION

This guidance document deals with the roles and responsibilities of/and coordination between the Police, Fire, County Hazmat, and the District Attorney's Office. However, many other agencies have interest in and/or jurisdiction over various hazardous materials situations. It is important that the Alameda County Office of Emergency Services and all relevant agencies be notified as soon as possible whenever an incident occurs. APPENDIX L contains a brief description of the agencies involved with hazardous materials response and regulations. In that appendix there is a list of phone numbers for those agencies. Below are listed some of the more common situations which are encountered and the additional agencies to be notified.

Discharge or Potential Discharge to the Sanitary Sewer

- The Local Wastewater Treatment Plant industrial pretreatment/waste source control.

Discharge or Potential Discharge to a Storm drain, Creek, or other Surface Water

- The Regional Water Quality Control Board via State O.E.S.
- California State Department of Fish and Game
- Flood Control District

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Appendix M

Managing Pollutant Sources At Municipal Facilities
(Including A Model Storm Water Pollution Prevention Plan)

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MANAGING POLLUTANT SOURCES AT MUNICIPAL FACILITIES

Municipal facilities (e.g., corporation yards and auxiliary storage yards) are potential sources of pollutants to storm drain systems from practices such as vehicle and equipment washing and storage of chemicals and materials. Since municipalities have responsibility for controlling the quality of all storm water discharges to their storm drain systems, it is important that municipal facilities provide a good example to industrial and commercial facilities.

POTENTIAL POLLUTANT SOURCES

Potential sources of pollutants to storm drain systems at municipal facilities are similar to potential sources at industrial and commercial facilities:

- wash water from vehicle and equipment washing;
- fuel dispensing;
- chemical and material storage;
- chemical usage; and
- fleet maintenance and vehicle storage.

During FY 1994/95, storm water quality control programs in the counties of Alameda, Marin and San Mateo contracted to have inspections of municipal corporation yards to help them identify problem areas. Based on the results of these inspections, a major concern is the discharge of wash water from vehicle and equipment washing to creeks and storm drains because this is a direct violation of the municipal storm water NPDES permit. Recommended actions typically include working with the local POTW to discharge wash water to the sanitary sewer and/or enlarging the size of or re-grading the wash pad area to contain all wash water.

RECOMMENDED BMPS

The Alameda Countywide Clean Water Program's Maintenance Subcommittee, which consists of public works supervisors from municipalities in Alameda County, developed and adopted BMPs for corporation yards. These BMPs are summarized in Table A-1 by pollutant category. As mentioned above, the biggest concern is preventing wash water from discharging to the storm drain system or creeks. If necessary, options include working with the local POTW to determine if pretreatment is required prior to discharge to the sanitary sewer, installing a recycling system (as done by San Mateo County and Alameda County for their corporation yards), or washing vehicles off-site at a commercial facility where wash water drains to the sanitary sewer. Other BMPs include labelling inlets with the message "No Dumping! Drains to Bay/Creek," storing spill containment kits near fuel dispensers, and covering chemical storage areas.

BMPs may be structural or operational. If structural improvements are necessary, a municipality will need sufficient time to budget for and implement a capital improvement project (CIP). It often takes

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several years to implement a CIP since improvements at the corporation yard may have lower priority than other municipal projects. If possible, temporary interim measures should be instituted in the meantime (e.g, washing vehicles off-site).

Operational improvements and training should be implemented as soon as possible. If a municipality is part of a regional or countywide storm water program, training could be provided by forming a subcommittee of public works supervisors and coordinating annual workshops for field staff.

SWPPPS FOR MUNICIPAL FACILITIES

A memorandum was prepared in September 1994 by staff of the State Board and Regional Boards to assist storm water permit program coordinators in developing their Storm Water Management Plans. In addition to suggesting that each municipality identify all their corporation yards and describe their functions, the memorandum strongly encourages municipalities to prepare SWPPPs for their municipal facilities. (Municipal facilities are excluded from the requirements of the Industrial Activity General Permit unless they perform the functions of a transportation or bulk fuel distribution facility.)

The guidance from the State and Regional Boards states that SWPPPs should:

- identify what the potential storm water problems are;
- who is responsible for implementing the storm water measures;
- what management practices will be used; and
- how they will be implemented.

For measures that are not already in place, a timetable for implementation should be provided. Lastly, municipalities should describe how the effectiveness of the BMPs will be judged.

Following this guidance, a Model SWPPP for corporation yards was prepared for the San Mateo Countywide Stormwater Pollution Prevention Program to allow municipalities to identify problem areas and develop a plan for any necessary improvements. The Model SWPPP is included at the end of this appendix. Key features of the Model SWPPP include:

- a (blank) facility map to identify locations of potential sources of storm water pollution and drainage;

- a form to document information on past and present spills or other non-storm water discharges;

- BMP worksheets to document the status of implementation of BMPs and identify personnel responsible for overseeing implementation of BMPs; and

- inspection forms to document visual observations during wet and dry weather.

Municipalities were requested to complete a SWPPP for each municipal facility and to update them periodically.

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MUNICIPAL FACILITY INSPECTIONS

Municipalities should assign one staff person at each municipal facility the responsibility for conducting inspections on a routine basis and ensuring implementation of BMPs. This person should be at the supervisor or superintendent level so that they can request funding for CIPs and assign staff to implement operational improvements, if necessary. Municipal facilities to be inspected include corporation yards used by public works departments, facilities used by parks and police departments, and storage yards.

The following recommended inspection procedure has been adopted by the Alameda Countywide Clean Water Program's Maintenance Subcommittee:

- An initial comprehensive inspection should be conducted of each municipal facility during dry weather. Major potential source areas listed in Table X should be inspected for non-storm water discharges (e.g. wash water and spills) as well as evidence of non-storm water discharges such as stains, wet spots and residual matter.

- Subsequent inspections should be conducted during wet weather to observe the quality of runoff from each facility. After a major storm event, runoff or ponded water should be inspected for clarity, discoloration, odor, etc. It is suggested that runoff or ponded water be observed after two major storm events at two locations or more.

(The Model SWPPP contains dry and wet weather observation forms.)

ESTABLISHING A SUCCESSFUL PROGRAM

The following activities are recommended to control pollutants at municipal facilities to the maximum extent practicable:

✓ assign a supervisor or superintendent the responsibility for conducting inspections and ensuring implementation of BMPs at each facility;

✓ complete a SWPPP for each municipal facility identifying problem areas and a plan for improvement;

✓ conduct dry and wet weather visual inspections;

✓ label all storm drain inlets in municipal facilities (and adjacent ditches and watercourses, if appropriate); and

✓ encourage regional/countywide storm water programs to establish a subcommittee to share information among maintenance staff and to sponsor workshops for maintenance field staff.

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Table A-1. Pollutant Sources at Municipal Facilities and Recommended BMPs

Pollutants Sources	BMPs
<u>Wash Water</u>	
Wash water discharges to a creek or the storm drain system.	Work with your local POTW to discharge wash water to the sanitary sewer, install a recycling system, or wash vehicles off-site at a commercial facility.
Wash pad area is too small or improperly graded to prevent spillage.	Berm the wash pad area and re-grade if necessary.
Staff wash vehicles off-site and wash water drains to the storm drain system.	Schedule washing times by department and notify employees to only wash vehicles and equipment at designated wash pads.
<u>Fuel Dispensing</u>	
Spills drain to the storm drain system.	Clean up spills immediately, using dry methods. Store spill containment kits nearby and train employees in proper fueling and spill response procedures. Label inlets with a "No Dumping" message. Consider opportunities for regrading area to prevent "runon" of storm water and runoff of spills into the storm drain system.
<u>Chemical and Material Storage</u>	
Chemicals and materials are stored outside in open containers/areas.	Store chemicals in a covered containment area where the floor is designed so any spilled materials will be contained and easily removed. Store hazardous waste in closed drums within a secondary containment structure. Store materials removed from streets and storm drainage facilities so that there is no discharge to the storm drain system. Dispose of wastes at an appropriate landfill or recycle.
Spills drain to the storm drain system.	Store spill containment kits nearby.
<u>Chemical Usage</u>	
Rinse water from cleaning (water-based paint) brushes discharges to the storm drain system.	Discharge rinse water to the sanitary sewer.
Spills drain to the storm drain system.	Use drop cloths when painting or mixing chemicals.
<u>Fleet Maintenance/Vehicle Parking Areas</u>	
Leaky vehicles are stored outdoors.	Inspect equipment for leaks on a regular basis. Place drip pans under leaky vehicles and repair vehicles with significant leaks. Cover sprayers, patch and paving equipment to prevent rainfall from contacting pollutants. Sweep the yard periodically.
Spills drain to the storm drain system.	Replace fluids in a covered shop area.

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San Mateo Countywide Stormwater
Pollution Prevention Program

Model Stormwater Pollution Prevention Plan

for Corporation Yards

March 1995

prepared to

satisfy Task 3.2.3
of the *Stormwater Management Plan*

by

EOA, Inc.
1410 Jackson Street
Oakland, CA 94612

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Appendix

Wet Weather Visual Observation Form

Dry Weather Visual Observation Form

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Corporation yards are potential sources of pollutants to storm drain systems from practices such as vehicle and equipment washing and storage of chemicals and materials. Since municipalities have responsibility for controlling the quality of all storm water discharges within their jurisdiction, it is important that municipal facilities provide a good example, and take the lead to ensure compliance with the National Pollutant Discharge Elimination System (NPDES) permit adopted by the Regional Water Quality Control Board in October 1993.

Consequently, San Mateo County's *Stormwater Management Plan* requires that the General Program assist municipalities with corporation yards evaluate the need for improving practices to control pollutants discharged to storm drains. Furthermore, State Water Resources Control Board and Regional Water Quality Control Board staff stated in a recent memo to storm water permit program coordinators that Stormwater Pollution Prevention Plans (SWPPP) or an equivalent method must be used to handle corporation yard discharges. By completing this Model SWPPP for corporation yards and auxiliary yards, municipalities will identify and document problem areas and develop a plan for any necessary improvements.

1.1 Background

1.1.1 Municipal Storm Water NPDES Permits

The Clean Water Act, as amended by the Water Quality Act of 1987, requires that municipal storm water discharge permits for discharges from municipal storm drains:

i) include a requirement to effectively prohibit non-storm water discharges into the storm drain system, and

ii) require controls to reduce the discharge of pollutants to the maximum extent practicable.

EPA adopted storm water regulations in 1990 and following Santa Clara and Alameda Counties, the Regional Water Quality Control Board required that San Mateo County apply for a storm water permit in 1992. A *Stormwater Management Plan* was finalized for San Mateo County in June 1993 and incorporated as part of its municipal NPDES permit. The *Stormwater Management Plan* includes tasks for public education, municipal government maintenance activities and controlling storm water discharges from commercial and industrial businesses and new development and construction sites.

1.1.2 General Industrial Activities Storm Water NPDES Permits

In addition to requiring that municipalities obtain NPDES permits, EPA's storm water regulations require that industries which discharge storm water associated with one or more specified industrial activities obtain storm water NPDES permits. Examples of industries requiring stormwater NPDES permits include manufacturing facilities,

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transportation facilities, and construction activities which disturb greater than 5 acres of total land area. In California, a General Industrial Activities Storm Water NPDES permit (General Permit) was adopted in September 1992 by the State Water Resources Control Board. One of the requirements of the General Permit is preparation of a SWPPP to plan and organize storm water pollution prevention efforts. It was decided that municipal corporation yards would not be required to comply with the General Permit requirements (unless they perform the functions of a transportation or bulk fuel distribution facility), but would be regulated under municipal stormwater permits.

1.2 Overview of the SWPPP

Using the format of SWPPPs required to be prepared for industrial facilities needing coverage under the General Permit, this Model SWPPP was prepared to assist municipalities evaluate the need for improving practices at corporation yards. However, some of the General Permit requirements were reduced (number of visual inspections) or eliminated (storm water sampling) to minimize the burden on municipalities and increase the likelihood of successful implementation of the most important aspects of a SWPPP.

The Model SWPPP should be completed for all corporation (and auxiliary yards, if appropriate) within a jurisdiction. Of course, if your municipality does not have a corporation yard for typical routine municipal maintenance practices like vehicle and equipment washing and material and chemical storage then the SWPPP is not applicable.

Key features of the Model SWPPP include:

- A facility map to identify locations of potential sources of stormwater pollution and drainage;
- A form to document information on past and present spills or other non-storm water discharges;
- Best Management Practice (BMP) worksheets to document the status of implementation of BMPs adopted by the Public Works Supervisors in 1994 and to identify personnel responsible for overseeing implementation of BMPs; and
- Forms to document visual observations during wet and dry weather.

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The objective of providing site information is to identify areas which could discharge pollutants to the storm drain system. Specific information for your facility can be provided by simply preparing a detailed facility drainage map.

2.1 Facility Map

Figure 1 illustrates potential sources of pollution at a typical corporation yard. Of particular concern are discharges of wash water from cleaning vehicles and equipment to the storm drain system and chemical spills. At this facility, the sump in the wash pad area was recently re-plumbed to the sanitary sewer. However, during a recent inspection potential discharges of pollutants to the storm drain system were found from outdoor material storage areas, waste disposal areas and vehicle fueling areas.

2.2 Drainage Map

Figure 2 illustrates storm water drainage at the example corporation yard. Understanding site drainage will assist in identifying locations for visual monitoring as discussed in Section 5.0.

Each municipality should provide facility information by filling in the blank map provided (Figure 3) or by modifying an existing map (e.g., from the Hazardous Materials Business Plan). If an existing map is used, include all potential sources of pollution and illustrate the storm water drainage system (use the legend at the bottom of Figure 3).

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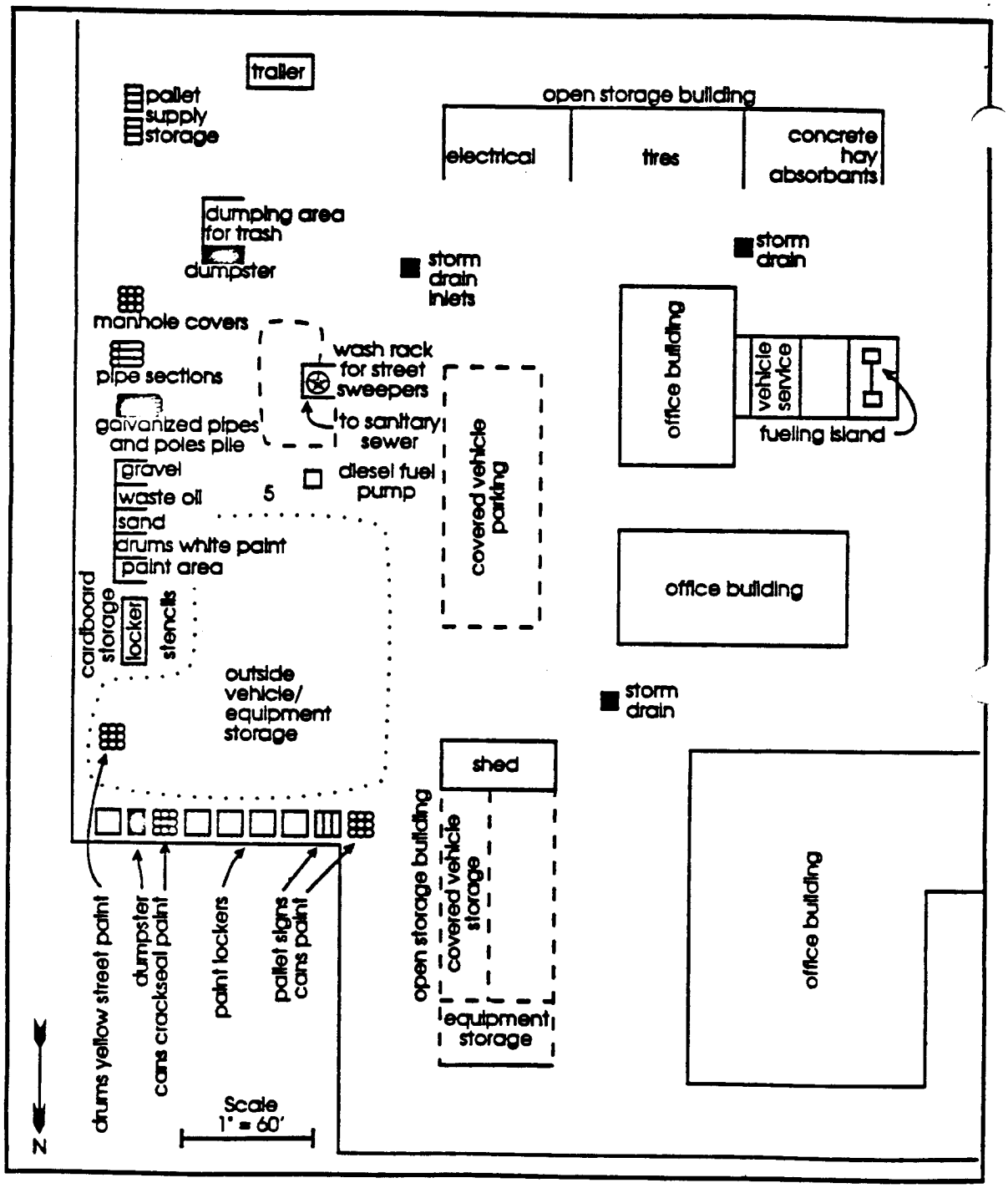

Figure 1
Example Corporation Yard Facility Map

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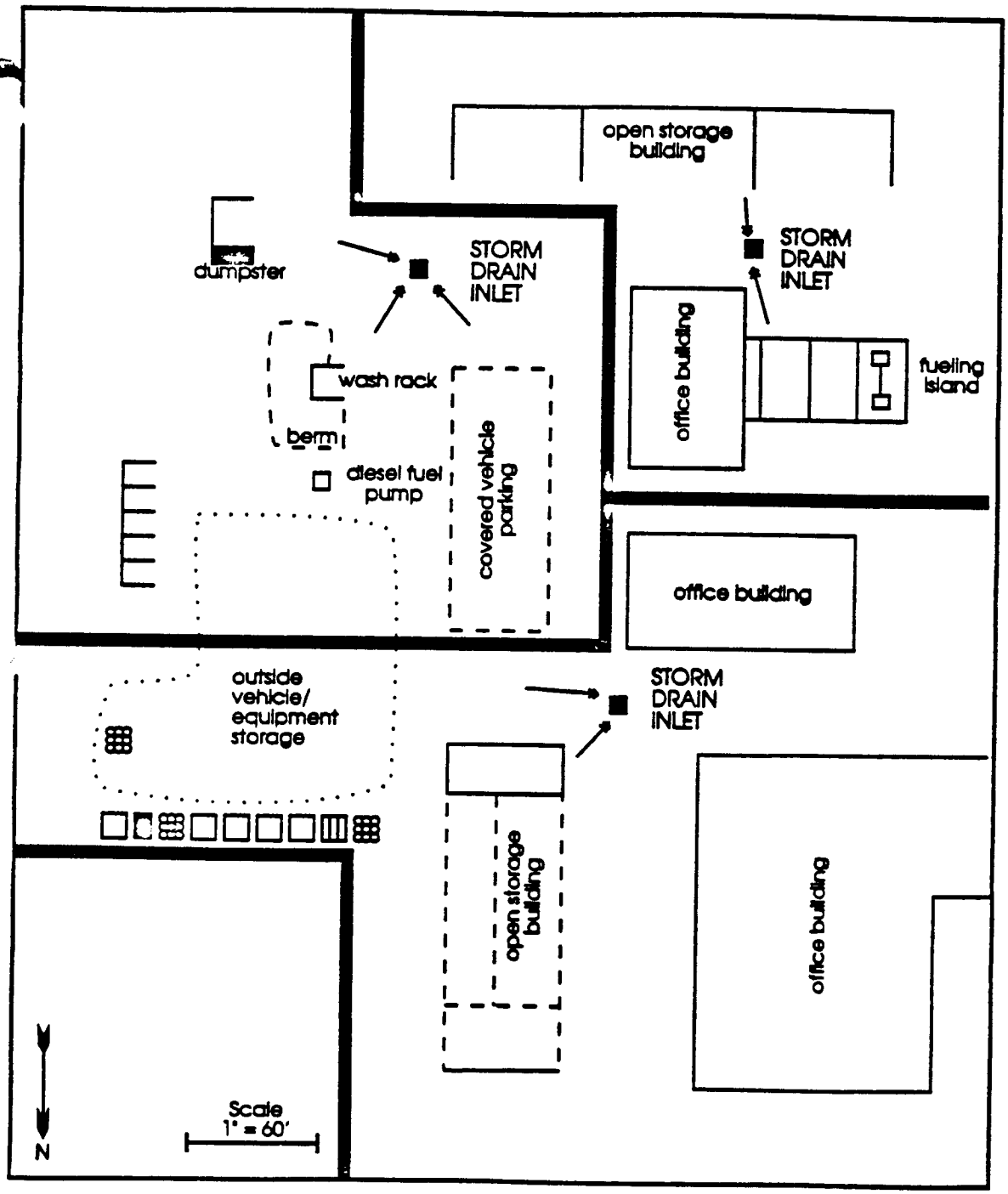

Figure 2
Example Drainage Map

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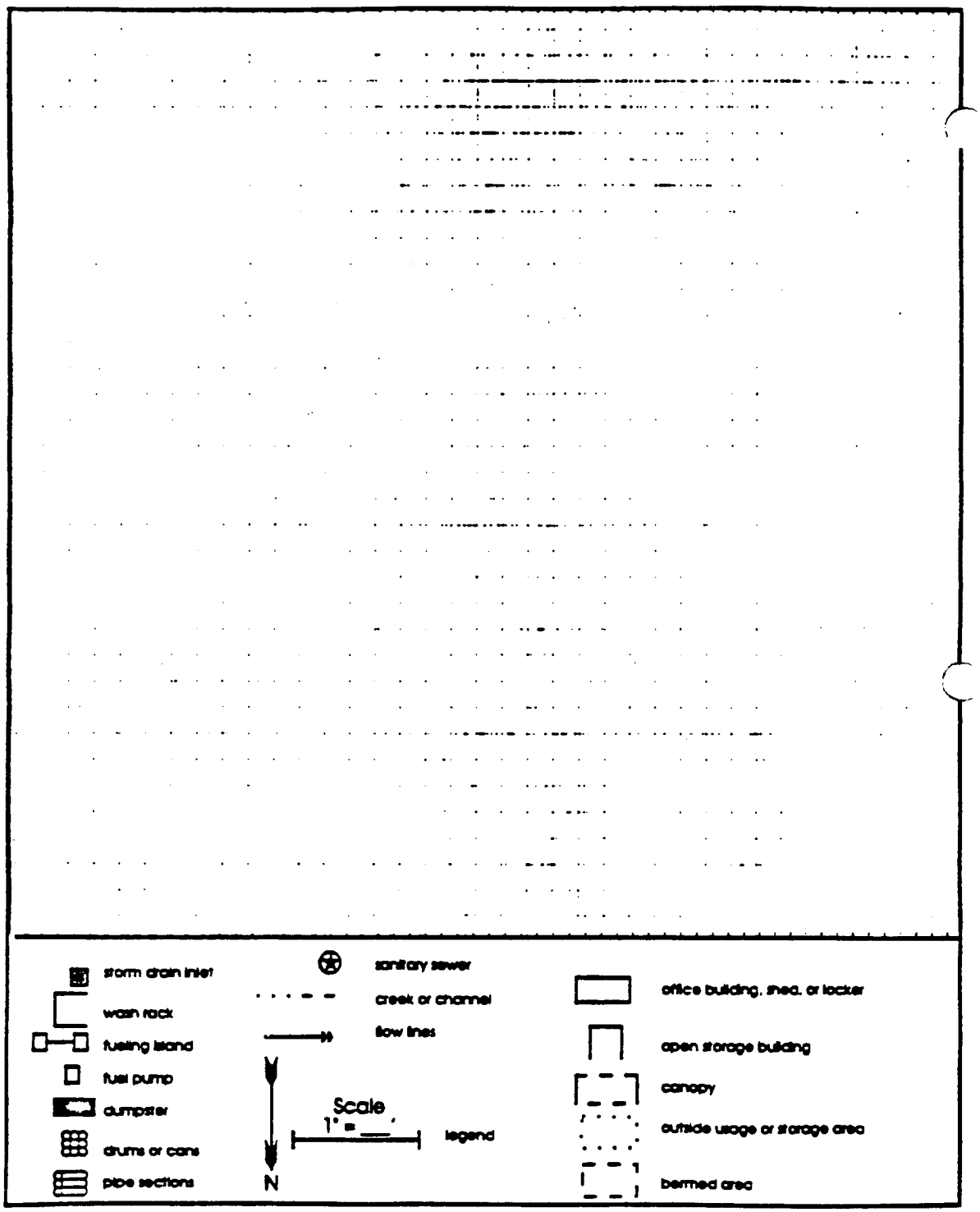

Figure 3
Facility Drainage Map

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As stated above, the overall goal of the storm water program is to effectively eliminate non-storm water discharges and implement controls to reduce the discharge of pollutants to the maximum extent practicable. One of the most important tasks in the *Stormwater Management Plan* is for municipalities who operate maintenance facilities to:

- review existing practices and budget for capital improvements needed to implement structural BMPs during FY 1994/95; and
- implement capital improvements for maintenance facilities by July 1, 1996.

This primarily relates to how wash water used to clean vehicles and equipment is disposed at maintenance facilities. By July 1, 1996, wash water must discharge to the sanitary sewer or be recycled. If not, vehicle and equipment washing must be conducted off-site at an acceptable facility or the municipality will be in violation of their municipal NPDES permit. Adequate spill prevention is also needed at corporation yards which may or may not require capital improvements.

Use the blank form provided (Table 1) to document non-storm water discharges. Information should be provided on past spills within the past two years, any ongoing wash water discharges to the storm drain system, and spills as they occur. This information can then be used to prioritize efforts to effectively eliminate non-storm water discharges.

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Table 1: Non-Storm Water Discharge Survey Form and Log

Record below all significant non-storm water discharges that have occurred at the corporation yard in the past two years and non-storm water discharges as they occur.

Date	Type of Non-Storm Water Discharge		Description			Response
(month/day/year)	wash water	spill	type of material	quantity	source	
ex. on-going	X			up to 2000 gallons per day	wash rack	Wash rack area will be connected to the sanitary sewer. Capital improvement project included in FY 1995/96 budget.

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Date (month/day/year)	Type of Non-Storm Water Discharge		Description			Response
	wash water	spill	type of material	quantity	source	

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In addition to effectively eliminating non-storm water discharges, the other major goal of the storm water program is to implement controls to reduce the discharge of pollutants to the maximum extent practicable using effective best management practices (BMPs). The Public Works Supervisors/Municipal Maintenance Activities BMPs Subcommittee (Subcommittee) has identified BMPs for corporation yards which are divided into two tiers:

- Tier I - BMPs to be implemented by every municipality now.
- Tier II - BMPs to be considered as equipment and other resources allow.

These BMPs were used to prepare worksheets to assist municipalities document the status of BMP implementation and identify tasks needed for planned improvements. On the worksheets, BMPs are categorized according to structural BMPs requiring capital improvements and operational BMPs.

The worksheets include seven categories of BMPs:

- General BMPs
- Washing Vehicles and Equipment
- Fuel Dispensing
- Chemical and Material Storage and Disposal
- Chemical Usage
- Fleet Maintenance/Vehicle Parking Areas
- Good Housekeeping Practices

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R0035372

4.1 GENERAL BMPs	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Structural BMPs Tier I. Capital improvements to ensure that non-storm water discharges to the storm drain system (e.g., wash water, floor drains in buildings) are effectively eliminated are included in the FY 1994/95 budget.				
Tier I. Capital improvements (identified above) will be implemented by July 1, 1996.				
Operational BMPs Tier I. Spill containment kits are stored in locations with potential for spills.				
Tier I. Inlets are labeled with the message "No Dumping, Drains to Bay." Inlets are inspected and cleaned as necessary at least once a year. Leaky vehicles are not parked over inlets and uncontained materials are not stored adjacent to inlets.				

R0035373

4.1 GENERAL BMPs	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Tier I. Municipal Government Maintenance Activities BMPs for Corporation Yards are incorporated into the "Hazardous Materials Business Plan" and/or "Spill Prevention Control and Countermeasures Plan." These plans are periodically reviewed with persons using the facility.				
Tier I. Facility survey of all maintenance facilities is conducted annually to ensure that all BMPs are implemented. If possible and appropriate, inspection is conducted in conjunction with hazardous materials management and/or spill prevention inspections.	(specify inspection date)			
Tier I. Person responsible for educating all persons using the facility of corporation yard BMPs, ensuring that all BMPs are implemented, and evaluating the effectiveness of BMPs.				
Tier II. Educational materials such as signs reminding people not to "top off" tanks are posted in appropriate areas.				

R0035374

4.2 WASHING VEHICLES AND EQUIPMENT If all washing is done off-site at a commercial facility check here ☐ (skip this page)	BMP Status			
	Existing BMP	Planned		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Structural BMPs*				
Tier I. Designated wash pad area exists for washing vehicles and equipment.				
Tier I. Wash pad drains to the sanitary sewer or wash water is recycled.				
Tier I. Wash pad area and sump are large enough and design is adequate to prevent spillage.				
Operational BMPs				
Tier I. All staff always use the wash pad area for cleaning vehicles and equipment.				
Designated person responsible for monitoring wash pad area	(specify name)			

* The *Stormwater Management Plan* requires that capital improvements be budgeted for during FY 1994/95 and implemented by July 1, 1996.

R0035375

4.3 FUEL DISPENSING	BMP Status			
	Existing BMP	Planned		
If all fueling is done off-site at a commercial facility check here ☐ (skip this page)		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Structural BMPs				
Tier II. Fuel dispensing area is covered.				
Tier II. Fueling area is paved with concrete or asphalt protected with a sealant.				
Tier II. Fueling area is designed to prevent "runon" of storm water and runoff of spills.				
Operational BMPs				
Tier I. Spill containment kits are accessible and stored nearby.				
Tier I. Spills are cleaned using dry methods.				
Tier I. "Hazardous Materials Business Plan" and "Spill Prevention Cleanup and Control Plan" are current and procedures are followed.				

R0035376

4.3 FUEL DISPENSING	BMP Status			
	Existing BMP	Planned		
If all fueling is done off-site at a commercial facility check here ☐ (skip this page)		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Tier I. Employees are trained in proper fueling and spill response procedures.				
Tier II. Designated area exists for fueling equipment with a mobile fuel truck.				
Tier II. Location of emergency shut-off valve(s) is clearly identified and labeled.				
Person responsible for monitoring fuel areas				

R0035377

4.4 CHEMICAL AND MATERIAL STORAGE AND DISPOSAL	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Structural BMPs Tier I. Chemicals are stored in an approved covered containment area. Floor is designed so any spilled materials will be contained and easily removed.				
Tier I. Hazardous materials and wastes stored outside are kept in closed drums within a secondary containment structure.				
Operational BMPs Tier I. All 55 gallon drums containing hazardous materials or waste are closed when not filling or emptying.				
Tier I. Chemical storage areas are protected from vandalism.				
Tier I. Chemicals wastes are disposed at an appropriate landfill or are recycled.				

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4.4 CHEMICAL AND MATERIAL STORAGE AND DISPOSAL	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Tier I. Material removed from streets and storm drainage facilities is stored on a concrete or asphalt pad in a contained area. Liquids, including decanted water from vactor trucks, drain to the sanitary sewer or are allowed to evaporate.				
Tier II. Material removed from streets and storm drain inlets is disposed at an appropriate facility.				
Person(s) responsible for monitoring chemical and material storage areas.	(specify name)			

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4.5 CHEMICAL USAGE	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
<u>Operational BMPs</u> Tier I. Safety equipment and spill containment kits are readily accessible in areas where chemicals are used.				
Tier I. Material Safety Data Sheets are reviewed.				
Tier I. Chemical usage is minimized. Water-based paints and non-toxic chemicals are used as much as possible.				
Tier I. Chemical waste generated is tracked.				
Tier I. **Oil-based Paints:** - Paint is wiped out of brushes. - Thinner is filtered and reused or disposed as hazardous waste. - Excess paint is disposed as hazardous waste or recycled.				

R0035380

4.5 CHEMICAL USAGE	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
Tier I. **Water-based Paints:** - Rinse water is discharged to the sanitary sewer. - Excess paint is dried in cans and disposed in trash or disposed as hazardous waste or recycled.				
Tier I. **Automotive Fluids:** Used fluids are collected and disposed at an appropriate facility or recycled.				
Tier I. **Pesticides:** Pesticide mixing, application and storage is according to CAL-EPA Department of Pesticide Regulation instructions.				
Tier I. **Solvents/Cleaning Solutions:** Used solvents and cleaning solutions are properly disposed of or recycled.				
Tier II. Drop cloths are used when painting, and outside work areas are cleaned each day.				

R0035381

4.6 FLEET MAINTENANCE/ VEHICLE PARKING AREAS	BMP Status			
	Existing BMP	Planned BMP		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
<u>Operational BMPs</u> Tier I. Equipment is inspected for leaks on a regular basis. Drip pans are placed under leaky vehicles. Vehicles with significant leaks are repaired.				
Tier I. Motor oil and other fluids are drained and replaced in a covered shop area. If fluids are changed outdoors, an area has been designated which does not drain to the storm drain system or sanitary sewer and where spills can be easily cleaned up.				
Tier I. Fleet maintenance and vehicle parking areas are periodically dry swept.				
Tier II. Vehicles and equipment used for asphalt repair are thoroughly cleaned and/or parked in covered areas.				
Person responsible for monitoring fleet maintenance and vehicle parking areas.	(specify name)			

R0035382

4.7 GOOD HOUSEKEEPING PRACTICES	BMP Status			
	Existing BMP	Planned		
		Task Needed to Implement BMP	Implementation Schedule	Department/ Person Assigned
<u>Operational BMPs</u> Tier I. The facility is inspected routinely to ensure that there are not illegal discharges to the storm drain system and that during storms, pollutant discharges are controlled to the maximum extent practicable.				
Tier I. Chemical storage areas are neat and orderly.				
Tier I. The yard is swept periodically (preferably once a week).				
Tier I. Material removed from streets and storm drainage facilities is disposed of often to minimize exposure to rainwater and runoff to the storm drain system.				
Tier I. Chemicals and materials stored in auxiliary yards are stored appropriately.				
Tier II. Adsorbent materials used to clean spills are removed promptly.				

R0035383

5.0 EVALUATION OF EFFECTIVENESS

The best way to evaluate the effectiveness of each municipality's program in eliminating non-storm water discharges to the storm drain system and controlling the discharge of pollutants to the maximum extent practicable is through visual monitoring. During wet weather, visual observations should be conducted at two locations or more for at least two storm events to observe the quality of storm water runoff. During dry weather, visual observations should be conducted at least once, preferably in conjunction with comprehensive annual inspections, to identify non-storm water discharges. The appendix contains forms to be used each year to document wet and dry weather visual observations.

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Appendix:

Wet and Dry Weather Visual Observation Forms

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6.0 CONCLUSION

In conclusion, completion of the Model SWPPP including tracking non-storm water discharges, implementing BMPs and conducting wet and dry weather inspections will ensure that municipalities comply with the goals of the Clean Water Act for their corporation yards as required by the *Stormwater Management Plan*.

Similar to SWPPPs required by the State Water Resources Control Board's General Stormwater Permit for industrial facilities, the Model SWPPP should be kept on the premises and updated as necessary over time. Each year, at least two wet weather and one dry weather inspection should be conducted. (The General Program will conduct corporation yard inspections during FY 1994/95 to assist municipalities identify potential problem areas and plan for any needed improvements.)

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Dry Weather Visual Observation Form

If possible, complete this form in conjunction with the annual facility inspection.

Date:_____ Time:_____

Inspector:_____

NON-STORM WATER DISCHARGES (Check all that apply)

☐ wash water ☐ vehicle washing ☐ equipment washing ☐ painting operations

☐ container washing ☐ parking area ☐ other_____

_____

☐ spills ☐ paint ☐ motor oil ☐ hydraulic oil ☐ axle oil ☐ gasoline

☐ diesel fuel ☐ used motor oil ☐ used engine fluids ☐ solvents

☐ disinfectants ☐ soap ☐ pesticides ☐ other_____

EVIDENCE OF NON-STORM WATER DISCHARGES (check and describe all that apply)

☐ stains Describe:_____

_____

☐ wet spots Describe:_____

_____

☐ residual material Describe:_____

_____

ARE BMPS EFFECTIVE? ☐ yes ☐ no

FOLLOW UP _____

_____

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Wet Weather Visual Observation Form

During the wet season conduct visual observations of at least two storm events that produce runoff. Preferably, runoff from the beginning of the first major storm of the year should be observed, and the next storm event observed should be preceded by at least 72 hours of dry weather. Make observations at two locations or more.

First storm event observed

Date:_____ Time:_____ Inspector:_____

Point 1 (check one): ☐ manhole ☐ outfall ☐ storm drain inlet ☐ ponded water ☐ other_____

(check all that apply which describe flow)

☐ discolored ☐ odor ☐ floating material ☐ suspended material

☐ turbid ☐ sheen ☐ muddy ☐ clear ☐ other_____

Follow up actions:_____

Point 2 (check one): ☐ manhole ☐ outfall ☐ storm drain inlet ☐ ponded water ☐ other_____

(check all that apply which describe flow)

☐ discolored ☐ odor ☐ floating material ☐ suspended material

☐ turbid ☐ sheen ☐ muddy ☐ clear ☐ other_____

Follow up actions:_____

Are BMPs effective? ☐ yes ☐ no _____

Second storm event observed

Date:_____ Time:_____ Inspector:_____

Point 1 (check one): ☐ manhole ☐ outfall ☐ storm drain inlet ☐ ponded water ☐ other_____

(check all that apply which describe flow)

☐ discolored ☐ odor ☐ floating material ☐ suspended material

☐ turbid ☐ sheen ☐ muddy ☐ clear ☐ other_____

Follow up actions:_____

Point 2 (check one): ☐ manhole ☐ outfall ☐ storm drain inlet ☐ ponded water ☐ other_____

(check all that apply which describe flow)

☐ discolored ☐ odor ☐ floating material ☐ suspended material

☐ turbid ☐ sheen ☐ muddy ☐ clear ☐ other_____

Follow up actions:_____

Are BMPs effective? ☐ yes ☐ no _____

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Nonpoint Source Control Program

Background

Nonpoint source (NPS) pollution generally results from land runoff, atmospheric deposition, drainage, or seepage of contaminants. Major sources of nonpoint pollution include agricultural runoff, runoff from urban areas, and runoff from silvicultural operations. Siltation and nutrients are the pollutants responsible for most of the nonpoint source impacts to the Nation's surface waters. These diffuse sources are often harder to identify, isolate, and control than traditional point sources. As a result, from 1972 to 1987, EPA and the States placed primary focus on addressing the obvious problems due to municipal and industrial discharges: issuing permits for point source discharges, then inspecting, monitoring, and enforcing those permits to ensure that point sources met the Clean Water Act requirements.

Sections 208 and 303(e) of the Clean Water Act of 1972 established the initial framework for addressing nonpoint sources of pollution. States and local planning agencies analyzed the extent of NPS pollution and developed water quality management programs to control it with funds provided by EPA under Section 208. Best management practices were evaluated, assessment models and methods were developed, and other types of technical assistance were made available to State and local water quality managers.

The National Section 319 Program

In 1987, Congress enacted Section 319 of the Clean Water Act, which established a national program to control nonpoint sources of water pollution. Section 319 created a three-stage national program to be implemented by the States with Federal approval and assistance. States were to address nonpoint source pollution by (1) developing nonpoint source assessment reports, (2) adopting nonpoint source management programs, and (3) implementing the management programs over a multiyear timeframe.

All States and Territories now have EPA-approved nonpoint source assessments. EPA has also fully approved 51 State nonpoint source management programs and has approved the high-priority portions of all remaining State management programs.

Section 319 also authorizes EPA to issue annual grants to States to assist them in implementing their

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EPA-approved programs. From FY90 through FY93, Congress appropriated more than $191 million for Section 319 assistance. EPA issued final guidance on the award and management of Section 319 funds in February 1991 following extensive public comment. The guidance encourages States to focus Section 319 funds on high-priority activities including:

- Addressing nationally significant, high-risk nonpoint source problems and focusing implementation activities in priority watershed or ground water areas
- Comprehensively integrating existing programs to control nonpoint source pollution
- Providing for monitoring and evaluation of program effectiveness including using water quality monitoring protocols
- Emphasizing pollution prevention mechanisms
- Protecting particularly sensitive and ecologically significant waters (wetlands, estuaries, wild and scenic rivers)
- Promoting comprehensive watershed management.

Roughly half of each State's annual award supports Statewide program activity (staffing, public education and outreach, technical assistance) and half supports specific projects to prevent or reduce nonpoint source pollution at the watershed level.

Funding under Section 319 is also available to American Indian Tribes with approved nonpoint source assessments and management programs. To date, EPA has awarded grants to the Poarch Band Tribe (Alabama) and the Colville Tribe (Washington). In addition, in FY91, one time funds were made available by EPA for tribal development of nonpoint source assessments and management programs.

In the summer of 1993, EPA will update the 319 grant guidance, incorporating lessons learned during 3 years of awarding and managing 319 grants and consulting with the States.

Section 319 National Monitoring Program

To improve technical understanding of nonpoint pollution and the effectiveness of various nonpoint source control technologies, the Section 319 grants guidance establishes requirements for a standardized water quality monitoring program for representative watersheds across the country. The guidance requires each of EPA's 10 Regional offices to award a portion of each year's funds to support more intensive water quality monitoring of selected watershed projects. To date, EPA headquarters has approved three projects: Long Creek, North Carolina, Sny Magill, Iowa, and Elm Creek, Nebraska. A total of approximately $1.4 million had been obligated for these projects as of July 1992. This national set-aside totalled approximately $2.1 million in FY91 and $2.3 million in FY92.

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The Sny Magill watershed involves an interagency effort to monitor and assess improvements in water quality resulting from the implementation of nonpoint source controls. The entire watershed is agricultural with no industrial or urban areas. Land use consists predominantly of cropland (corn, oats, and alfalfa), pasture, and forest. Sediment is the major pollutant but nutrients, pesticides, and animal waste are also of concern. The U.S. Department of Agriculture (USDA) will provide technical assistance, cost sharing, and educational programs to assist agricultural producers in implementing nonpoint source control measures such as sediment control, stream corridor management improvements, and animal waste management systems. Land treatment application will be coordinated with water quality monitoring.

The Bloody Run watershed (a neighboring watershed of approximately the same size) serves as the paired comparison watershed. Primary monitoring sites were established on both watersheds to measure discharge and suspended sediment. Other sites on both creeks will be sampled for chemical and physical water quality variables on a weekly to monthly basis. A habitat assessment will be conducted along stretches of both stream corridors annually, fishing surveys will be conducted annually, and biomonitoring of macroinvertebrates will be performed bimonthly.

The Long Creek project is located in south-central North Carolina. The watershed contains mixed agricultural and urban/industrial land use. Long Creek serves as the primary water supply for Bessemer City (population 5,000). Sediment from eroding cropland is the major problem in the upper third of the watershed (above the water supply intake). Long Creek is impaired mainly by bacteria and nutrients from urban areas and animal holding facilities below the intake. Proposed nonpoint controls involve implementing the land use restrictions of the State watershed protection law for areas above the water supply intake and a comprehensive nutrient management system for a farm below the intake. Water quality monitoring will include a station before and after the land treatment design near the water intake, an upstream/downstream design on the Creek above and below the dairy farm, and a paired watershed design at a cropland runoff site on the dairy. Continuous and grab samples will be collected at various sites to provide the data needed to assess the effectiveness of the nonpoint controls.

Reports on Section 319 Activities

The 1990 Report to Congress on Section 319 of the Clean Water Act, "Managing Nonpoint Source Pollution," provides the most current (as of October 1, 1990) and comprehensive information on nonpoint source programs at the national, State, and local levels. Included are findings of State nonpoint source assessments; related activities of EPA, other Federal agencies, and other entities; State

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achievements to date in controlling NPS pollution; and summaries of the activities and views of other private and public organizations active in the NPS arena. EPA is currently preparing an update to the 1990 report that will include activities carried out with the FY91 and FY92 grant awards. This update will be available in the fall of 1993.

National NPS Strategic Plan

In January 1989, EPA developed the *Nonpoint Source Agenda for the Future*. This Agenda was designed to assist EPA in defining the goals of the national NPS program and the means to achieve those goals.

The stated goal of the Agenda was to protect and restore the quality of U.S. waters through strong national leadership and by helping State and local governments overcome barriers to the successful implementation of NPS measures. Among identified barriers were (1) inadequate public awareness of the nonpoint source problem, (2) inadequate knowledge or inadequate transfer of knowledge about successful solutions to nonpoint source problems, and (3) inadequate incentives to correct nonpoint source pollution.

EPA organized the goals of the Agenda under five themes:

- Raise public awareness of nonpoint source pollution
- Provide States and local governments with information on practical nonpoint source solutions
- Provide financial incentives that encourage the public to install pollution controls and change land management practices.
- Help States and localities improve their regulatory capabilities (e.g., by developing water quality criteria and monitoring protocols specifically designed to evaluate control activities)
- Develop tools needed by States and localities to establish sound water-quality-based nonpoint source control programs.

EPA has made progress in all of the theme areas. For example, EPA (with assistance from the States and other Federal agencies) developed the first comprehensive nationally recognized technical guidance on nonpoint source management techniques during 1991 and 1992. EPA also initiated the first phase of its public awareness program: a nonpoint source brochure and poster were distributed in early 1990, and EPA's *Nonpoint Source Newsnotes* now serves as the primary vehicle for sharing State and local success stories on nonpoint control. EPA also began operating an electronic bulletin board to support transfer of nonpoint pollution information.

EPA believes that much of the Agenda continues to be sound and relevant. At the same time, 4 years of Federal funding for State nonpoint source implementation and the experiences that has provided, initiation of a new coastal nonpoint source program, and significant increases in State's commitment to address nonpoint source pollution create new opportunities.

Five Themes for NPS Action

- *Public Awareness*
- *Practical Solutions*
- *Financial Incentives*
- *Regulatory Capabilities*
- *Tools*

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Therefore, EPA, with the involvement of all parties who have a role to play in preventing and reducing nonpoint source pollution, will conduct, during 1993 and 1994, a broad and inclusive effort to develop an updated strategic plan for the national nonpoint source program.

Nonpoint Source Management Programs and Implementation

The States, local governments, community groups, and EPA Regions have initiated many innovative projects across the Nation to manage nonpoint source pollution problems. The projects described in this section exemplify the diversity of approaches that have been applied to NPS pollution prevention and control. In some cases, prevention or control is only beginning. In other situations, prevention and/or control measures have been in place long enough to show significant results.

Lake Whitney Reservoir, Connecticut

The Lake Whitney Reservoir in Hamden, Connecticut, has been a public water supply for the city of New Haven since 1862. The reservoir's watershed area (36.4 square miles) is primarily impervious due to residential, commercial, and industrial development. More than 60 storm water outlets discharge near or directly into Lake Whitney or the nearby Mill River without treatment. Main water quality problems are: sedimentation, accelerated eutrophication, and anoxia, which is largely the result of urban storm water runoff.

In an effort to restore Lake Whitney, a plan was developed to capture and treat storm water prior to discharge into Lake Whitney or its tributaries as well as to work with local townships to adopt storm water regulations. The 2-year project will demonstrate how the construction of a storm water treatment system can reduce the input of contaminants associated with urban runoff. Postconstruction monitoring of inflow and outflow from the storm water treatment basin will characterize the quality of urban runoff and the average pollutant removal efficiency. The results of the project will be applied to other subwatersheds that contribute to Lake Whitney.

Middle Fork River, West Virginia

In 1990, the American Fisheries Society (AFS) initiated a meeting with EPA and the Department of Interior's (DOI) Office of Surface Mining to discuss deteriorating water quality conditions and dwindling fisheries resources in eastern streams caused by acid mine drainage from abandoned coal mines. In response, the participants signed a Memorandum of Understanding agreeing to commit technical and financial support to a project in the Middle Fork River watershed.

The Middle Fork watershed encompasses 151 square miles in

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north central West Virginia. Acid mine drainage has eradicated fish from the lower 24 miles of the river. The effort to date has focused on inventorying all coal mine sites in the watershed, developing baseline water quality data, and designing and installing abatement techniques to remedy or reduce acid mine impacts. Along with contributions from the West Virginia Division of Environmental Protection and Division of Natural Resources, the West Virginia State Soil Conservation Committee, USDA's Soil Conservation Service (SCS), and DOI's Office of Surface Mining, EPA has provided Section 319 funds to establish a Geographic Information System to analyze the resource data provided by other agencies, to install an anoxic limestone trench and engineered wetlands to assimilate acid mine drainage and prevent entrance of acid waters into the river, and to evaluate and implement abatement technologies.

Indian Lake, Ohio

Indian Lake is a eutrophic lake in a rural watershed. The primary water quality problems are sedimentation and, to a lesser degree, nutrient enrichment. The project provides an excellent example of the use of a mix of EPA and USDA programs to address agricultural nonpoint source problems. First, EPA allocated Clean Lakes Phase I funds for evaluation of the lake's water quality problems.

Currently, Phase II Clean Lakes grants are funding implementation efforts such as construction of shoreline erosion controls and spot dredging so that the lake can be used for recreational purposes until sediment source control is accomplished in the watershed. Section 319 money provides assistance to farmers purchasing no-till planters and supports technical assistance and education costs throughout the watershed. USDA's SCS provides additional education and technical assistance to farmers through the Hydrologic Unit Program. Extra USDA cost-share funds are also being targeted to the watershed through its designation as an Agricultural Stabilization and Conservation Service's ACP Special Water Quality Project Area.

West Lake Reservoir, Iowa

West Lake is a reservoir owned and operated by the City of Osceola, which serves as a public drinking supply for the cities of Osceola, Woodburn, and several hundred rural users. In a watershed dominated by agricultural land use, runoff from cropland impacts the lake's water quality. Sediment, pesticides, and nutrients are major pollutants. Pesticides, such as atrazine, are of particular concern. Samples of treated drinking water often exceed EPA's maximum contaminant level of 3 parts per billion of atrazine (determined on an annual basis by averaging results of quarterly tests of treated drinking water).

To protect the reservoir, a comprehensive nonpoint pollution control project has been developed. The project emphasizes education and voluntary adoption of best management practices by farmers. Section 319 funds have been

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awarded to promote better farm management including the use of conservation tillage or no-till methods and integrated crop management (nutrient and pesticide management). To address the atrazine problem, more than 90% of the watershed's farmers voluntarily agreed to reduce or eliminate atrazine use during the 1992 cropping season. Initial monitoring results after the voluntary reductions found only one sample with atrazine levels greater than 3 ppb. Monitoring over a longer period will be necessary to determine if atrazine levels will remain below the maximum contaminant level.

Maskenthine Lake, Nebraska

In 1989, the Nebraska Department of Environmental Quality began one of its first Clean Lakes Program projects monitoring Maskenthine Lake in northeastern Nebraska with a Phase I grant. Project implementation began with funding from the Clean Lakes Program (Phase II), Section 319, the Lower Elkhorn Natural Resources District, and the USDA. In addition, EPA's TMDL "Swat Team" is assisting the State in calculating a TMDL for the lake with funding from a TMDL mini-grant. The project will determine the assimilative capacity of the lake for targeted pollutants (atrazine, nutrients, and sediment) and loading targets for the lake inflow. The TMDL process will evaluate various watershed management scenarios that include load allocations for subwatersheds, uplands, and stream channels. The State will use the TMDL to refine and implement the watershed management plan.

Godfrey Creek, Montana

The Godfrey Creek project combines a Section 319 nonpoint source pollution management project with a USDA Hydrologic Unit Area project. It addresses severe dairy/animal waste related water quality problems (i.e., high nutrient and bacteria levels and physical channel degradation) in the creek and the surrounding 8,000-acre watershed. The project strives to reduce nutrient and bacteria levels in the creek by 80% and to restore fisheries through on-farm implementation of best management practices over a 10-year period (1991-2000).

The Gallatin County Conservation District is managing the Godfrey Creek project with assistance from the SCS, the Extension Service, and the Montana Water Quality Bureau. Best management practices (BMPs), such as renovated and expanded dairy waste handling facilities, relocation of animal confinement areas, off-stream livestock watering, channel shaping, revegetation, improved grazing systems, and improved irrigation management are being implemented. Education, peer pressure, and observation of the successes of BMP implementation by the initial cooperating landowners have helped overcome initial resistance to the project. Although BMP implementation will take several years to complete, great progress has been made in securing the cooperation of the watershed's landowners.

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Morro Bay, California

The State of California established a cooperative agreement between the State Water Resources Control Board and the California Coastal Commission in response to the nonpoint source requirements of Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. The agreement provides resources for a nonpoint source control project in the Morro Bay watershed. Morro Bay is located in San Luis Obispo County within the central California coastal area. The watershed supports a $16 million agricultural industry. Limited grazing and the presence of several abandoned mines on public lands contribute sediment and heavy metals to the Bay. Major impairments are sediment, increased temperature, and agricultural pollutants such as nutrients. Cost-share funds are being provided for implementation of selected erosion control practices. California, with support from EPA Region 9, will support a long-term monitoring effort in the watershed and the project is being considered for inclusion in the Section 319 national monitoring program.

Malheur Experiment Station Best Management Practices Research and Development Program

Oregon has used Section 319 funds to support multiple, interrelated ground water protection projects in the Malheur Basin, an irrigated area in the eastern part of the State. Heavy fertilizer and chemical applications have contaminated the shallow aquifer underlying the Malheur Plains. Nitrate concentrations exceed EPA's maximum contaminant level in many private wells. Oregon's Department of Environmental Quality has designated the Malheur Basin as a ground water management area under the State's Groundwater Management Act. This designation enables State agencies to focus resources on nonpoint source problems contributing to ground water contamination.

Oregon State University's Agriculture Experiment Station is leading the research efforts to develop modified fertilizer applications (rate and timing) and new irrigation practices that reduce nitrate contamination of the ground water. The Experiment Station shares its results with local growers through widely attended annual field days, during which they take growers on tours of various experiment sites and explain the objectives and results of each project.

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Upper North Bosque Watershed, Texas

The Upper North Bosque Watershed demonstration project, west of Fort Worth, supports technical assistance, water quality monitoring, and technology transfer activities. The Texas State Soil and Water Conservation Board (TSWCB) provides an onsite coordinator to integrate animal waste management activities in the basin. The coordinator assists area dairy operators in understanding the technical requirements of the Texas Water Commission's animal waste rules. The project also supports water quality monitoring by the Texas Agriculture Extension Services (TAEX) at the edge of fields on two dairies that land-apply their waste. Both farms have established filter strips (of varying size and grass species) that are instrumented with automatic samplers to measure nitrogen, phosphorus and bacteria in the runoff water.

Monitoring for sediment, nutrients, dissolved oxygen, bacteria, and oxygen-demanding waste will be conducted to assess best management practices at selected sites. Biological monitoring of benthic organisms will be performed on the three tributaries and on the main stem of the Bosque River to evaluate the effectiveness of the project. The USDA also has begun a Hydrologic Unit Area project in the watershed that will determine the cost of shared lagoon installation and provide increased technical assistance to dairy farmers.

The demonstration project, working through the Tarleton Institute for Applied Environmental Research (TIAER) at Tarleton State University, coordinates the actions and policies of private citizens, dairy farmers, city and county governments and State agency personnel to promote changes in waste handling practices. Each member is to transfer the technology and program information back to his/her respective group or agency and work to implement the changes agreed upon. Demonstration of new technology on six sites will be part of the TIAER education/outreach program.

Bluewater Creek, New Mexico

The Bluewater Creek watershed is located 60 miles west of Grants, New Mexico, in the Cibola National Forest. In this project, the USDA Forest Service and the USDA Soil Conservation Service are implementing best management practices (BMPs) on Federal lands to prevent further overgrazing in the watershed. Newer and innovative BMPs include riparian fencing to exclude cattle, people, and elk; rerouting of roads and road closures; and rechannelizing a stream away from sloughing stream banks too steep and unstable to repair. The Forest Service also added improved livestock management requirements to new grazing leases, such as rest/rotation grazing systems.

These agencies and New Mexico's Environment Department are also monitoring BMP effectiveness with instream grab samples above and below each BMP site during all seasons. The agencies monitor physical, chemical, and biological parameters, as well as physical habitat. The data gathered by New Mexico's Environment Department on this project suggest

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that some BMPs are truly more effective than others and other BMPs would be effective if their design and installation location were modified. The Forest Service has used this information to modify their BMP handbook and design specifications.

Funding for Nonpoint Source Control

In addition to Section 319 funds, several States have taken advantage of State revolving funds (SRFs) to provide loans to finance nonpoint source and other water pollution control programs. SRFs were originally established to assist States in upgrading their sewage treatment systems, but the 1987 amendments to the Clean Water Act provide States with the opportunity to use these funds for nonpoint source control. SRF loans are particularly suitable for funding structural BMP construction, such as storm water detention ponds and manure storage structures.

At present, four States – Washington, California, Delaware, and Wyoming – are using SRF loans to fund a wide variety of nonpoint programs. Approved projects will retrofit failed septic tanks, construct storm water management structures, remediate leaking underground storage tanks, and build poultry composting facilities. As States meet sewage treatment system upgrade requirements, SRF funds will become increasingly available to address nonpoint source problems.

New Initiatives in NPS Control

The 1990 Farm Bill

The Food, Agriculture, Conservation and Trade Act of 1990 (1990 Farm Bill), enacted by Congress on October 25, 1990, contains strong water quality provisions and offers new opportunities to link USDA and EPA water quality programs in the States. The bill, hailed by many as the most environmentally sound agricultural legislation ever passed by Congress, builds on existing USDA and EPA efforts, broadens the applicability of the Conservation Reserve Program (CRP) to environmentally sensitive areas and establishes a new Wetland Reserve Program (WRP) and Water Quality Incentives Program (WQIP).

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The CRP, created by the 1985 Farm Bill, has paid producers to remove highly erodible cropland from production for a 10-year period to protect and improve soil and water resources. The 1990 Farm Bill expands the land eligibility requirements to include not only highly erodible land, but also other cropland areas that are potential threats to surface water quality and ground water quality in wellhead protection areas. The bid evaluation process also provides higher priority for producers who provide filter-strips, sod waterways, shelterbelts, and contour grass strips on their property, which increase water quality benefits under the CRP.

The Act also established a Wetland Reserve Program with an enrollment goal of up to 1 million acres. Land accepted into the WRP would be removed from production through easements.

The WQIP allows the USDA to provide technical assistance and up to $3,500 in incentive payments to individual producers to develop and implement farm-level water quality plans. An additional $1,500 in cost-share payments is available to individual farmers to implement some practices. Lands identified by States under the Wellhead Protection Provisions (Section 1428) of the Safe Drinking Water Act and Section 319 of the Clean Water Act are explicitly targeted under the WQIP. Other areas targeted are endangered or threatened species habitat areas and areas of karst topography, which are particularly vulnerable to seepage of contaminants.

In addition to the WQIP and CRP, the Farm Bill contains provisions for greater flexibility to allow crop rotations, sustainable agriculture research and education programs, pesticide recordkeeping for certified applicators, and an organic food certification program.

The Coastal Zone Management Reauthorization Amendments of 1990

Congress also enacted the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990, which established under Section 6217 a new coastal nonpoint source pollution control program that integrates State Section 319 (CWA) programs with State Coastal Zone Management Act (CZMA) programs. NOAA administers the

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CZMA and EPA administers Section 319, and the two agencies have worked cooperatively toward implementing Section 6217.

Section 6217 requires that States with federally approved coastal zone management programs develop and implement Coastal Nonpoint Pollution Control Programs to ensure protection and restoration of coastal waters. Twenty-nine States and Territories, including several Great Lakes States, currently have approved coastal zone management programs.

Under CZARA, State Coastal Nonpoint Pollution Control Programs must provide for implementation of (1) management measures specified by EPA in the national technical guidance, and (2) additional, more stringent measures developed by each State as necessary to attain and maintain water quality standards where the baseline measures do not accomplish this objective. The CZARA further provides that States' Coastal Zone Management Programs must contain enforceable policies and mechanisms to ensure implementation of the baseline and additional management measures.

EPA issued final technical guidance in January 1993. This guidance specifies management measures for five major categories of nonpoint pollution: agricultural runoff, urban runoff, silvicultural runoff, hydromodification, and marinas and recreational boating. The guidance also describes specific practices that may be used to achieve the level of prevention or control specified in the management measures.

EPA and NOAA have also issued joint program guidance to assist the States in developing coastal nonpoint pollution control programs. Final program guidance was issued in January 1993. The program guidance addresses issues related to development by the States of coastal nonpoint programs for joint approval by NOAA and EPA. The States must submit coastal nonpoint control programs to NOAA and EPA within 30 months of issuance of the management measures guidelines (July 1995).

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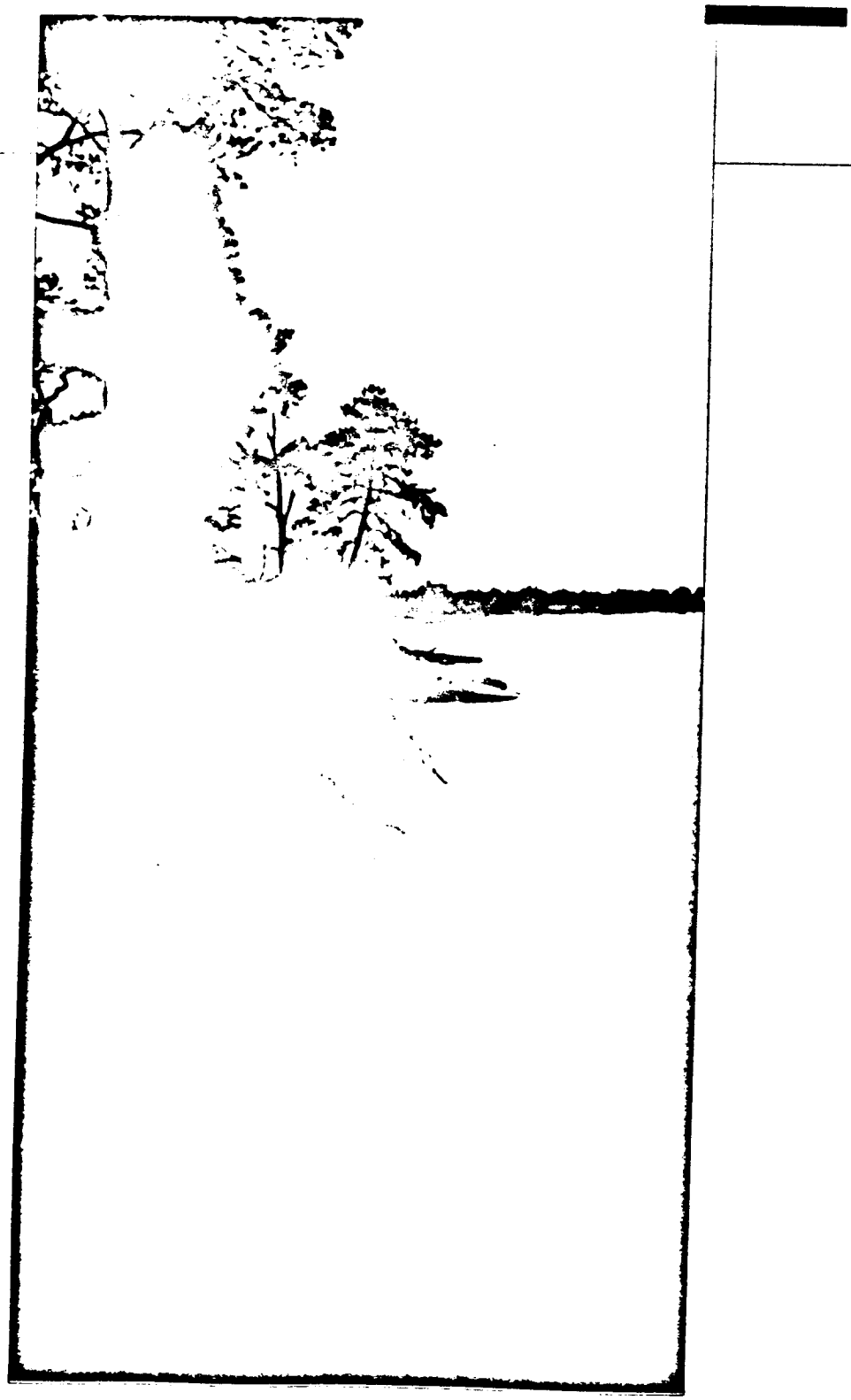

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The Section 314 Clean Lakes Program

Introduction

Background and New Themes Since the 1987 CWA Reauthorization

The principal Federal program dealing with restoration of degraded lakes is EPA's Clean Lakes Program (CLP), established by the Clean Water Act (CWA) of 1972. Activities under the CLP began in 1975 as congressional appropriations were used to develop a national program to clean up publicly owned freshwater lakes. From 1975 to 1978, research and development grants were issued to identify restoration techniques and conduct demonstration projects to restore specific lakes. By 1980, formal regulations were finalized governing the award of Federal funds for Clean Lakes grants. These regulations (40 CFR Part 35, Appendix H) still provide the framework for use of the Federal grants and for States seeking to create their own programs.

The CLP has always stressed the need for skillful coordination with other State or Federal programs. During the 1970s and early 1980s, a major goal of CLP grants was to rehabilitate lakes that had experienced excessive nutrient inputs from point and nonpoint sources of pollution. The CLP requires that all point sources be treated or have treatment planned under Sections 201 and 402 of the CWA before a grant is awarded for in-lake restoration activities.

In the course of the 1980s, and especially with the 1987 CWA reauthorization, States were encouraged to consider control measures for nonpoint source impacts and even for multimedia issues such as acid rain. Programs that integrated support from CLP with assistance from other Federal, State, or local initiatives were encouraged. In particular, States were encouraged to coordinate their CLP activities with their Section 319 Nonpoint Source Management Programs. The CLP helped pioneer a holistic watershed approach to identifying lake pollution control and restoration needs. This watershed perspective is prominent in Section 319 programs and is a major organizing principle for the Section 303(d) TMDL process and for such efforts as EPA's new Watershed Protection Approach (WPA). These integrated management concepts are important for projects carried out wholly within the scope of a Federal CLP grant. Such concepts become essential when projects are designed to address concerns that could easily exceed the levels of support from a conventional Section 314 project.

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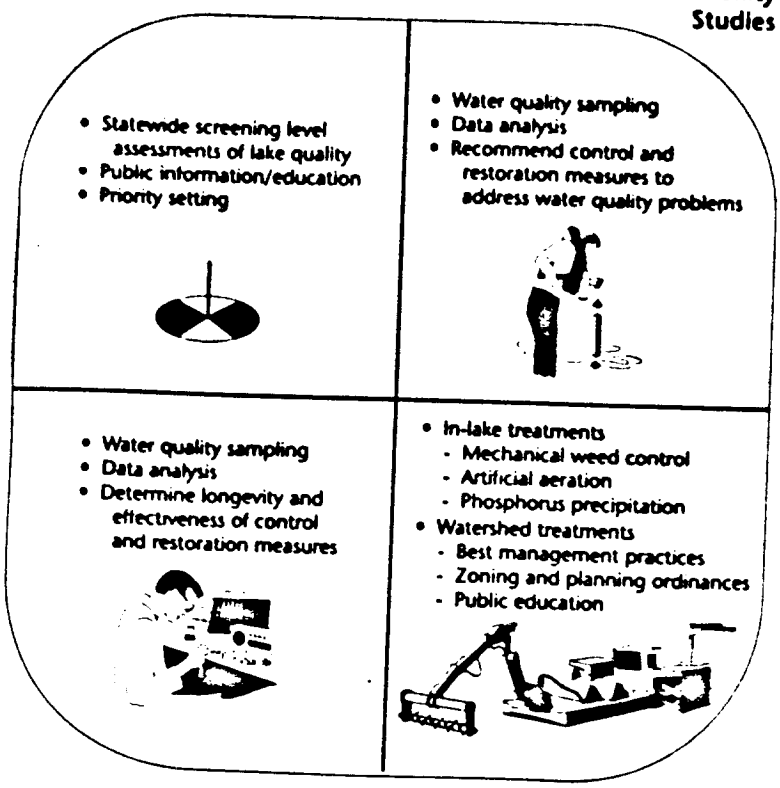
Especially for larger lakes, or where watershed control measures are vital to successful lake protection or restoration, the Clean Lakes Program becomes just one component in a larger institutional framework.

Figure 15-1

Activities Conducted with Clean Lakes Program Grants



Program Goals and Objectives

The CLP encourages States to develop active, ongoing monitoring and assessment programs and has supported these efforts with Lake Water Quality Assessment Grants. These activities should be sufficiently broad to cover all important publicly owned lakes in a State, with general monitoring procedures geared to those lakes with high-priority protection or restoration needs. For as many lakes as possible, and certainly for lakes with serious water quality concerns, more detailed investigations should be conducted to outline the major pollution problems (or threats) and identify appropriate restoration or control techniques. Where this sort of background information is available, and where stakeholders can be identified who are willing to assume management or stewardship responsibilities, the stage is set for actual lake projects.

The first step is to carry out an appropriate limnological study to document baseline conditions and to make a careful determination of the most appropriate techniques for pollution controls and in-lake or watershed restoration measures. The next step is to implement the recommended management measures, making use of available CLP grants but also leveraging support from other local, State, and Federal resources. The final step is to document the success of the lake project, gathering technically sound evidence that water quality conditions have improved.

The three steps described coincide with CLP Phase I, Phase II, and

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Phase III grants (Figure 15-1). One of the most difficult parts of the Clean Lakes Program lies in putting together enough information to initiate a Phase I grant. After adoption of the formal rules and regulations in 1980, EPA provided funds for States to carry out classification surveys. These classification survey grants provided States an opportunity to evaluate existing information, and collect new data where needed, to provide an ample candidate pool of publicly owned lakes. A typical State would be able to assemble good background information on approximately 100 lakes. From the classification information, a ranking system could be developed to highlight lakes with the more pressing management concerns for award of CLP project grants.

By the 1987 CWA reauthorization, many States were using classification and priority lists that did not always reflect current conditions. In addition, the original classification surveys had focused almost exclusively on adverse impacts from excessive nutrient loadings, excessive sedimentation, or other signs of significant cultural eutrophication.

The 1987 reauthorization encouraged States to adopt an even broader water-quality-based perspective. Although there was still a need for evaluating lakes according to their trophic condition, States were also asked to consider any other major pollution problems. In addition to conventional pollutants (e.g., nutrients or sediment), States were to pay attention to impacts from toxics and acidity problems resulting from acid mine drainage or acid deposition.

Instead of a one-time classification survey, lake monitoring and assessment were to become part of each State's continuing planning process. Available information was to be summarized biennially and submitted as part of the biennial 305(b) reports. To help States institutionalize these enhanced lake monitoring and assessment expectations, EPA has made available special Lake Water Quality Assessment grants. Most States, and other groups such as American Indian Tribes, have taken advantage of these grants, and, with the 1992 National Inventory Report, many States have completed the transition from their older classification surveys to more current information generated over the past 2 to 4 years.

Publicly Owned Lakes

The CLP requires participating States to define "significant publicly owned lakes" that are eligible for CLP assistance. The CLP and the States focus on highly utilized lakes because local citizens and governments are more likely to assist in control and restoration projects and assume ongoing stewardship for these lakes and their watersheds. High-value lakes attract a diverse group of local stakeholders to anchor the activities associated with a Section 314 project.

States define significant publicly owned lakes with varied physical and legal criteria, but most States include minimum size criteria and recreational use caveats in their definitions. For example, New Hampshire's definition of significant publicly owned lakes is "any freshwater lake or pond that has a

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surface area of 10 or more acres, is not private, and does not prohibit recreational activity."

Some States further refine their definition of significant publicly owned lakes with quantitative criteria that describe recreational use. In another example, Iowa's screening criteria for significant publicly owned lakes exclude shallow marsh-like lakes, reservoirs used solely for water supply, and flood control impoundments constructed by the U.S. Army Corps of Engineers.

As a general rule of thumb, most States settle on a set of significant lakes ranging in number from less than a hundred (for a smaller State like Rhode Island) to a few hundred lakes in larger western or midwestern States.

Clean Lake Program Implementation Grants

Based on the most current monitoring and assessment information for significant publicly owned lakes, States prepare a classification list and a ranking and prioritization system to help target the lakes most in need of restoration or pollution control attention. High-priority candidate lakes can be considered for three types of cooperative agreements under the Clean Lakes Program:

■ Cooperative Agreements for Phase I:

Diagnostic/Feasibility Studies: These studies investigate the causes of the decline in quality of a publicly owned lake and determine the most feasible procedure for protecting and restoring the lake. The maximum Federal contribution is $100,000 with a 30% non-Federal match required.

■ Cooperative Agreements for Phase II Projects:

These projects implement the recommended methods and procedures for controlling pollution entering a lake and for restoring or protecting a lake. Phase II agreements follow Phase I studies or equivalent investigations. There is a 50% non-Federal match for Phase II awards. There is no absolute cap on the size of the Federal share.

■ Cooperative Agreements for Phase III Studies:

Postrestoration monitoring cooperative agreements offer selected projects the opportunity to conduct long-term, postrestoration monitoring studies to verify the longevity and effectiveness of various restoration techniques. The non-Federal share is 30% with the maximum Federal share set at $125,000.

In addition to these lake-specific cooperative agreements, States can be eligible for cooperative agreements for Lake Water Quality Assessments.

■ Cooperative Agreements for Lake Water Quality Assessments:

These awards are intended to help States compile a comprehensive Statewide assessment of lake water quality, to enhance overall State lake management programs, and to increase public awareness and commitment to protecting lakes.

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The Clean Lakes regulations require that any lake project must be consistent with the State Water Quality Management Plan (40 CFR Part 35). This is to ensure that EPA and the States coordinate a variety of programs under the Clean Water Act, the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and other laws administered by EPA. The Clean Lakes Program is conducive to integration with other water quality management programs because of the natural linkages between lake management and other environmental efforts.

EPA has provided support to help States develop ongoing lake assessment efforts through special Lake Water Quality Assessment (LWQA) grants. In addition to detailed monitoring work carried out through State water quality agencies, LWQA grants have been used to provide technical assistance to citizen or lake association monitoring groups. These local volunteer groups typically use Secchi depth measurements to monitor lake transparency. Although many States feel that additional measurements are needed to provide an adequate characterization of lake trophic status, time series data collected by volunteers can be valuable to document trends in lake water quality. This information can also be used to develop relative ranking systems based on an important aspect of a lake's recreational appeal. Grass roots involvement starting with volunteer monitoring activities can also help build the institutional frameworks vital to undertaking a successful lake restoration project. These grants have very successfully created and fostered strong working relationships among EPA, States, local governments, and citizens.

In addition to its work with the States and such political entities as the District of Columbia and Puerto Rico, the Clean Lakes Program has made substantial progress in expanding its work with American Indian Tribes. The 1987 CWA reauthorization stressed enhanced partnerships in all programs in which American Indian Tribes could assume management or stewardship responsibilities. In addition to activities such as the National Pollutant Discharge Elimination System (NPDES) permitting program, American Indian Tribes are also encouraged to develop monitoring and assessment programs and to use this information to address both point and nonpoint source pollution control efforts. Many American Indian Tribes are interested in developing watershed-based approaches to improve the management of lakes and streams on tribal lands. The CLP has proved a very attractive vehicle for American Indian Tribes to develop monitoring and resource stewardship capabilities. To become eligible for CLP grants, Tribes must meet several requirements in CWA Section 518 that enable EPA to treat Tribes as States. Since 1989, 18 American Indian Tribes in seven EPA Regions have participated in LWQA grants, and several American Indian Tribes have proceeded with Phase I or Phase II implementation grants.

As specified in the Clean Lakes Program Guidance, Clean Lakes projects must be developed and implemented on a watershed basis. This ensures that restoration

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activities funded by EPA are long term and address symptoms of water quality impairments as well as immediate lake restoration. The Guidance further states that this geographic approach to water quality management has been identified as a key element of success in nonpoint source control, ground water protection, water-quality-based permitting, estuanne protection and cleanup, and wetlands protection. In awarding cooperative agreements under the competitive Clean Lakes Program, EPA favors projects with a watershed-based approach to water quality management.

Starting with grant awards for fiscal year 1990, the Clean Lakes Program has recommended that EPA Regional offices (which have been delegated authority to enter into Clean Lakes cooperative agreements with the States) encourage States to integrate their Clean Lakes projects with other State and Federal programs. This memorandum also encourages States to consider technical and financial assistance that may be available through Section 319 State nonpoint source programs for targeted watershed demonstration projects. The memo also mentions that USDA P.L. 83-566 projects (for small watershed conservation assistance) promote land treatment activities in watersheds significantly affected by agricultural nonpoint source pollution.

Section 314 Reporting Requirements

Biennial Lake Assessment

Under the 1987 CWA reauthorization, several new provisions were added to the original provisions encouraging States to identify their publicly owned lakes and classify them according to their eutrophic condition. Lake assessment information was to be updated in a fashion analogous to other State water quality assessments and reported biennially following the same time lines as the Section 305(b) reports. Most States now include their Section 314 lake assessments in their 305(b) reports. Recent procedural changes to the regulations governing the Water Quality Planning and Management Program (FRL-3979-8, *Federal Register*, Vol. 57, No. 143, Friday, July 24, 1992) now clearly specify that lake assessment materials should be part of the 305(b) report submittals.

Continued Importance of Trophic Status Classifications

Reporting on trophic conditions is still a central feature under the 1987 CWA reauthorization, and most States still use ranking systems based primarily on this trophic status information as the foundation for their selection of candidates for the Federal Clean Lakes Program grants.

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Pollution Control and Restoration Techniques

The Clean Water Act encourages reporting on in-lake restoration techniques to improve lake water quality and control techniques for reducing pollutant loadings from the surrounding watershed. Lake pollution controls may include provisions in point source permitting or other regulatory programs. States can describe lake quality standards and monitoring programs related to standards enforcement as a means of controlling lake pollution. States should also describe the relation of their CLP to other State programs, especially their Section 319 nonpoint source management programs. Approaches working with other State or Federal programs can also be included.

States should also provide materials on their lake restoration techniques. For example, States may provide specific restoration techniques from which they will draw to develop lake-specific management plans. Where possible, States are encouraged to document specific techniques recommended for individual publicly owned lakes. This information could be drawn from CLP projects completed or under way as well as techniques anticipated to be promoted for specific lakes.

Toxics and Acidity Impacts or Threats

During the 1980s, considerable national attention was focused on how pollution factors can lower the pH of receiving waters, especially lakes. Acidity can pose a direct threat to aquatic life and lake recreational amenities. Major potential sources would be atmospheric deposition or acid mine drainage. In addition to impacts from acidity per se, low pH conditions can accentuate impacts from a variety of toxicants. For instance, many metals show increased availability as the pH drops and, where acid mine drainage is involved, the pollutant source for the acidity may also be a source of toxicants. Acidity may also accentuate the impacts on aquatic organisms of a variety of toxics and may often increase bioaccumulation or biomagnification processes that move toxicants into the tissues of fish and thus into the food chain. Toxic accumulations in sediment also complicate the use of lake restoration techniques such as dredging.

In light of these concerns, Congress added provisions for State lake assessment reporting to document known instances of acidity or toxics impact to public lakes. If such issues are related to actual impairments or pose real degradation threats, States are encouraged to document methods and procedures that could mitigate the harmful effects of high acidity or toxic metals and other toxic substances. These activities are funded with LWQA grants.

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The Red Lake Chippewa Lake Assessment Grant

The 1987 Clean Water Act reauthorization encouraged States, and other groups with lake stewardship responsibilities, to develop ongoing monitoring and assessment programs. To help institutionalize these assessment activities, the national Clean Lakes Program created special Lake Water Quality Assessment (LWQA) Grants, which became available starting in fiscal year 1989. By the end of the 1992 305(b) reporting cycle, most States had availed themselves of these "modified" Clean Lakes Phase I cooperative agreements. Section 518(e) of the CWA also encouraged EPA to work with those American Indian groups interested in assuming responsibilities for programs or grants. In addition to activities such as the National Pollutant Discharge Elimination System (NPDES) permitting program, Tribes may apply for a variety of water quality management grants. Since 1989, the EPA Clean Lakes program has awarded Lake Water Quality Assessment grants to 18 American Indian Tribes in seven EPA Regions. These LWQA grants can help equip American Indian groups to organize their own Clean Lakes programs.

There has been considerable interest in these LWQA grants in Region 5. States such as Wisconsin and Minnesota are dotted with natural lakes and have numerous large tracts of American Indian lands. A good example of an LWQA grant is work being completed by the Red Lake Chippewa Tribe. The Chippewa, also known as the Ojibway, are part of the Sioux Indian Group that inhabitated an area from the forests of the upper Midwest out into the prairies. By 1919, the Chippewa people in Minnesota had been assigned to a number of scattered holdings and two large reservations. The Red Lake Chippewa have set up a so-called "closed" reservation–they direct their tribal government, have control over their resource base and livelihoods, and have preserved their native language and customs.

The reservation covers an area the size of Rhode Island and is the home for around 4,000 people. The tribal lands surround the 230,000 acres of the Upper and Lower Red Lakes. These waterbodies represent remnants of the mammoth Lake Agassiz that covered most of the

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present drainage of the Red River of the North during the Ice Ages. The Red Lakes are perched above several ancient shoreline terraces in a scenic wooded landscape completely different from the flat prairies on the Red River's course along Minnesota's border with the Dakotas. The Red Lakes are famous for their walleye pike, perch, and whitefish. Since 1929, the Tribe has operated a cooperative that harvests and packages fish for commercial markets as far away as Minneapolis and Chicago. The Tribe grows much of its own food. There are commercial timber operations as well as a sawmill, a factory for cedar fencing materials, and shops producing other finished wood products. The Tribe operates its own schools, general stores, and other commercial and social services.

These diversified economic enterprises and land use activities can pose threats to the integrity of water resources on the reservation. An LWQA Grant awarded with FY 1989 funds has enabled the Red Lake Chippewa to gather baseline data on the trophic condition of the Upper and Lower Red Lakes and inventory possible pollutant sources in the lakeshore area and along small tributaries.

The Tribe is especially eager to identify critical erosion areas and activities that could increase nutrient loadings. Traditionally, the oligotrophic Red Lakes contain few nutrients, but considerable natural inputs of humic materials from marshes and wetlands give the water a brownish appearance. The natural coloration of the water prevents the Chippewa from detecting trophic status with simple measurements such as Secchi disk depth. Therefore, they must perform detailed site evaluations and chemical analyses to detect nutrient and sediment hotspots. To date, sampling performed with the LQWA Grant has documented nutrient inputs from a malfunctioning lift station in a community sewerage system. When complete, the findings of this assessment grant will help the Tribe pursue an integrated approach to implementing lake restoration or watershed control measures.

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Lake Beneficial Use Impairments and Trends

The 1987 CWA reauthorization contained many provisions encouraging a water-quality-based approach to pollution assessment, planning, and management activities. Biennial lake assessments are now expected to make use of available information to document publicly owned lakes where uses are known to be impaired as well as lakes where there is evidence of water quality deterioration. Most States use EPA's Waterbody System to produce summary tables that categorize lake acreages by use attainment (e.g., fully supporting, threatened, partially supporting, or not supporting). Summary tables are also generally provided that categorize the major causes and sources of pollution. However, many States still lack water quality standards for lakes. Without standards, States cannot assess beneficial use support and lake impairments in a consistent manner.

Under the 305(b) reporting process, States are encouraged to provide waterbody-specific summaries of various public health and aquatic life concerns. This can include information on fishing advisories, fish kills, sites with sediment contamination, restrictions on surface water drinking supplies, bathing area restrictions, and incidents of waterborne diseases. This information is reported for all waterbody types, including lakes. Perhaps the most common concern reported is the contamination of fish tissue by toxicants, leading to fish consumption warnings or advisories. Although valuable, many States have difficulty relating this information clearly to provisions in their own water quality standards. For instance, a public health agency may declare a fish consumption advisory for a lake based on trigger values for some toxicant (for instance, mercury) that are not tied to numeric standards criteria for any particular beneficial use. States are making progress in achieving consistency in their reporting of concerns such as fish consumption advisories in relation to their reporting State beneficial use attainment status. However, results for these two types of assessment information may require careful scrutiny to avoid misinterpretation.

A final provision in the 1987 CWA reauthorization encourages States to make use of available information to identify apparent trends in water quality for public lakes. Where possible, such determinations should look not only at shifts in trophic status but at all forms of point and nonpoint source pollution. Attention to trends involving toxics is particularly recommended.

Trophic Status

Trophic condition is a characterization of a lake's biological productivity based on the availability of plant nutrients. Commonly accepted systems for describing trophic status recognize a range of conditions, with oligotrophic indicating the least biologically productive lakes and eutrophic indicating significantly higher levels. For national reporting purposes, the following categories are recommended: oligotrophic, mesotrophic, eutrophic,

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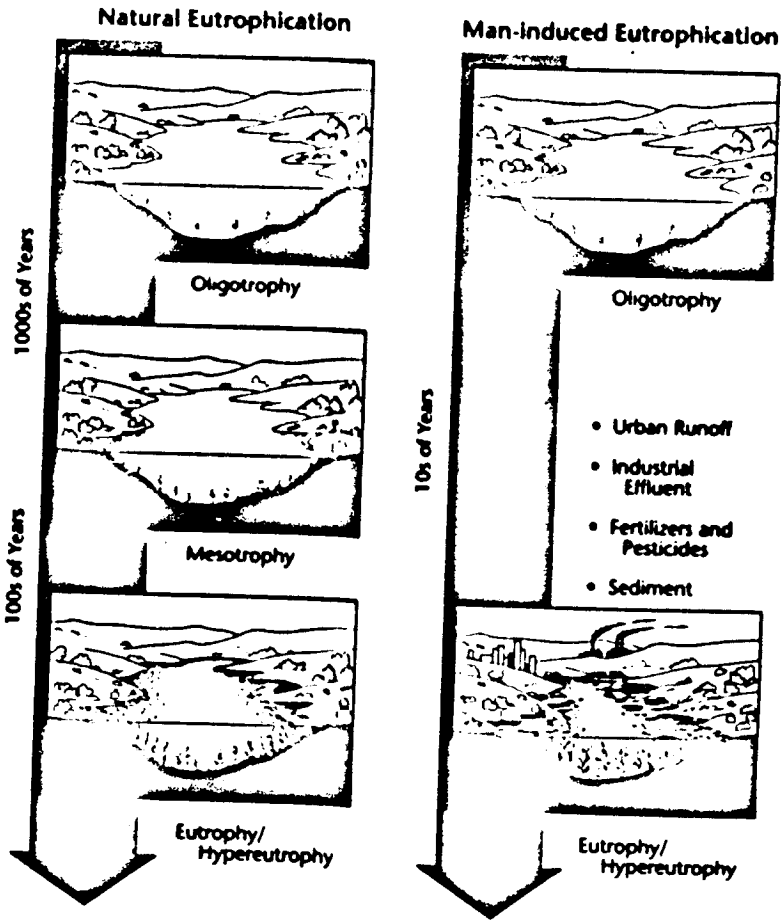
and hypereutrophic. For those lakes showing exceptionally high levels of organic materials and associated reduced pH levels, humic substances, and natural color, the term dystrophic is used.

Both natural lakes and manmade reservoirs will usually show shifts in their trophic condition over time (Figure 15-2). As natural lakes fill in, a process that ordinarily may take centuries, they may naturally shift from an oligotrophic to a more eutrophic status. Reservoirs have design lives ranging from a few decades to perhaps a few hundred years. Sedimentation processes will eventually lead to trophic shifts in manmade impoundments, generally in a much shorter time period than for natural lakes. Similarly, newly impounded reservoirs may initially be characterized as eutrophic because of the decay of woody debris but may shift to a less eutrophic status for most of the impoundment's useful life.

Because there is an inherent dynamic aspect to the trophic balances in lakes, caution must be exercised in characterizing anything other than an oligotrophic condition as undesirable. On the other hand, many types of anthropogenic stresses may result in rapid trophic status shifts. If a lake shows rapid progression toward a state exhibiting excessive algae growth (i.e., algal blooms), rapid organic and inorganic sedimentation and shallowing, and seasonal or diurnal dissolved oxygen deficiencies leading to obnoxious odors, fish kills, or a shift in the composition of aquatic life forms to less desirable forms, then cultural eutrophication is very likely. Most commonly, large inputs

Figure 15-2

The Progression of Eutrophication



(left column) The progression of natural lake aging or eutrophication through nutrient-poor (oligotrophy) to nutrient-rich (eutrophy) sites. Hypereutrophy represents extreme productivity characterized by algal blooms or dense macrophyte populations (or both) plus a high level of sedimentation. The diagram depicts the natural process of gradual nutrient enrichment and basin filling over a long period of time (e.g., thousands of years).
(right column) Man-induced or cultural eutrophication in which lake aging is greatly accelerated (e.g., tens of years) by increased inputs of nutrients and sediments into a lake, as a result of watershed disturbance by humans.

Source: *NC Lake Assessment Report*. NCDEHNR, DEM. Report No. 92-02. June 1992.

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of nutrients or nutrient-laden sediments associated with point or nonpoint source pollution will lead to cultural eutrophication. Restoring a lake to a more desirable trophic condition will then require implementation of control techniques to reduce the nutrient loadings and possibly in-lake restoration activities to mitigate the impacts of previous pollution inputs.

Trophic classification begins with an assessment of conditions in a lake at a given time. There are many aspects of reservoirs that make it difficult to categorize them by traditional trophic status assessments. When evidence suggests that pollution factors are driving the lake to a more eutrophic state, a State's Clean Lakes Program will likely rate that waterbody as a relatively higher priority candidate for management attention. Other types of information are helpful in prioritizing a public lake's management needs (e.g., documentation of trends and consideration of factors such as acidity or toxics), but trophic status assessments are the backbone of the classification systems used in most States.

At least half the States make use of a trophic classification methodology developed by R.E. Carlson in the 1970s. Carlson worked primarily with natural lakes in the Midwest. He developed a series of indices involving simple logarithmic transforms of monitoring records based on total phosphorus, chlorophyll *a*, and Secchi depth. For many lakes, these parameters provide a measure of a principal cause of cultural eutrophication (the nutrient phosphorus), a reasonable indicator of the standing crop of algae associated with nutrients (chlorophyll *a* is the major photosynthetic pigment in algal phytoplankton), and a measure of unwanted reduction in water transparency due to elevated levels of algal biomass.

The formulas for these trophic status indexes (TSIs) were calibrated to conditions in the Midwest so that an increase of 10 index units would match a change in lake eutrophic condition to the next highest status (e.g., from oligotrophic to mesotrophic). For many lakes studied by Carlson, there was a strong correlation among the predictions provided by the TSIs. Because it is generally much less expensive to gather total phosphorus data than chlorophyll *a* data and much easier to measure a light transparency from a Secchi disk than to develop actual water chemistry data, there has been a tendency to rely heavily on Secchi disk measurements when using a Carlson TSI to characterize trophic state.

Well over half the States use one or more of the Carlson TSIs or indices very similar to Carlson's. For the 1992 305(b) reporting cycle, there is a noticeable tendency on the part of the States to use greater discretion when the only measurement for a TSI comes from Secchi disk readings. Without other information about a lake, and especially reservoirs where reductions in transparency may be due more to suspended inorganic particles than to blooms of algae or due to location of the sampling site or other factors, a Secchi measurement may give false signals as to the degree of biological productivity.

States are increasingly giving greater precedence to TSIs using phosphorus or, where possible, chlorophyll *a* measurements.

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However, light transparency data may still be useful, especially when correlated with visual observations of color. Even if loss of transparency is due more to turbidity and suspended solids than to algae, it may indicate unwanted sedimentation problems affecting trophic balances and a lake's recreation value. When available, long time series of Secchi depth readings are often a good tool for trend analysis. Secchi readings, often collected by volunteer monitoring groups, can therefore still play an important role in a State's lake monitoring programs; but, for the highest quality characterization of lake trophic status, measurements more closely related to biological process and food chain dynamics are preferred.

With support from EPA Lake Water Quality Assessment grants, many States are evaluating different ways to supplement methods such as Carlson TSIs to make cost-effective characterizations of trophic status. For instance, using a broader range of parameters, there are other standard indexes that may prove helpful, many of these originally developed in the 1970s as part of EPA's pioneering National Eutrophication Survey. Whatever the general form in a TSI formula, it is highly desirable to regionalize the system to conditions found in a specific State or ecoregion. States such as North Carolina have developed regional indices, and Oregon, Minnesota, and Arkansas have applied ecoregion concepts in interpreting their lake monitoring data. Oklahoma and Texas are evaluating different methods to assess trophic status in reservoirs.

Because a TSI is a simplified analysis tool with a strong correlation to basic aspects of the biological structure for lakes in a region, many States are exploring ways to develop bioassessment techniques. For instance, the presence or absence of certain types of zooplankton is often strongly correlated with a well-balanced biological community. Diverse and healthy populations of algae-consuming zooplanktons such as *Daphnia pulex* can help prevent the buildup of objectionable algal biomass even in lakes showing appreciable nutrient inputs. Shifts in the populations of game fish or plankton-eating forage fish can sometimes lead to a decimation of the zooplankton, allowing algae to flourish. Biomanipulation techniques aimed at increasing the populations of top predator fishes or reducing the populations of forage fishes can often correct the trophic imbalances. Bioassessments of the plankton communities or the fish populations can therefore indicate overall trophic status. Other techniques being explored look at benthos or macrophytes in lake littoral areas. These techniques can be valuable supplements to the more traditional Carlson TSIs that focus on algal standing crop, nutrients, or transparency parameters.

In 1992, 41 States reported that 17% of the 11,477 lakes they assessed for trophic status were oligotrophic, 35% were mesotrophic, 32% were eutrophic, 8% were hypereutrophic, and 8% were dystrophic. This information may be somewhat biased, as States often assess lakes in response to a problem or public complaint or because of their easy accessibility. It is likely that more remote lakes–which are probably less impaired–are underrepresented in these assessments.

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Acid Effects on Lakes

Acidic lakes are generally found in areas where watershed soils have limited buffering capabilities. Acid rain or acid mine drainage can then depress a lake's pH levels to a point at which many forms of aquatic life are stressed or eliminated. Table 15-1 summarizes some of the common biological effects at progressively lower pH ranges.

Acid conditions can also aggravate toxics impacts, especially for heavy metals. During the 1980s there was major public concern over the impacts of lowered pHs to lakes, primarily from atmospheric deposition. EPA coordinated a major multi-agency study called the National Acid Precipitation Assessment Program (NAPAP). NAPAP led to actual data collection efforts on many lakes and stream systems. It also provided insights into promising monitoring designs to document receiving waters with actual acidity problems or sensitivities to potential acid impacts.

NAPAP's conclusion was that the incidence of serious acidification problems was far more limited than originally feared, and this Federal hypothesis seems to be reflected in evidence reported by the States in their lake water quality assessments. At least for significant publicly owned lakes, the Adirondacks area of New York emerges as the only region showing appreciable numbers of public lakes with significant acidification damage. States have documented areas where local geological and soil factors may render lakes deficient in natural buffering capacity and therefore vulnerable to acidity stress. Such sensitive areas seem quite prevalent in high-altitude glacial lakes in mountainous areas in the Rockies and several western States. A major concern here is low pH water introduced from snowpack meltwater. Many of these high-altitude lakes may show a seasonal pulse of low pH inflows, usually during the Spring. The ecological consequences are not entirely clear, and States such as Colorado and Washington will continue to study this episodic phenomenon.

In the eastern United States, such areas as southern New Jersey have been shown to have limited natural buffering capacity, making many lakes potentially vulnerable to acid deposition impacts. In addition to lakes, some States are concerned about acidity impacts on high-gradient trout streams. Where the acidity concerns affect whole watersheds, this encourages a search for mitigation techniques that could benefit both lakes and streams. New York has undertaken some innovative demonstration projects aimed at liming whole watershed areas instead of the more traditional strategy of liming just the lakes.

Serious impacts from acid mine drainage also seem relatively rare. No State has found clear documentation of acidity impacts related to active mining activities. However, there is some concern about abandoned mine workings. At least one

Table 15-1 Effects of pH on Aquatic Life

pH Range	General Biological Effects
6.5 to 6.0	Some adverse effects for highly acid-sensitive species
6.0 to 5.5	Loss of sensitive minnows and forage fish; decreased reproductive success for trout and walleye
5.5 to 5.0	Loss of many common sports fish and additional nongame species
5.0 to 4.5	Loss of most sports fish; very few fishes able to survive and reproduce where pH levels commonly below 4.5

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State, Oklahoma, is undertaking a CLP Phase I study on a portion of the Eufaula Reservoir that lies in a region with a long history of surface and hard rock coal mining activities.

Toxic Effects on Lakes

In the 1987 CWA reauthorization, there was an expectation that if toxics concerns were encountered in lakes, they might be tied to an anticipated widespread incidence of acidity problems. From evidence submitted by the States and from the Federal NAPAP investigations, lake acidity problems are much rarer than anticipated. Toxics concerns States have submitted, therefore, will generally not be related to depressed pH levels.

Many States do report serious toxic concerns, with the most common centering on fish consumption advisories. Most States maintain programs to sample fish tissues from their major public lakes. These collections also generally involve sampling of ambient water and sediments. Rarely do ambient water levels exceed detection limits for heavy metals or common pesticides. For sediments and fish flesh, however, virtually all States have at least one public lake at which elevated levels of some toxicant have been documented. Any exceedances of FDA alert levels or other Federal or State threshold levels will be noted in the 305(b) reporting process. Especially for contaminants in fish flesh, State health authorities will issue consumption advisories so that the public can make appropriate fish consumption decisions.

If a State has established provisions in its water quality standards regarding these public health issues, lakes may be reported as showing beneficial use impairments. Where such standards are not well-defined, the information may show up only in the 305(b) sections dealing with public health/aquatic life concerns. If it is carried over into the use attainment portion of the 305(b) documents, States may choose to characterize the concern as a 305(b) "assessment" issue. This is a rapidly evolving field, with many States attempting to add public health features to their water quality standards or expanded standards' provisions for wildlife protection.

Because many of the toxicants in question are persistent substances (e.g., chlordane or PCBs), it is often likely that there are no active pollutant sources; rather the problems are related to in-place contaminants. This situation is compounded by the fact that many of the organic or heavy metal toxicants are multimedia problems, with any ongoing pollutant loading coming from atmospheric deposition. The sources for such "air pollution" inputs are generally not well known; in some cases the ultimate sources may even lie outside the United States, reflecting pollution processes on a hemispheric or global scale. Faced with these uncertainties, most States are continuing to gather monitoring data and are adopting risk management strategies.

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Trends in Significant Public Lakes

Lakes are dynamic systems, which means that they may naturally display shifts in trophic status over time. The only exception might be bog-like dystrophic lakes that constitute a special case in terms of the ordinary evolution for lake waterbodies. Without some time series records of lake conditions, it can be hard to interpret the management implications of a eutrophic classification based solely on current conditions.

Trend analysis can be extremely valuable in documenting rapid shifts toward more eutrophic features. Waterbodies in which changes can be related to ongoing pollution inputs are generally considered to warrant higher priority in management attention. Although the desirability of trend assessments is widely recognized, States still face challenges in gathering adequate information to document a trend signal, especially when they try to apply sophisticated statistical methods to document the significance of an apparently empirical change.

The majority of States do attempt some sort of trend determination when they have at least a recent set of trophic classifications in conjunction with other data, usually from their original classification survey in the early 1980s. Determinations made based on data from only two points in time must rely heavily on best professional judgment (BPJ). Virtually every State that presents such BPJ trends assessments notes that confidence limits or other measures of reliability or precision are not available.

At least three States–Illinois, Wisconsin, and Minnesota–did apply statistical analysis techniques to select lakes for which approximately 5 to 10 years of time series data were available. Illinois used least squares regressions (using a "parametric" statistical approach) combined with examination of scatter plots of the raw data and residuals. From 212 lakes, about 50 results suggested either alinear improvement or a degradation trend. Nearly 60 percent of the lakes had extremely complicated fluctuating patterns suggesting cyclical or nonlinear patterns, perhaps related to weather variability. Illinois therefore felt that additional data and further analysis would be worthwhile.

Wisconsin and Minnesota used the Kendall tau test available with the WQSTAT computer program developed at Colorado State University. This is a nonparametric test considered by many to be

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preferable to parametric techniques for use with water quality data. Minnesota applied the test to 161 lakes; trends were suggested in 32. Wisconsin looked at 49 lakes, with the test suggesting trends for 25. Wisconsin, in particular, expressed some reservations. They felt the main patterns in the raw data reflected normal, short-term, cyclical changes rather than genuine long-term trends in water quality.

Although States continue to explore ways to detect empirically significant trends, virtually every State expressed the need to acquire additional data, a common estimate being that at least 10 years of observations would be needed to apply rigorous statistical methods. Another common theme is that the patterns displayed in many lakes do not seem linear. Most available statistical tests are geared to spotting simple, linear trends. Where the underlying physical patterns are nonlinear or cyclical, more complex analysis systems may be needed.

Lake Restoration and Pollution Control Measures

Managing lake quality often requires a combination of in-lake restoration measures and pollution controls, including watershed management measures:

Restoration measures are implemented to reduce existing pollution problems. Examples of in-lake restoration measures include harvesting aquatic weeds, dredging sediment, and adding chemicals to precipitate nutrients out of the water column. Restoration measures may not address the source of the pollution.

Pollution controls deal with the sources of pollutants degrading lake water quality or threatening to impair lake water quality. Control measures include planning activities, regulatory actions, and implementation of best management practices to reduce nonpoint sources of pollutants. Regulatory measures include point source discharge prohibitions and phosphate detergent bans. Watershed management plans and lake management plans are examples of planning measures. Watershed management plans simultaneously address multiple sources of pollutants, such as runoff from urbanized areas, agricultural activities, and failing septic systems along the lake shore.

During the 1980s, most States implemented chemical and mechanical in-lake restoration measures to control aquatic weeds and algae. In their 1992 Section 305(b) reports, the States report a shift toward watershed planning

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techniques and nonpoint source (NPS) controls to reduce pollutant loads responsible for aquatic weed growth and algal blooms. Although the States reported that they still use in-lake treatments (Table 15-2), the States recognize that source controls are needed in addition to in-lake treatments to restore lake water quality.

The States reported that they most frequently rely on their NPDES permit programs and their Section 319 NPS management programs to control pollutants entering lakes (Table 15-3). Through the State NPDES permit programs, States often impose stricter nutrient limits for effluents discharged into lakes than into rivers and streams. Seven States reported that they enhanced sewage treatment plant compliance with NPDES nutrient limits for lakes by imposing phosphorus detergent restrictions.

Twenty-two States reported that they use their Section 319 NPS programs to implement BMPs in watersheds surrounding impaired or threatened lakes. The States reported that they implemented agricultural practices to reduce soil erosion, constructed retention and detention basins to cleanse urban storm water, revegetated shorelines, and constructed or restored wetlands to remove pollutants before they entered lake waters.

Control Measures	Number of States Reporting
Dredging	16
Lake Drawdown	14
Chemical Weed and Algae Control	13
Mechanical Weed Harvesting	12
Biological Weed Control	9
Artificial Circulation/Hypolimnetic Aeration	9
Chemical Nutrient Inactivation	7
In-Flow Diversion	6
Hypolimnetic Withdrawal	5

Control Measures	Number of States Reporting
Section 319 NPS Program	22
NPDES Permit Program	22
State Lake Water Quality Standards	15
Watershed Management Planning	12
Restrict Phosphate Detergents	7
Restrict Point Source Discharges	6
Regulate Shoreline Activities	5
Lake Management Planning	4

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Wetlands Protection Programs

A variety of public and private programs protect wetlands. The Conservation Foundation organized the National Wetlands Policy Forum in 1987 to coordinate these disparate efforts and develop a national, coordinated vision for wetlands protection. The forum included three State governors and representatives from State and local governments; the oil, gas, agriculture, and forestry industries; academic institutions; environmental/conservation groups; and EPA and other Federal agencies The group issued a report in November 1988 containing over 100 recommended actions for all levels of government and the private sector.

The Forum established an interim goal to achieve no overall net loss of the Nation's wetlands base and a long-term goal to increase the quantity and quality of the Nation's wetlands resource base. The Clinton Administration has adopted these goals and plans to issue a Presidential Executive Order to implement them. In addition, the Administration has recommended that Congress amend the Clean Water Act to include them.

Section 404

The major Federal program for regulating activities in wetlands is Section 404 of the Clean Water Act. Section 404 establishes a permit program for regulating discharges of dredged and fill material to wetlands and other U.S. waters. The EPA and the U.S. Army Corps of Engineers (COE) jointly implement the Section 404 program. The COE is responsible for administering the permit program day-to-day, reviewing permit applications, and issuing or denying permits. The EPA is responsible for reviewing COE permit decisions, determining geographic jurisdiction, overseeing State programs, and enforcing with the COE the Section 404 program.

The COE processes permit applications under Section 404. EPA reviews and evaluates applications using its Section 404(b)(1) guidelines, which contain the environmental criteria for Section 404 permit decisions. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service also influence the Section 404 permitting process through their review of applications. After receiving comments from these agencies, the States, and other interested parties, the COE makes a permit decision.

Under Section 404(c), EPA has the authority to veto a COE decision to issue a permit or to otherwise prohibit or restrict the discharge of dredged or fill material to wetlands or other waters of the United States. EPA has the ultimate authority to determine the geographic scope of the CWA (i.e., whether an area is a wetland or other U.S. water). Similarly, EPA has the final word on the applicability of Section 404(f), which exempts certain discharges from regulation. EPA and the COE share authority for enforcing the requirements of Section 404. Also, EPA

The Administration's goals are to

- *Achieve no overall net loss of the Nation's remaining wetlands base*
- *Increase the quality and quantity of the Nation's wetlands resource base*

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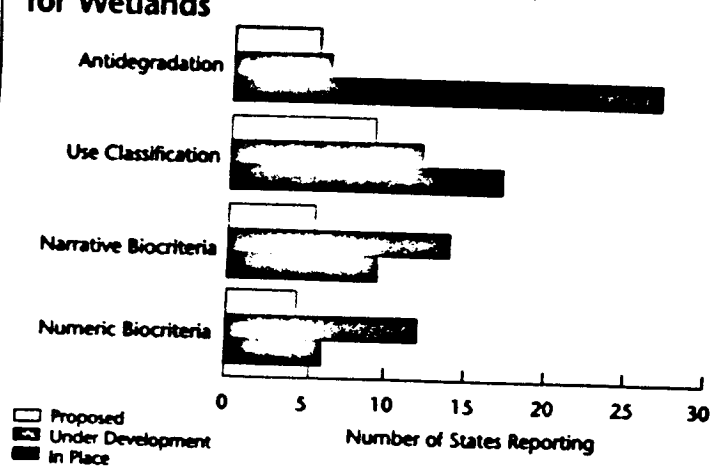
approves and oversees State assumption of the Section 404 program. To date, Michigan and New Jersey are the only States to have assumed this responsibility.

Wetlands Water Quality Standards

Water quality standards for wetlands ensure that the provisions of CWA Section 303 that apply to other surface waters are also applied to wetlands. In July 1990, EPA issued guidance to States for the development of wetlands water quality standards. Figure 16-1 indicates the State's progress in developing these standards (see Appendix D, Table D-5, for individual State data).

Figure 16-1

Development of State Water Quality Standards for Wetlands



Based on data contained in Appendix D, Table D-5.

Water quality standards have three major components: designated uses, criteria to protect those uses, and an antidegradation policy. States designate uses that must, at a minimum, meet the goals of the CWA by providing for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water. States may choose to designate additional uses for their wetlands, such as flood water attenuation or ground water recharge. Once uses are designated, States are required to adopt criteria sufficient to protect their designated uses. Criteria are general narrative statements or specific numerical values such as concentrations of contaminants and water quality characteristics (e.g., dissolved oxygen concentration = 5.0 mg/L). Narrative criteria are particularly appropriate to wetlands. An example of a narrative criteria is "natural hydrological conditions necessary to support the biological and physical characteristics naturally present in wetlands shall be protected."

Standards provide the foundation for a broad range of water quality management activities under the CWA including, but not limited to, monitoring for the Section 305(b) report, permitting under Section 402 and 404, water quality certification under Section 401, and the control of nonpoint source pollution under Section 319.

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Water Quality Certification of Federal Permits and Licenses

Section 401 of the CWA gives States and eligible American Indian Tribes the authority to grant, condition, or deny certification of federally permitted or licensed activities that may result in a discharge to U.S. waters, including wetlands. Such activities include discharge of dredged or fill material permits under Section 404 of the Clean Water Act, point source discharge permits under Section 402 of the Clean Water Act, and Federal Energy Regulatory Commission's hydropower licenses. States review these permits to ensure that they meet State water quality standards. In 1989, EPA issued guidance to States and American Indian Tribes on how to use 401 certification authority to protect wetlands. Ideally, 401 certification should be used to augment State programs because it applies only to projects requiring Federal permits or licenses. Activities that do not require permits, such as draining of wetlands, are not covered.

State Wetlands Conservation Plans

A new tool that States are using to protect wetlands are State Wetlands Conservation Plans (SWCPs). Essentially, these plans are strategies for States to achieve their wetlands management goals, such as no net loss of wetlands, by integrating both regulatory and cooperative approaches to protecting wetlands.

Wetlands are impacted by a large number of land- and water-based activities not addressed by a single Federal, State, or local agency program. In addition, many public and private programs and activities exist to protect wetlands, but often each program is limited in scope and is not well coordinated with the others. Also, these programs often do not address all of the problems affecting wetlands.

An SWCP can help to integrate programs; avoid duplication of effort; identify problems that need to be addressed; maximize efficient use of budgets, staff, and expertise; and tap or combine unused resources. Twenty States are currently involved in different stages of developing an SWCP; 19 of these States have received financial assistance from EPA. Michigan's SWCP will focus on nonregulatory aspects of wetlands management. New York will work toward a no net loss/net gain goal under its SWCP. California plans to inventory its wetlands, identify crucial wetlands, develop a statewide strategy to plan wetlands protection and restoration, and take a crucial role in overall wetlands regulation through its SWCP. Missouri, Tennessee, Delaware, New Jersey, North Dakota, Ohio, Oklahoma, Oregon, Texas, Louisiana, Alabama, Arkansas, Illinois, Montana, Nebraska, Vermont, and Massachusetts are also pursuing SWCPs.

STATE WETLANDS CONSERVATION PLANS integrate regulatory and cooperative approaches to protect wetlands

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State Wetlands Protection Grants

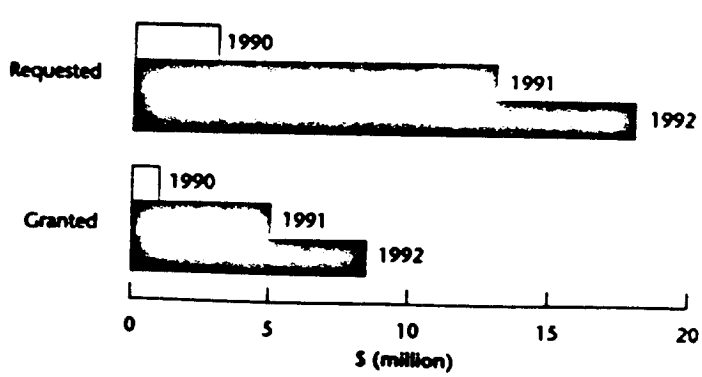
In FY90, Congress first appropriated funds to establish a grant program specifically aimed at supporting State wetlands protection programs. This grant program has provided and continues to provide financial support to States and federally recognized American Indian Tribes to enhance existing State wetlands programs or develop new ones.

Grant funds are available to State agencies administering or developing wetlands protection programs or to State agencies with wetlands-related programs. Since the program began in 1990, these grants have been instrumental in enhancing State expertise in the following areas: Section 404 assumption, Section 401 water quality certification, State Wetland Conservation Plans, watershed approach demonstration projects, improved coordination, and wetlands water quality standards development.

Each year, more States and American Indian Tribes participate in the EPA Wetlands Protection Grants Program and each year funding for the program has grown (Figure 16-2).

Figure 16-2

Funding for Wetlands Protection Projects



Environmental Monitoring and Assessment Program

The wetlands component of EPA's Environmental Monitoring and Assessment Program (EMAP) aims to assess and report the status and trends of ecological conditions in wetlands on regional and national scales. In the short term, the EMAP-Wetlands program will provide standardized protocols measuring and describing wetlands conditions, provide estimates of wetlands conditions in several regions, and develop formats for reporting program results.

Nonpoint Source Pollution and Wetlands

Section 319 of the 1987 CWA amendments created a comprehensive program to integrate Federal and State programs aimed at controlling nonpoint source (NPS) water pollution. The physical location of wetlands between water and land links wetlands protection with abatement of NPS runoff and water quality improvements in adjacent waters. In 1990, EPA published

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guidance on the coordination of State and Federal NPS control programs and wetlands protection programs. The guidance discusses the implementation of activities that benefit both NPS and wetlands programs.

Under the NPS control program, Section 319(h) authorizes Federal grants to States with approved assessment reports and management programs. These grants assist the States in implementing the NPS controls identified in their management programs. Thirty-two States received 319(h) funds in fiscal years 1990 and 1991 for NPS control projects with a wetlands or riparian area component. Nineteen of the projects involved protection or restoration of wetlands or riparian areas. Other projects involved program development, education and training materials development, or wetlands construction.

Swampbuster

The swampbuster provisions of the 1985 and 1990 Food Security Acts ("Farm Bills") deny crop subsidy payments and other agricultural benefits to farm operators who convert wetlands to cropland after December 23, 1985—the date the 1985 Farm Bill was signed into law. The U.S. Department of Agriculture's Soil Conservation Service (SCS) is responsible for determining compliance with swampbuster provisions and for determining whether agricultural wetlands sites fall under the jurisdiction of the swampbuster provisions. EPA and the COE have sole authority to determine Section 404 jurisdiction.

State Programs to Protect Wetlands

States protect their wetlands with a variety of approaches, including use of CWA authorities (such as Section 401 and 303), permitting programs, coastal management programs, wetlands acquisition programs, natural heritage programs, and integration with other programs. For this report, States described particularly innovative or effective approaches they use to protect wetlands.

State-Reported Information

The following trends emerged from individual State reporting:

- States are making progress in developing wetlands water quality standards.
- States are beginning to incorporate wetlands considerations into other programs.
- States are working with the Army Corps of Engineers and other State and Federal agencies to coordinate Section 404 permit reviews and Section 401 certifications.
- A large number of States reported that they denied Section 401 certification of Section 404 nationwide permits.
- The pressure to develop in wetlands areas remains high based on the number of Section 404 permit applications States are receiving.

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■ States continue to lose wetlands.

Some highlights from individual State reports are as follow:

■ Alaska reported that it integrates wetlands protection into existing water quality programs such as nonpoint source pollution control, ground water protection, and wetlands monitoring through land use planning and local controls.

■ Arizona reported that it has integrated wetlands protection into the nonpoint source program. Arizona reported an incident in which it used Section 401 certification to require changes to an original plan to reduce wetlands loss from 20 to 3 acres.

■ Florida reported that it has in place a joint Federal/State application form for dredge and fill projects. In addition to direct dredging and filling, the quantity and quality of water delivered to wetlands is extremely important to wetlands integrity in Florida. The most notable example is the Everglades in southern Florida. Florida also mentioned that degraded wetlands are used primarily for treatment of storm water; in these cases, restoration of the hydroperiod is an important goal and extensive monitoring is sometimes required.

■ Wisconsin, which recently had its wetlands water quality standards approved by EPA, reported that wetlands water quality standards appear to be the most effective mechanism for protecting wetlands. Wisconsin's Department of Natural Resources reported that it will be making use of its 401 certification authority now that standards are in place. The State is also considering implementing a wetlands monitoring program.

Wisconsin also reported that standards may influence Federal Energy Regulatory Commission (FERC) dam relicensing, Wisconsin Pollution Discharge Elimination System permits to discharge treated wastewater, landfill siting and Superfund cleanup activities, fish and wildlife management decisions, construction and operation of cranberry marshes, park acquisitions, selection of best management practices in priority watersheds, and chemical applications for controlling aquatic weeds.

■ Louisiana reported that 401 certification in coastal areas is more effective when done in conjunction with coastal use permits. Louisiana is sponsoring wetlands research to find out how wetlands respond to municipal wastewater and processing wastewater. The State developed numeric biocriteria in the Thibodaux swamp.

■ Rhode Island denied 401 certification for most nationwide permits, feeling that these projects should be reviewed individually. It also reported that the Department of Environmental Management's Division of Forest Environment and the Freshwater Wetlands Division coordinate on forest management plans.

■ South Dakota reported that it is developing a comprehensive, interagency, statewide wetlands protection program.

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■ Idaho reported that it used its 401 certification authority to prevent the draining of significant wetlands as part of a residential development. Idaho is currently in the process of developing 401 certification regulations; one objective of these regulations is to include wetlands impacts in the 401 certification process.

■ Indiana reported that largely through placing conditions on 401 certification of permits, the State is obtaining approximately 3 acres of wetlands as mitigation for every acre lost.

■ South Carolina denied certification for nationwide permit 26 because it believes that protection of isolated and headwater wetlands is imperative for South Carolina to achieve the goals of the CWA.

■ North Carolina has a State General Permits Program for 404 permits and has developed a State wetlands rating method currently used in 401 certification evaluations.

■ The Pennsylvania Department of Environmental Resources (DER) reported that it has adopted a joint permit application with the COE that enables applicants to enter both State and Federal permit review processes with one application. An Environmental Review Committee, consisting of representatives from the U.S. Fish and Wildlife Service, Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, EPA, COE, and DER, meets monthly to review selected applications submitted under Section 404.

The DER receives 1,500 applications each year for water obstruction permits under the Dam Safety and Encroachments Act of 1978, which establishes DER's jurisdiction for the protection of wetlands. The DER reported that there are 3,000 violations of the Act each year, 75% of which involve wetlands resources.

■ Hawaii reported that it denied 401 certification for all nationwide permits.

■ Virginia reported that it uses a joint permitting process that allows applicants to submit one application to the Commission, which coordinates review with appropriate agencies whose comments are considered in development of or denial of 401 certification. Virginia denied certification of nationwide permit 26 for areas greater than 1 acre. It also denied three other nationwide permits because associated impacts would not be addressed adequately through other regulatory processes (e.g., FERC licensing procedures and storm water management pond construction).

■ Texas reported that it received a wetlands protection grant to improve its 401 certification program.

■ Minnesota reported that it is undertaking a permit simplification program. It wants to produce a combined permit application that may serve as an application for a 404 permit and as notification to Minnesota's Department of Natural

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Louisiana Coastal Wetlands Program

Coastal Louisiana is losing marshes and swamps at a rate of 25 square miles per year. Yet, Louisiana's remaining 10,160 square miles of coastal marshes account for 40% of the Nation's marsh resource, support 25% of the Nation's fishing industry, support the largest furbearing trade in North America, and provide habitat for more than two-thirds of the wintering waterfowl on the Mississippi flyway.

Historically, the Mississippi River carried extremely large quantities of sediment that formed most of Louisiana. Under natural conditions, water would overflow onto surrounding land via overbank deposition. This water would be dispersed through an extensive network of delta tributaries, depositing large volumes of sediment in the surrounding marshes and wetlands. Through these deltaic building processes, wetlands generation kept pace with natural subsidence and sea level rise.

In modern times, levees built along the Mississippi River prevent fresh water and sediment from overflowing into coastal wetlands during floods. Without this replenishment of sediment, wetlands and marshes are gradually deteriorating to open water. Exacerbating this problem are the numerous navigation and oil and gas pipelines and flood control levees that speed the river's flow, which prevents sediments from settling out over the marshes. As a result, sediments are not captured and enter the deep waters of the Gulf of Mexico. It is estimated that Louisiana's land loss is directly attributable to the marshes not being able to capture sediment and provide subsequent accretion. For example, between 1954 and 1963, subsidence rates were 1.32 centimeters per year, while backmarsh accretion rates were approximately 0.72 centimeters per year. Coupled with subsidence, sea level rise is estimated to be 0.3 meters per century, further endangering wetlands resources.

To address this national resource crisis, the U.S. Congress passed the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) (P.L. 106-646) in 1990. The CWPPRA authorizes appropriations for up to approximately $70 million dollars a year, depending on small gasoline tax revenue collections, to develop priority restoration projects. Under the Act, a list of priority projects is sent to Congress each year for projects

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to be funded and implemented during the coming fiscal year.

In addition, the CWPPRA mandates a plan to restore coastal Louisiana. Possible options will be presented in the Comprehensive Coastal Restoration Plan for decreasing wetlands loss and restoring the Mississippi Delta. The Plan, currently under development, divides the delta into nine distinct hydrologic units or basins. The overall plan selects alternatives to aggressively approach the rebuilding and maintenance of the coast by initiating growth of a new delta through enhancement of natural processes, except in areas where erosion is severe. Other strategies include enforcing the barrier island chain as a primary defense to protect inland wetlands, decrease the advance of saltwater intrusion, and decrease the wave energy of the Gulf in the marshes and estuaries. The major objectives of this plan will be to determine the maximum use of the flow of sediment of the Mississippi River; to create and sustain wetlands; to possibly curtail wetlands loss; and to restore the first line of defense–the barrier island chain.

In addition to the restoration efforts in Louisiana, resource protection of wetlands may benefit across the country through information gained from this large-scale restoration effort:

- New restoration strategies and techniques, as well as coastal erosion prevention techniques that are being developed and demonstrated through this effort, may provide viable restoration options for other areas of the country.

- Methodologies will be developed to evaluate the relative benefits of these environmental projects.

- Intensive monitoring will allow detailed analysis to determine the success of individual restoration project techniques and document these techniques as successful in a summary Report to Congress.

- The intensive planning process will be documented and planning techniques may be transferred to other areas of the country where dramatic wetlands loss is occurring or where intensive resources are targeted to address wetlands loss and degradation.

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Resources (DNR), SCS, and local governments. The Governor of Minnesota issued an Executive Order in January 1990 directing all State departments and agencies to follow "no net loss" of wetlands policy and requiring them to protect, enhance, and restore the State's wetlands to the full extent of their authority. Minnesota reported that it will be expanding its antidegradation policy to include a sequencing review process, requiring avoidance/minimization of impacts before considering a project for approval.

■ The Massachusetts Department of Environmental Protection (MDEP) reported that unreported or unpermitted wetlands alterations continue to present a highly significant problem. In response, it is undertaking a pilot project in Merrimack River Watershed that combines legal assistance to municipalities with an increased focus on enforcement actions with multiple resource interests. MDEP also reported that it has spent considerable effort in coordinating wetlands considerations within its department and with other State agencies. One area mentioned is its role in revising the hazardous waste site cleanup program to ensure maximum protection of wetlands. Massachusetts said that the pressure to develop in wetlands areas and buffer zones remains high throughout Massachusetts with an estimated 5,300 applications expected to be received during FY92.

■ Ohio reported that it applies its antidegradation policy to wetlands, which are classified as State resource waters. Ohio EPA has denied 401 certification for fill projects and reduced the scope of proposed activities in wetlands by issuing conditional certification. Two examples of the types of conditions it is requiring are: an unmaintained buffer area around mitigation wetlands and existing wetlands and extensive monitoring of water quality, sediment, vegetation establishment, and hydroperiod for 5 years.

■ Wyoming reported that the only mechanism it has at present to require preservation of any particular wetland is to show that the destruction of that wetland will result in an exceedence of an ambient water quality standard.

Opportunities and Recommendations from States

Several States identified challenges and opportunities for the future and came up with specific recommendations on how to improve wetlands protection.

■ Hawaii recommended that wetlands protection would improve if "wetlands planning" and "regulatory administration" functions were consolidated into a single State agency.

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■ Oregon reported that it lacks the capability for assessing and monitoring ecological and water quality functions of wetlands. This inhibits its ability to establish definitive wetlands-specific beneficial uses and criteria to protect those uses.

■ Alabama recommended that activities that impact wetlands such as draining and logging operations be regulated in addition to discharges.

■ Arizona recommended that the Army Corp of Engineers' area of interest be expanded to include the 100-year floodplain. In addition, the State recommended that the COE definition of wetlands be revised to better accommodate arid climates.

■ Rhode Island suggested that jurisdiction extend to some activities adjacent to wetlands. To illustrate the need for such protection, it offered as an example the clearing of natural vegetation adjacent to wetlands. This can result in decreases in the natural filtering capacities of wetlands and in concomitant increases in runoff velocities and pollutant loads.

■ Florida said that the quantity and quality of water delivered to wetlands is an issue and cited as the most notable example the Florida Everglades in southern Florida.

■ Louisiana called for a permitting system in which requests are considered on the basis of the whole landscape.

■ Wisconsin reported that the all or nothing delegation of the Section 404 permit program to the States is inflexible. Wisconsin expressed concern that it will become swamped by the 404 permit process due to its denial of nationwide permits. Specifically, the State feels that changes in the COE's approach to permitting is resulting in case-by-case calls under 401.

■ Pennsylvania reported that it will not change criteria for wetlands until EPA comes out with aquatic life criteria specifically for wetlands.

■ Massachusetts reported that more attention and effort must be provided for long-term project monitoring, especially for wetlands replication projects.

■ Delaware reported that certain activities allowed in wetlands through nationwide permits have an adverse cumulative impact. It gave as an example a house built on pilings in wetlands that must then be connected to underground utilities.

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Summary

There are a variety of public and private programs to protect wetlands. A forum was held in 1987 to coordinate these and provide national direction in the area of wetlands. Section 404 of the Clean Water Act is the major Federal program for regulating activities in wetlands. Other important tools to protect wetlands include wetlands water quality standards, State water quality certification, State wetlands conservation plans, swampbuster provisions of the Farm bills, as well as incorporating wetlands considerations into other programs.

States reported that they are making progress in developing their programs to protect wetlands, especially in the areas of application of 401 certification, development of water quality standards for wetlands, and formation of more efficient joint application procedures for permits. Despite these efforts, States reported that they continue to lose wetlands and the pressure to develop in wetlands remains high. In addition, there is little known about the quality of the remaining wetlands. States put forward a variety of recommendations on how to improve protection of wetlands, including consideration of wetlands on a landscape or ecosystem basis, development of scientific tools for States to assess and monitor ecological and water quality functions of wetlands, greater sensitivity for and climates, and regulation of additional activities that impact wetlands.

More information on wetlands can be obtained from EPA's Wetlands Hotline at 1-800-832-7828 (9 a.m. to 5 p.m., eastern standard time).

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Ground Water Protection Programs

The EPA is responsible for 20 programs related to ground water protection. EPA has issued National Guidance to assist States in developing Comprehensive State Ground Water Protection Programs (CSGWPPs), which are a key component of the Agency's Ground Water Protection Strategy. Several concepts are fundamental to this new approach to ground water protection:

1. States have the primary responsibility for ground water protection

2. The CSGWPP approach is resource-oriented, using resource protection needs to guide priorities across programs, focusing on the highest priorities first

3. In partnership with States, EPA will organize coordinated Federal interagency approaches

4. In organizing a coordinated Federal approach, EPA will stress development of consistent Federal policies and regulations.

Comprehensive State programs will be the focal point for long-term joint commitments between the Federal government and the States. These programs promote a more coherent and comprehensive approach to protecting the Nation's ground water resources, with emphasis placed on preventing contamination. State activities will center on

- Ground water protection goals
- Resource characterization and priority setting
- Coordination mechanisms
- Roles and responsibilities
- Implementation programs
- Data management
- Public participation.

Federal programs will support CSGWPPs by offering programmatic and funding flexibility and by targeting Federal efforts to better address the unique needs and priorities of each State. Highlights of a number of Federal and State ground water protection programs are presented according to the following protection categories: resource protection, pollutant source control, nonpoint source control, and chemical product control.

Resource Protection

Ground water protection activities are addressed under the Clean Water Act (CWA), the Safe Drinking

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Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Pollution Prevention Act (PPA).

Comprehensive State Ground Water Protection Program

The CSGWPP approach embraces all the above-mentioned ground water protection activities. As an integral part of the CSGWPP approach, EPA is committed to identifying or developing new opportunities for State flexibility within the Agency's various ground-water-related programs. For instance, under EPA's regulations on municipal landfills under Subtitle D of the Resource Conservation and Recovery Act, States may make site-specific decisions on landfill design or monitoring requirements based, in part, on the relative vulnerability of the ground water. Decisions related to corrective action at municipal landfills may be based on the underlying ground water's use, value, and vulnerability.

EPA expects that the Agency's endorsement of States' CSGWPPs will be key to eliciting the involvement and support of other Federal agencies, as well as EPA programs, in the CSGWPP process. The U.S. Geological Survey, for example, could target mapping of aquifer recharge areas, studies of ground and surface water interactions, and other similar activities to areas of high-priority ground water as identified by the State. Other Federal agency programs, such as the Department of Agriculture's Soil Conservation Service, Extension Service, and Cooperative State Research Service, could similarly focus technical assistance, education, and research activities related to ground water on State priorities.

EPA intends the CSGWPP approach to be the catalyst for fundamental changes in the development and implementation of ground water protection programs at the Federal, State, and local levels. These changes will lead to increased integration of all ground water protection efforts, linked by a comprehensive resource-based perspective and State-directed priorities. As a result, EPA anticipates that coordination will be significantly enhanced and ground water resources will be protected more effectively.

Clean Water Act

In the CWA (Public Law 92-500) of 1972 and in the CWA Amendments of 1977 (Public Law 95-217), Congress provided for the regulation of discharges into all navigable waters of the United States. Ground water protection is addressed indirectly by several components of this Act, specifically with respect to areas where surface water and ground water are hydraulically connected. Funds allotted under Section 106 of the CWA are intended to assist States in the prevention and abatement of surface and ground water pollution. Section 104(b)(3) allows grants to support State programs

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that focus on pollution prevention, reduction, and elimination. Grants to facilitate the development of water quality management plans by States and regional comprehensive planning agencies are allotted under Section 604(b).

Safe Drinking Water Act

The SDWA (Public Act 93-523) was passed by Congress in 1974 and amended in 1986 in response to accumulating evidence that unsafe levels of contaminants in public drinking water supplies, including ground water, were posing a threat to the public health. There are several major provisions to the Act that impact ground water quality. The Act provides protection to ground water through the establishment of drinking water standards, sole source aquifer designation, and the establishment of the Wellhead Protection Program and the Underground Injection Control Program. Standards known as maximum contaminant levels (MCLs) were developed under the SDWA and also may be used for enforcement in ground water monitoring programs.

Drinking Water Standards

EPA, under the SDWA, seeks to ensure that public water supplies are free of contaminants that may cause health risks and to protect ground water resources by preventing the endangerment of underground sources of drinking water. EPA has pursued a twofold approach, protecting drinking water at the tap and preventing contamination of ground water sources of drinking water supplies. The 1986 Amendments provided for an expanded Federal role in protecting drinking water, mandating sweeping changes in nationwide safeguards, and new responsibilities to enforce them in the event of State inaction.

EPA's strategy has been to usher in a comprehensive level of drinking water protection by maximizing voluntary compliance through a balance of enhanced enforcement presence, pollution prevention, State capacity building, mobilization of local government support and innovative partnerships. EPA has established its implementation priorities according to the degree of human health risk, focusing on four classes of contaminants with the highest health risks nationwide: microbiological pathogens, lead, radionuclides and disinfection byproducts. Similarly, enforcement priorities, embodied in the definition of Significant Non-Compliance (SNC) of Public Water Systems (PWSs), have been risk based.

EPA has also focused on the prevention of contamination of vulnerable ground water resources by assisting States in the development and implementation of comprehensive ground water protection strategies. These strategies address both the full range of actual and potential sources of ground water contamination and provide for wellhead protection activities in the areas around public water systems. In addition, EPA has targeted specific activities to protect drinking water sources from the harmful effects of injection of wastes and other fluids. In particular, EPA is increasing emphasis on the vast number of diverse shallow (Class V) injection

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wells by developing new regulations, and reviewing the permitting of Class I hazardous waste wells.

Wellhead Protection Program

The 1986 Amendments to the Safe Drinking Water Act established the Wellhead Protection (WHP) Program. Under SDWA Section 1428, each State must prepare a WHP Program and submit it to EPA for approval. The objective of this program is to protect ground water quality by identifying the areas around public water supply wells that contribute ground water to the well and managing the potential sources of contamination to reduce threats to the resource in that area.

27 States
had EPA-approved WHP Programs in place by the end of 1992.

By the end of December 1992, a total of 27 States and Territories had EPA-approved WHP Programs in place (Figure 17-1). EPA is currently working with the remaining States and Territories to help them develop WHP Programs. EPA's Office of Ground Water and Drinking Water is supporting the development and implementation of WHP Programs with Wellhead Protection Demonstration grants and a cooperative agreement with the League of Women Voters (LWV). An additional form of EPA-funded support is provided through the National Rural Water Association (NRWA) Wellhead Protection programs as depicted in Figure 17-2.

In fiscal years 1990-1992, EPA awarded $3,400,000 in WHP demonstration grants for a total of 116 projects. Through these projects, municipalities and American Indian Tribes design and test ground water protection approaches that may be applied statewide in developing and implementing effective WHP programs. In 1991, EPA funded a 2-year cooperative agreement with NRWA to promote ground water protection. At the conclusion of the first 18 months of the NRWA program, over 550 communities in 14 States were actively involved in developing their own WHP programs. Also in 1991, EPA funded the first year of a 3-year cooperative agreement with the LWV. One objective of the LWV program is to develop and test models of community outreach in

Figure 17-1

States with EPA-Approved Wellhead Protection Programs

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18 communities, which are designed to stimulate development of WHP programs or similar ground water protection programs.

According to the States' 305(b) reports, WHP programs have taken varying forms in different States. Among the stages of WHP program development reported by States are

- Grants to communities to explore and tailor WHP approaches
- Mapping of sensitive ground water protection areas
- Establishment of mandatory WHP programs to protect public water-supply wells
- Establishment of public education and outreach programs
- Establishment of specific protection criteria for wells tapping confined aquifers and more stringent protection criteria for wells tapping unconfined aquifers.

Sole Source Aquifer Program

The Sole Source Aquifer (SSA) program was established under Section 1424(e) of the SDWA of 1974. The program allows individuals and organizations to petition the EPA to designate aquifers as the "sole or principal" source of drinking water for an area. EPA has approved 58 SSA designations nationwide and 12 petitions are currently being evaluated for possible designation. An SSA designation authorizes EPA to review plans for Federal financially assisted projects in the subject area to determine the potential for aquifer contamination that would create significant hazards to public health.

After designation, no commitment of Federal financial assistance may be made to a project that is found through EPA review to have the potential to contaminate the aquifer and create hazards to public health. Federal financially assisted projects eligible for review under the SSA program may include highway construction projects, animal waste disposal plans, airport construction approved by the Federal Aviation Administration, deep water dredging projects proposed by the Army

15 States had established NRWA Programs by the end of 1992.

Figure 17.2

States with National Rural Water Association Wellhead Protection Programs

States and Territories with NRWA Wellhead Protection Programs

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Corps of Engineers, and subway construction projects.

Between fiscal year 1991 and fiscal year 1992, the number of Federal financially assisted projects reviewed for potential impacts on designated sole source aquifers grew while the number of projects found to have potential impacts declined (Table 17-1). This decline could be attributed to an increased awareness of potential ground water impacts. Petitioners for and agencies offering Federal financial assistance are designing projects to minimize potential adverse effects on ground water.

In fiscal year 1991, EPA required modifications to 25 projects and denied approval to four projects because of their potential to contaminate the sole source aquifer over which they were planned. In contrast, EPA required modifications in only six projects and denied approval of only one project during fiscal year 1992.

Project modifications due to SSA concerns include

- Highway storm water drainage system construction
- Installation of clay/synthetic liners for wastewater ponds and lagoons
- Rehabilitation of water wells
- Alteration of highway bridge construction design
- Installation of pollution abatement equipment.

EPA denied approval to projects, based on SSA concerns, that submitted insufficient information regarding ground water protection or insufficient project plans to ensure ground water protection.

Fiscal Year	Number of Projects Reviewed	Number of Projects Modified to Prevent Potential Contamination of a Sole Source Aquifer	Number of Projects Not Recommended Due to Potential Contamination of a Sole Source Aquifer
1990	159	20	0
1991	152	25	4
1992	214	6	1

State Ground Water Protection Programs

States are currently working in conjunction with Federal and local agencies to provide the necessary educational, financial, and technical assistance required to restore impaired water resources, to prevent future impairment, and to evaluate the effects of these activities on ground and surface water resources. Many States have reported on a variety of activities intended to address ground water contamination and the sources of these contaminants. These activities include adopting and implementing best management practices and ground water protection strategies, enacting legislation aimed at the development of ground water protection programs and coordinating the efforts of local, State, and Federal agencies in meeting the goals of ground water protection.

The ground water protection activities reported in State 305(b) reports provide only a partial picture of State efforts to protect ground water. As an initial step in implementing CSGWPPs, EPA and States are developing individual State

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assessments during fiscal year 1993. These assessments will better document the full range of State ground water protection activities.

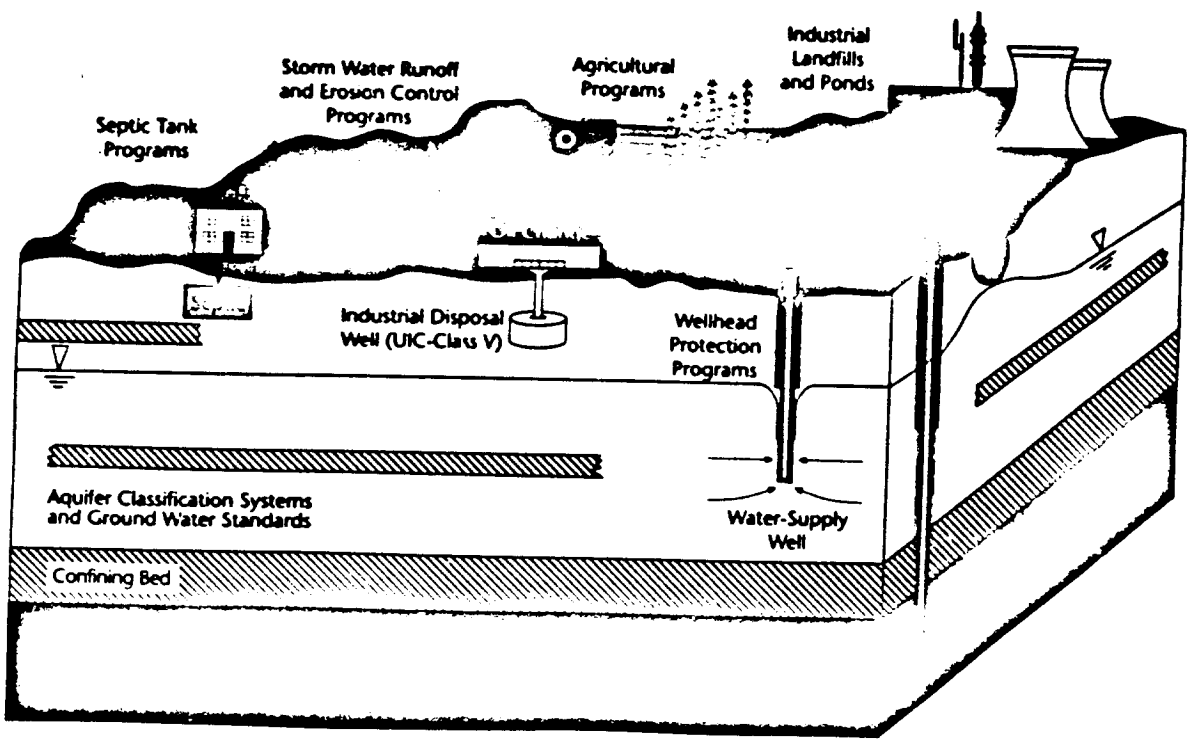
The principal State programs and strategies that address ground water protection are depicted in Figure 17-3. These include agricultural programs, septic tank programs, certification programs for well drillers or pesticide applicators, storm water runoff and erosion control programs, underground injection control programs, aquifer classification systems, ground water standards, and strategies aimed at controlling contamination from industrial landfills and ponds.

Figure 17-4 shows ongoing State ground water protection programs reported in 1992. Components of State ground water protection programs are summarized in Table 17-2. The table identifies

- Ground water protection legislation that has been adopted or is under development by State governing bodies

Figure 17-3

Types of State Ground Water Protection Programs



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- Wellhead Protection Programs that have been submitted, reviewed, or approved by EPA

- Ground water strategies or Comprehensive State Ground Water Protection Program initiatives that have been adopted or are under development

- State-specific ground water protection standards

- Statewide ground water monitoring programs or initiatives that consist of a statewide network of wells periodically sampled and analyzed for specific ground water quality parameters

- Aquifer classification or mapping programs to characterize ground water resource regions

- Special programs or methods that address the control or remediation of specific contamination sources

- The existence of a plan, advisory committee, or task force established to facilitate or coordinate interagency ground water protection programs

- Controls or measures established to address nonpoint source contamination.

State Ground Water Standards

Although many States have used Federal drinking water standards to direct their ground water protection activities, a number of States have tailored standards to their specific conditions. State ground water protection standards can be either narrative or numeric. Numeric standards set health-based maximum contaminant levels. Narrative standards are adopted for pollutants for which no numeric standards have been adopted.

Minnesota updated their standards in 1990, adding 53 toxic pollutants and a detailed set of procedures to establish criteria for adding toxic pollutants. That State has also set Recommended Allowable Limits (RALs) that may be enforced at a later time. Arizona has drafted Health-Based Guidance Levels for 230 chemicals, including pesticides, organics, metals, and other inorganics in drinking water. A total of 35 States reported the development or implementation of State ground water protection standards.

State Aquifer Classification Systems

Thirty-one States report the existence or development of programs to classify or map vulnerable ground water supplies. State programs are combining elements of Federal guidelines along with elements aimed at meeting the individual State's needs and problems. Ground water is classified by factors such as the intended ground water use, current ground water quality, and hydrology.

Massachusetts currently classifies its ground water according to its most sensitive use. The three ground water classes in Massachusetts are

- Class I: fresh ground water designated as a source of potable water supply

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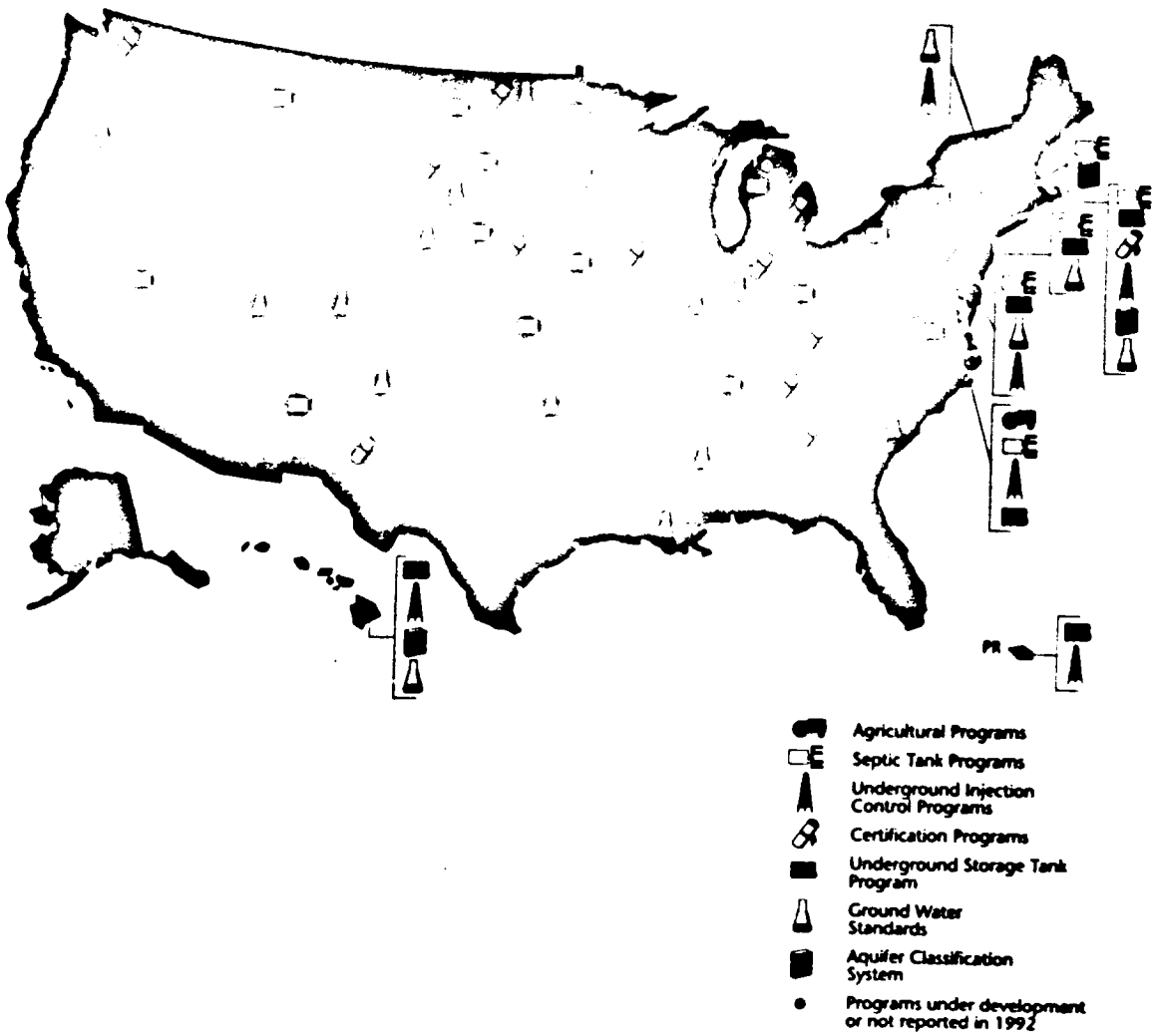
Figure 17-4

Ongoing Ground Water Protection Programs of States and Territories Reporting



Note: This map excludes Wellhead Protection Programs. Not shown are American Samoa, Guam, and the Virgin Islands. Programs in those Territories either were not reported or are under development.

Source: 1992 State Section 305(b) reports.

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State	Ground Water Legislation[a]	Wellhead Protection Program	Ground Water Strategy[a]	Ground Water Protection Standards[a]	Statewide Ground Water Monitoring Systems[a]	Aquifer Classification/ Mapping Program[a]	Special Source Controls	Interagency Coordination[a]	Nonpoint Source Controls[a]
Alabama	—	●	●	●	●	—	●	●	●
Alaska	—	—	●	—	●	●	●	●	—
Arizona	●	●	●	●	—	—	●	●	●
Arkansas	—	●	●	—	●	—	●	●	●
California	—	—	●	—	—	—	●	●	●
Colorado	●	—	●	●	—	●	●	●	●
Connecticut	●	●	●	●	—	—	●	●	—
Delaware	—	●	●	●	●	—	●	●	●
District of Columbia	—	—	●	—	—	—	●	●	●
Florida	●	—	●	—	●	●	●	●	●
Georgia	●	●	●	—	●	●	●	●	—
Hawaii	—	—	●	●	●	●	●	●	
Idaho	●	—	●	●	●	●	●	●	
Illinois	●	●	●	●	●	●	●	●	
Indiana	●	—	●	—	●	●	●	●	●
Iowa	●	—	●	—	—	●	●	●	●
Kansas	●	—	●	—	●	—	●	●	●
Kentucky	—	●	●	●	—	—	●	●	●
Louisiana	●	●	●	●	●	●	●	●	●
Maine	—	—	●	—	●	●	●	●	●
Maryland	—	●	●	—	●	●	●	●	●
Massachusetts	●	●	●	●	—	●	●	●	●
Michigan	●	●	●	—	●	●	●	●	●
Minnesota	●	●	●	●	●	●	●	●	●
Mississippi	—	—	—	—	—	—	●	●	●
Missouri	●	—	●	—	●	—	●	●	●
Montana	●	●	●	●	●	—	●	●	●
Nebraska	●	●	●	—	—	●	●	●	●
Nevada	●	●	●	—	—	—	●	●	●
New Hampshire	●	●	●	—	—	—	●	●	●

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State	Ground Water Legislation[a]	Wellhead Protection Program	Ground Water Strategy[a]	Ground Water Protection Standards[a]	Statewide Ground Water Monitoring Systems[a]	Aquifer Classification/ Mapping Program[a]	Special Source Controls	Interagency Coordination[a]	Nonpoint Source Controls[a]
New Jersey	●	●	●	●	●		●	●	
New Mexico	●	●	●	●	●		●	●	●
New York	●	●	●	●	—	●	●	●	—
North Carolina	—	—	●	—	—	—	●	●	●
North Dakota	●	●	●	●			●	●	●
Ohio	●	●	●		●	●	●	●	—
Oklahoma	—	●	●	●	●	●	●	●	●
Oregon	●		●				●	●	●
Pennsylvania	●		●	—	●	—	●	●	●
Rhode Island	●	●	●	●	●	●	●	●	—
South Carolina	—	●	●	●	—	—	●	●	—
South Dakota	●	●	●	●	●	—	●	●	●
Tennessee	—		●	—	—		●	●	—
Texas	●	●	●		●		●	●	
Utah	—	●	●	●	—	—	●	●	●
Vermont	●	●	●	—			●	●	●
Virginia	●		●	●		—	●	●	—
Washington	●		●	●	—	—	●	●	
West Virginia	—	●	●	—	—	—	●	●	—
Wisconsin	●	—	●	●	●	●	●	●	●
Wyoming	—		●	—	—		●	●	
American Samoa	●		●	●	—	—	●	●	●
Guam	—	●	●	—	—	—	●	●	—
Puerto Rico	●	●	●	●	●	—	●	●	
Virgin Islands	—	—	●	—	●	—	●	●	—
Total[b]	35	46	55	35	38	31	55	55	42

● Program in place.
◐ Program under revision or review.
Program under development.
— Not reported.

[a] Information derived from 1992 State 305(b) reports.
[b] Total number of programs in place, under development, or under revision or review.

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- Class II: saline ground water designated as a source of potable mineral waters or as a raw material for the manufacture of such products as sodium chloride

- Class III: fresh and saline ground water designated for uses other than potable water supply.

People may request by petition a specific use for a local ground water resource. Ground water for which no petition is received is automatically designated as Class I. Ground water quality standards and protection guidelines are strictest for water classified as Class I.

Pollutant Source Control

Four principal programs control pollutant sources under four different laws: solid and hazardous waste treatment, storage, and disposal and underground storage tanks are regulated under RCRA; underground injection of waste fluids is regulated under SDWA; abandoned waste is regulated under CERCLA; and nonpoint sources are regulated under CWA.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (Public Law 94-580) was passed by Congress in October 1976, amending the 1965 Solid Waste Disposal Act to address the problem of safe disposal of the huge volumes of solid and hazardous waste generated nationwide each year. This Act authorizes a regulatory program to identify and manage wastes that pose a substantial hazard to human health or the environment. RCRA is a part of EPA's comprehensive program to protect ground water resources. Protection is achieved through the development of regulations and methods for handling, storing, and disposing of hazardous material and through the regulation of underground storage tanks.

Poorly managed or poorly located municipal landfills rank high among State ground water contamination concerns. Of the quarter million solid waste disposal facilities in the United States, about 6,000 are municipal solid waste facilities. Approximately 25% of these municipal facilities have ground water monitoring capabilities.

Solid and Hazardous Waste

RCRA has evolved from a relatively limited program dealing with nonhazardous solid waste to a far-reaching program that also encompasses the handling, storage, and disposal of hazardous waste. Hazardous waste generators, transporters, and owner/operators of treatment, storage, and disposal facilities (TSDFs) constitute the RCRA-regulated community. On November 8, 1984, Congress passed the Hazardous and Solid Waste Amendments (HSWA) to RCRA, thereby greatly expanding the nature and complexity of activities covered under RCRA.

The goals of RCRA, as set forth by Congress, are

- To protect human health and the environment

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- To reduce waste and conserve energy and natural resources
- To reduce or eliminate the generation of hazardous waste as expeditiously as possible.

RCRA also requires the promulgation of standards related to underground storage tank systems for both chemicals and petroleum products.

In 1990 and 1991, RCRA programs continued to emphasize the preparation of risk assessment documents and development and evaluation of tests and procedures for conducting risk assessments. Health and Environmental Effects Documents, Reference Doses, and technical evaluations are provided to support the RCRA waste listing, permitting, and land disposal restriction programs. The 1990 program emphasized the development of health and environmental effects documents for the listing/delisting programs and reference doses for the land disposal restriction program. In addition, techniques for determining soil gas concentrations and constituents and for determining ground water contamination potential were evaluated under field and laboratory conditions. Guidelines for monitoring ground water around RCRA Subtitle D landfill facilities are being developed.

Underground Storage Tanks (UST) Program

The EPA is working with State and local governments to develop support for, and improve the effective management of, USTs. To facilitate compliance with UST regulations, EPA is developing standard test procedures for leak detection equipment. These standards will allow tank owners to choose equipment that meets EPA requirements. In addition, a nationwide marketing campaign is being conducted to promote resource-efficient methods for State monitoring of owner/operator compliance. The EPA continues to support the development of State UST regulations and encourages States to apply for UST program approval. The Agency also provides technical advice and assistance in the development and implementation of State UST data management systems.

Under the UST Program, EPA also assists municipalities by providing guarantees to local owner/operators and by encouraging the development of State assurance programs and loan funds. Loan programs may be used by tank owners to upgrade or replace tanks, thereby preventing many leaks from ever occurring. These guarantees and assurance programs help owner/operators to meet their financial responsibility requirements.

In 1990 and 1991, EPA issued final regulations on corrective action, leak detection, and technical performance standards for new and existing tanks that contain petroleum products and hazardous substances. Final regulations concerning financial responsibility requirements were also issued. EPA also negotiated UST grants with all States and provided technical assistance and guidance for implementation and enforcement of UST regulations.

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State Underground Storage Tank Programs

About 400,000 of an estimated 5 to 6 million USTs and associated piping are thought to be leaking. About 30% of all tanks store petroleum or hazardous materials. Each State, under RCRA requirements, has designated a State agency that registers new and existing USTs. Thirty-three States have reported that they have UST regulations in place or under development that are no less stringent than Federal regulations. State agencies involved with UST regulations vary, including fire, environmental, public health, or labor departments.

State-reported strategies include annual registration, strict installation requirements, and monitoring standards. They also include oversight of owner and operator compliance with Federal UST technical and financial responsibility requirements. Several States require permitting for USTs. Pennsylvania requires all USTs with a capacity greater than 110 gallons to be permitted. Permits are given only to tank owners who comply with State and Federal siting, design, leak detection, and operation requirements. They also provide a guidance document for tank owners and operators.

Several States, including Virginia and Minnesota, maintain a UST database. Minnesota's database of USTs contains known and potential sources of ground water contamination. Virginia's database tracks upgrades, repairs, and closures of USTs.

Safe Drinking Water Act

Pollutant source control is addressed under the SDWA through the Underground Injection Control (UIC) program.

UIC Regulations

EPA's UIC program was developed to regulate underground injection wells and fluids and thereby ensure that underground sources of drinking water are protected. Injection wells are classified as follows:

- Class I: Wells used to inject hazardous substances or industrial and municipal waste beneath the lowermost formation containing a source of drinking water. There are approximately 80 hazardous waste wells at 175 facilities controlled by stringent design, construction, and operating requirements.

- Class II: Wells used to inject fluids in the process of oil or natural gas production. These more than 170,000 disposal and enhanced recovery wells return brines back down to deep formations.

- Class III: Wells used to inject fluids for the purpose of in situ mineral extraction.

- Class IV: Wells used to dispose of hazardous or radioactive waste into or above an underground drinking water source. These wells are banned.

- Class V: Injection wells not included in the above classifications. These wells include more than 100,000 shallow injection wells such

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as those used to dispose of waste from automotive service bays.

Grants allotted under Sections 1443(b) and 1451 of the SDWA may be used to support UIC activities to protect ground water resources. State and Federal UIC programs include permitting and review of permits to ensure that wells meet requirements for well construction, operation, monitoring, plugging and abandonment, and financial responsibility to ensure underground sources of drinking water are not endangered. Section 1422 provides EPA with authority to grant primary enforcement authority (primacy) to States to administer a UIC program in their States. Section 1425 allows an alternative test for EPA to use to approve of a State's UIC program for oil and brine (Class II) wells.

UIC Programs

EPA and the States currently administer 57 UIC programs to maintain regulatory coverage of the more than half million underground injection wells. The majority of these programs are State-administered, as depicted in Figure 17-5. State agencies with primary enforcement authority respond to UIC violations. If a response cannot be made in a timely manner, EPA takes enforcement action.

In 1990 and 1991, EPA continued to review "no-migration" petitions for hazardous waste injection wells to ensure conformance with RCRA and UIC provisions. EPA has targeted specific enforcement, outreach, and regulatory activities to protect drinking water sources from the harmful effects of injections of wastes and other fluids through the vast number of diverse Class V injection wells. EPA Regional offices administering UIC programs in nonprimacy States continue to review permit applications for injection wells, and continue oversight of State primacy programs to ensure that UIC permits issued meet program requirements. Regional offices also continue to review petitions from operators of hazardous waste injection wells seeking exemptions from the injection ban under Part 148.

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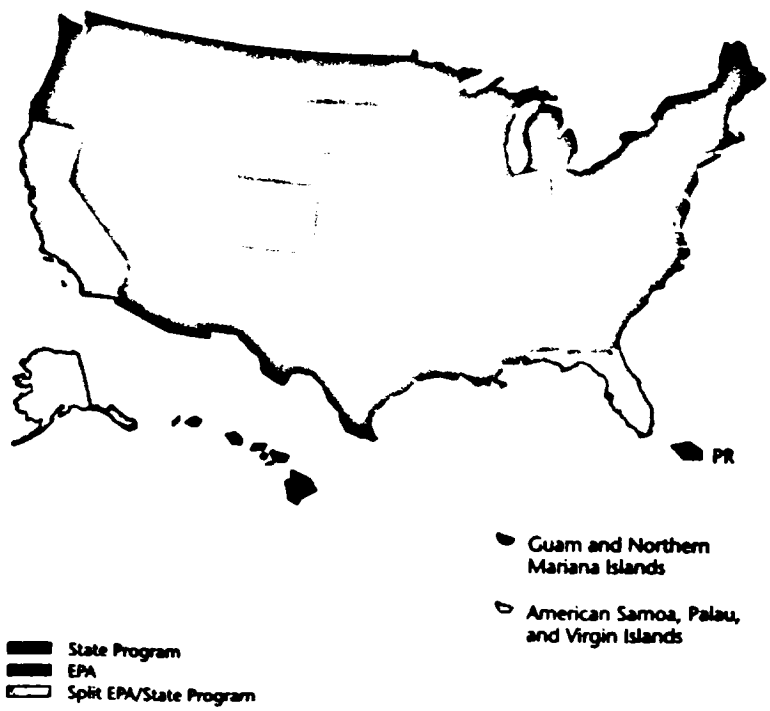
Figure 17-5

Underground Injection Control (UIC) Programs



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Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act, more popularly known as "Superfund," was passed by Congress in December 1980 to deal with threats posed to the public by abandoned waste sites. Approximately 33,000 sites have been identified as abandoned hazardous waste sites, of which 42% involve ground water contamination. With the Superfund Amendments and Reauthorization Act (SARA) of 1986, CERCLA has assumed a larger role in the cleanup of hazardous waste sites. The main objectives of CERCLA, as established by Congress are

- To develop a comprehensive program to set priorities for cleaning up the worst existing hazardous waste sites
- To make responsible parties pay for those cleanups whenever possible
- To set up a Hazardous Waste Trust Fund for the twofold purpose of performing remedial cleanups in cases where responsible parties could not be held accountable and responding to emergency situations involving hazardous substances
- To advance scientific and technical capabilities in all aspects of hazardous waste management, treatment, and disposal.

Grants to States are allotted under Section 104(b) of CERCLA. These funds are intended to support implementation, coordination, enforcement, training, community relations, site inventory and assessment, administration of remedial activities, and legal assistance relating to CERCLA implementation.

Nonpoint Source Control

Funds allotted under Sections 319(h) and (i) and 518 of the CWA are intended to assist States in implementing EPA-approved nonpoint source management programs and ground water protection activities. At least 10% of each State's annual work under these programs should be devoted to priority ground water protection activities. These activities include assessing and characterizing ground water resources, delineating wellhead protection areas, aquifer recharge areas, and zones of significant ground water surface water interactions, establishing a basis for priority protection needs, and addressing ground water protection priorities.

State Nonpoint Source Control/Agricultural Programs

As the need for American farmers to increase their productivity rises so does concern about agricultural nonpoint source pollution. Of the 1.1 billion pounds of pesticides produced annually in the United States, 77% is applied to land in agricultural production. Twenty-seven States have reported that they have either full-scale agricultural

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programs or best management strategies in place. Most of these programs focus on controls for nitrate and pesticides.

Arizona, along with several other States, regulates concentrated feeding operations, nitrogen fertilizer application, and agricultural applications of sludge. They also review registered pesticides to determine if their applications have an unreasonable adverse effect on the environment. When pesticide residues are detected in drinking water supplies in Hawaii, the Chairperson of the Board of Agriculture and the Director of Health must suspend, cancel, or restrict the use of that pesticide. Numerous States reported current monitoring of ground water near agricultural regions conducted to determine the need for future programs and strategies.

Educating the public on how farming operations and other land activities may cause pollution is a key component of most State ground water protection initiatives. Kentucky implemented a program that includes instructing farmers on use of agricultural best management practices. The program also affords water-well users an opportunity to have their water tested for nonpoint source contaminants. New York incorporates water quality in farm-level planning, provides technical assistance to farmers, and develops educational programs that heighten awareness of water quality problems that can result from improper land management.

Approximately 23 million domestic septic systems are in operation in the United States. About half a million new systems are installed each year. State septic tank programs incorporate strategies to protect ground water from contamination. Strategies include certification of septic tank installers, construction, siting, operation, and maintenance guidelines. A variety of State agencies are responsible for enforcing septic tank regulations including fire marshals, planning boards, and local and State health departments.

In New Jersey, septic tank regulations are enforced by the Local Planning Board. They must approve construction plans for individual sewage disposal systems and regulate multiple connections to a single septic system. The Ohio Department of Health (ODH) regulates the siting, design, operation, and maintenance of septic tanks. New Mexico requires that each system include a treatment unit and be situated in conformance with local and State siting standards. When necessary, New Mexico officials modify the State's standards on a case-by-case basis.

APPROXIMATELY 23 MILLION domestic septic systems are in operation in the United States.

Chemical Product Controls

The Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act control the use and disposal of commercial products thereby minimizing the risks to public health and the environment.

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Toxic Substances Control Act

The Toxic Substances Control Act (Public Law 94-469), enacted by Congress in 1976, brought significant changes in the day-to-day operation of the U.S. chemical industry. With TSCA, EPA was given the authority to identify and control chemical products that pose an unreasonable risk to human health or the environment through their manufacture, chemical distribution, processing, use, or disposal. To enable EPA to monitor the marketing of new chemicals, TSCA requires manufacturers to submit premanufacture notices on new chemical substances.

EPA is authorized to take a variety of steps to protect against threats to human health or the environment by the introduction or unrestricted use of new chemicals. Such steps include publication of the chemical inventory, information-gathering authority, and permitting access to manufacturing data that could assist in the development of source inventories for ground water protection planning and investigation.

The Federal Insecticide, Fungicide and Rodenticide Act

Under FIFRA, the EPA may deny registration for a pesticide if its normal use will result in unreasonable adverse effects on ground water quality. A number of ground water protection initiatives have been undertaken in support of FIFRA. In 1991, EPA put forth a Pesticides and Ground Water Strategy that establishes the policy framework for using the regulatory authorities available under FIFRA to implement ground water protection principles. The practical objective of this Strategy is the prevention of ground water contamination by regulating the normal use of certain pesticides.

Grants to States are available under Section 23(a)(1) of FIFRA. These funds are intended to promote the enforcement of pesticide compliance and ground water protection programs.

Pesticides and Ground Water Strategy

EPA's Pesticides and Ground Water Strategy describes the national policy framework for addressing the risks of ground water contamination by pesticides. The Strategy discusses EPA's authority under a number of statutes, but focuses on the use of FIFRA authority to achieve the Agency's goals for the protection of ground water from pesticide contamination.

This Strategy emphasizes prevention and protection of the Nation's ground water resources and provides a flexible framework for tailoring programs to the conditions in different geographic areas. The centerpiece of the Strategy is the development of State Management Plans for pesticides that may pose environmental concerns. The management plan approach affords States the opportunity to manage the use of pesticides so as to protect the ground water resource.

EPA has worked with States to develop a framework for the development of comprehensive State Management Plans that will focus on the protection of ground water resources. The management plan approach will allow States the

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flexibility to tailor pesticide use and ground water protection programs to local conditions. States have been encouraged to develop this management framework in the form of "generic" management plans. In 1993, EPA plans to release a list of chemicals for which pesticide-specific management plans will be required. The Pesticide State Management Plans may subsequently be integrated with State Comprehensive Ground Water Protection Programs.

Prevention of Ground Water Contamination by Restricting Pesticide Use

Classifying a pesticide for Restricted Use limits its use to certified applicators or supervision by certified applicators. Certification depends upon completion of required training concerning the proper handling and application of pesticides with the potential to contaminate ground water. Restricting use to certified applicators has three practical results for the reduction of ground water contamination:

- Reduction in the population of pesticide users
- Education of the certified users to reduce the ground water contamination risks
- Training and experience in proper mixing and loading of pesticides to reduce the chances of spills or other potential ground water contamination hazards.

Therefore, Restricted Use classification is intended to reduce both the risks of some "point source" causes of ground water contamination as well as nonpoint source causes of contamination.

Pollution Prevention

The Pollution Prevention Act of 1990 was enacted by Congress to promote pollution prevention and environmental protection goals. Under this Act, the EPA Office of Pollution Prevention and Toxics and the USDA Cooperative State Research Service have worked cooperatively to lead the Nation in the development of environmentally sound agricultural policies. The Agriculture in Concert with the Environment Program promotes the use of sustainable agriculture and the integrated management of nutrients, pesticides, resources, and wastes to reduce the risks of environmental pollution. Grants allotted under this Act may be used to fund outreach projects involving education, demonstration, and training in sustainable agriculture and other agricultural practices that emphasize ground water protection and reducing the excessive use of nutrients and pesticides.

Grants are also available under this Act to support State and local pollution prevention programs that address the reduction of pollutants across all environmental media: air, land, surface water, ground water, and wetlands. These grants may be used to promote and coordinate existing State pollution prevention activities that focus on specific media, to develop new multimedia pollution prevention programs, to develop mechanisms to measure progress in multimedia pollution prevention, and to conduct education and outreach programs.

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EPA Management of Ground Water Data

A number of mechanisms have been developed to manage the ever-growing volume of information on the Nation's ground water resources. These include the development of a standard nomenclature for reporting ground water data, the development of geographic information systems (GISs) to integrate ground water data that have been collected under different programs, and the development and management of two databases concerning pesticides and ground water.

Minimum Set of Data Elements

In keeping with EPA's Ground Water Protection Strategy for the 1990s, the Agency has identified the need to improve the collection, accessibility, transfer, and use of information on the Nation's ground water resources. Therefore, the Agency has established a Minimum Set of Data Elements (MSDE) for Ground Water Quality. The MSDE are intended to improve access to ground water data and to increase information sharing capabilities by standardizing the elements used in ground water database development. The MSDE is implemented when States, Federal agencies, or other officials are creating or updating ground water quality databases. The 21 data elements in the minimum set are divided into four categories:

- General descriptors pertaining to where the well information is maintained
- Geographic descriptors pertaining to the location of the well in relation to the earth's surface
- Well descriptors pertaining to construction details and other features of the well
- Sample descriptors pertaining to aspects of sample collection, analysis, and recording of the results of ground water sampling.

These elements represent the *minimum* data elements that States and Federal agencies should include during ground water information collection and reporting activities. In addition, formats and conventions for reported data are presented as examples to guide the development of standardized databases and facilitate data sharing.

Cross-Program Integration Approach Using GIS

EPA recognizes that it is critical for the Agency to integrate its ground water protection programs and provide assistance to the States as they seek to build State and local capacity. States have the responsibility to implement a number of Federal programs that may impact the quality of surface-water and ground-water resources. For this reason, a project has been undertaken in the EPA's Office of Ground Water and Drinking Water to integrate the information obtained in a number of Federal programs (Public Water Supply, Underground Injection Control, Wellhead Protection, and Comprehensive State Ground Water Protection Program) and to

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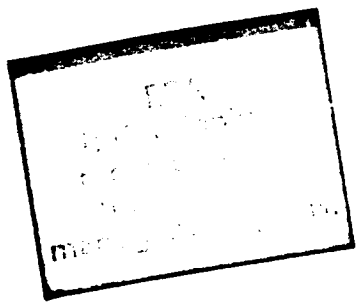
demonstrate how these programs complement and support each other in protecting ground water and drinking water.

The specific goals of the project are to use GIS to investigate the types of ground water data needed to facilitate State, Regional, and national programs and support the development of Comprehensive State Ground Water Protection Programs and to assess the application of existing data to characterize the contamination threats to the Nation's water supplies. Information on ground water and surface water contaminants will also be used to investigate perceived threats to drinking water supplies and to target critical geographic areas for ground water protection activities. The multiyear project will involve the analysis of data from six study sites that characterize a number of potential ground water contamination threats and various hydrogeologic regimes. It is further hoped that the project will demonstrate an approach for linkage to the USGS NAWQA program and selected State monitoring programs.

Pesticides in Ground Water Database

The Pesticides in Ground Water Database was created by the EPA's Office of Pesticide Programs to provide a more complete picture of ground water monitoring for pesticides in the Nation. It is a collection of ground water monitoring studies conducted by Federal, State, and local governments, universities, and private institutions. The focus of these studies must include the analysis of samples for pesticide residues. The Pesticides in Ground Water Database consists of monitoring data and auxiliary information in both computerized and hard copy form. The computerized portion of the database consists of files describing the study, each monitoring well, and information on ground water samples. This portion of the database is a part of the Pesticide Information Network (PIN), a computerized collection of files that contain pesticide monitoring and regulatory information in an electronic bulletin-board format. The EPA's Office of Pesticide Programs is planning to publish a summary report of the data in the Pesticides in Ground Water Database on approximately a yearly basis.



Prevention of Ground Water Contamination from Pesticides: Information Systems for State Use

The development of State Management Plans to implement the Pesticides and Ground Water Strategy will require technical information and tools to predict vulnerability of ground water to pesticide use. Some information and tools are available, and others can be developed, to locate problem areas and develop strategies for management of pesticides on a State or local level. These tools include models to predict the leaching of pesticides to ground water, data on soil properties and other relevant environmental factors, GISs for integrating information spatially, and monitoring strategies for detecting and tracking pesticide movement in the

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subsurface. The EPA's Office of Research and Development has undertaken a set of projects to provide the technical tools that States may use to develop and implement locally meaningful pesticide management plans. These projects include:

- Development of a user-friendly model or screening system for locating vulnerable soils within a State
- Identification of, and guidance to, the access of useful national databases
- Development of guidance on using GIS for pesticide management
- Development of guidance on monitoring strategies considering temporal, spatial, and environmental factors affecting pesticide occurrence and transport
- Enhancement of the PIN to include additional databases and sources of information useful to States.

This work is based on the best available knowledge and is being coordinated with related projects and research on the effects of agricultural chemicals on water quality at EPA and other Federal and State agencies.

USGS Ground Water Quality Investigations

The USGS initiated the National Water Quality Assessment (NAWQA) pilot program in 1986. In 1991, the USGS began the transition from the pilot program to a full-scale program. The NAWQA program is designed to address national and regional water quality concerns through comparative studies in a variety of hydrologic systems. Study-unit investigations of 60 areas that include most major river basins and aquifer systems have been initiated. Goals include providing nationally consistent water quality information to define long-term water quality trends and describing the primary factors affecting the Nation's surface and ground water quality. An ongoing goal of the NAWQA program is to facilitate data exchange, communication, and coordination among the USGS, water resource managers in agencies at Federal, State, and local levels, as well as other interested scientists.

National issues being addressed by the NAWQA Program focus on the degradation of water quality from nonpoint sources of pollution. Specific issues being addressed in many of the study-units focus on pesticides, nutrients, and sediment. Several specific questions related to pesticides that will be addressed by the program include:

- What are the occurrences and concentrations of pesticides in selected river basins and aquifer systems nationwide?
- What is the relation of pesticide concentrations in surface and ground water to natural factors, changes in hydrologic conditions, pesticide use, chemical properties, and land management practices?
- What significance do key findings have on current water quality monitoring, management, and regulatory practices?

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USEPA. 1992. *Case Studies in Wellhead Protection: Ten Examples of Innovative Wellhead Protection Programs*. EPA 813R/92-002. Office of Ground Water and Drinking Water, Washington, DC.

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USEPA. 1991. *Best Management Practices for Protecting Ground Water: Facilities Using Special Drainage Wells*. EPA 570/9-91-036N. Office of Ground Water and Drinking Water, Washington, DC.

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Part IV

Costs and Benefits of Water Pollution Control

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Costs and Benefits of Water Pollution Control

Introduction

Section 305(b) of the Clean Water Act calls for States to prepare estimates of the economic and social costs necessary to achieve the objectives of the Act. States are also requested to report on the economic and social benefits of these achievements. This section draws upon the information submitted by States and developed by EPA and other Federal agencies concerning the benefits and costs of water pollution control.

None of the States and Territories reporting on their water quality programs attempted to describe the full extent of economic benefits and costs associated with progress made in improving and protecting water quality conditions.

Instead, studies have been undertaken on either a State, local, or regional scale to generate benefit and/or cost information for more specific water quality issues. Most studies of this type analyze a limited number of beneficial outcomes associated with water quality changes occurring within a given watershed, lake, or estuary. The results of these studies are used to assess implementation options or to provide a means of evaluating the effectiveness of water quality control programs. EPA and the States and Territories have had to rely upon such studies in order to provide information on the economic benefits and costs of water quality controls.

This chapter presents information both prepared by EPA and reported by the States in their 305(b) reports that pertains to the economic costs and benefits of water quality protection programs. This information does not present a comprehensive view of conditions throughout the Nation but illustrates the types and magnitude of benefits and costs that result from water quality control programs in specific situations.

EPA and the States are taking many steps toward transforming the 305(b) process into one that provides comparable data with known accuracy. These steps include implementing the recommendations of the National 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality, as well as improving the Section 305(b) guidelines and implementing the Office of Water's Monitoring Strategy. These efforts will foster consistency and accuracy among the States and allow for better sharing of data for watershed protection.

Costs

Estimates of the economic costs of water quality programs include public and private expenditures for

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personnel and equipment used to reduce and treat discharges to waterbodies and governmental expenditures for developing, implementing, and enforcing water quality regulations. Previous 305(b) reports have included tables showing national cost estimates prepared by the EPA and the U.S. Department of Commerce. These tables are reproduced here with some minor modifications to reflect additional information and changes in methodologies followed in cost calculations conducted by the U.S. Department of Commerce.

As displayed in Table 18-1, the costs for water quality controls (both point source programs and nonpoint source programs) continue to constitute the largest portion of water pollution control expenditures (91% as of 1987). Water quality costs are those associated with actions taken to meet the Marine Protection, Sanctuaries, and Research Act of 1972 and the Clean Water Act as amended in 1987.

Nonpoint source expenditures are those incurred to control pollution from sources such as land runoff, precipitation, drainage, and seepage, including agricultural storm drainage and irrigation return flows. As shown in the table, expenditures for point source controls account for the lion's share of the expenditures for improving water quality. Although the table includes estimates of expenditures for nonpoint source controls, there is much uncertainty associated with this estimate. Estimates of expenditures for point source controls, on the other hand, are much more reliable.

Total annual water pollution costs (including drinking water protection expenditures) have increased steadily over time, from about $9.9 billion in 1972 to $40.5 billion in 1990 (in constant 1986 dollars). The majority of historical point source control costs are for sewerage services and wastewater treatment and for control of industrial effluents and the pretreatment of wastewater discharges to

Program	1972	1980	1987	1990	1995	2000
Point Source	8,543	20,726	27,546	36,075	44,162	52,537
Nonpoint Source	567	647	779	823	893	959
Drinking Water	802	1,982	2,765	3,591	5,350	6,563
Total	9,912	23,355	31,090	40,489	50,405	60,059

Source: U.S. EPA, *Environmental Investments: The Cost of a Clean Environment – A Summary*, Office of Policy, Planning, and Evaluation, December 1990, Table 3-3, page 3-3. Updated and revised based on U.S. Department of Commerce, Pollution abatement and expenditures: 1972-1990, in *Survey of Current Business*, June 1992.

Program	1972	1980	1987	1990	1995	2000
Water	9,912	23,355	31,090	40,489	50,405	60,056
Land	8,412	13,449	15,716	31,159	40,973	51,535
Air and Radiation	7,826	17,218	22,562	26,755	35,187	42,390
Multimedia[a]	107	868	687	1,580	2,122	2,299
Chemicals	92	889	773	1,608	2,466	2,886
Total	26,349	55,779	70,828	101,591	131,153	159,166
Percent of GNP[b]	0.87	1.52	1.70	2.13	2.53	2.80

[a] Includes costs not attributable to individual media programs (e.g., EPA management and support, Emergency Planning and Community Right to Know Act, and undesignated non-EPA Federal costs.

[b] GNP = Gross National Product using the GNP implicit price index.

Source: U.S. EPA, *Environmental Investments: The Cost of a Clean Environment – A Summary*, Office of Policy, Planning, and Evaluation, December 1990, Table 3-3, page 3-3. Updated and revised based on U.S. Department of Commerce, Pollution abatement and expenditures: 1972-1990, in *Survey of Current Business*, June 1992.

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municipal treatment facilities. Future costs are projected to reach $60 billion by the year 2000. Much of the projected increase is attributable to additional drinking water regulations and the need to construct backlogged municipal wastewater treatment facilities. Future cost increases to control nonpoint sources are also anticipated, but the magnitude of this increase is highly uncertain. Therefore, the forecasted increase in nonpoint source controls is based on increases associated with recent trends for changes in nonpoint source expenditures.

Several other environmental statutes expressly recognize that pollution sources regulated under their protection programs can contribute to changes in water quality conditions. For example, the 1990 amendments to the Clean Air Act contain sections that call for air quality controls that will reduce the effects of acidic deposition and the delivery of other toxic materials to affected waterbodies. Measures taken to reduce runoff and leakage from landfills and underground storage facilities under the Resource Conservation and Recovery Act can prevent the contamination of surface and ground water supplies. The regulation of toxic chemicals and pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act and the Toxic Substances Control Act can prevent the deterioration of natural ecosystems and enhance recreational and commercial fisheries. Table 18-2, which describes the costs of all pollution control programs, gives some perspective on the magnitude of pollution control expenditures in the United States. The relevant proportion of these costs that can be directly or otherwise related to water quality improvements has not been computed. But, as the estimates in Table 18-2 indicate, water

[illegible]

Year	EPA New Grants	EPA Grant Exp. Expds.	FHA Grant Expds.	Federal Dept. of Comm. Expds.	PA DER Act 443 Expds.	PA DER Act 339 Expds.	PA DER Act 537 Expds.	PA ARC*	PA Dept. of Comm. Expds.	PENN VEST Loan and Grant Obligat.
1987	78,083	109,973	3,861	1,000	49	18,920	1,868	0	4,314	—
1988	107,261	135,225	4,615	600	637	19,865	1,961	200	6,558	162,508
1989	41,398	69,691	4,565	1,180	249	20,934	1,037	0	0	152,525
1990	34,116	83,987	5,533	950	8	23,778	2,097	0	5,146	110,251
1991	32,137	51,473	13,554	0	5	27,211	1,103	0	935	128,243
Total	292,995	450,349	32,128	3,730	948	110,708	8,066	200	16,953	553,527

Source: 1992 Pennsylvania 305(b) report, Table 23, page 128.

*Appalachian Regional Development Act.

Note: EPA new grants column refers to EPA's delivery of grants to the State in that year. EPA grants expenditures column refers to the State's actual use of grant funds during that period and prior years. Thus, the grants and expenditures in any one year will not necessarily be equal.

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Year	Manufacturing Industries Water Pollution Control Costs			State and Local Government	State and Federal Financial Assistance Grants and Loans			WA State Department of Ecology
	Capital Expenditures	Operating Costs	Payments for Public Sewage Services	Sewerage Expenses	Centennial Clean Water Fund	CWA Construction Grants	State Revolving Fund	Annual Funding
1986	16.4	90.3	13.0	286.6	—	10.9	—	No data
1987	No data	No data	No data	441.5	—	17.5	—	No data
1988	21.7	113.8	15.7	433.4	10.6	51.9	—	3.4
1989	45.4	112.2	21.9	346.0	22.6	22.2	—	5.5
1990	No data	No data	No data	369.4	60.0	18.7	16.0	6.3
1991	No data	No data	No data	No data	80.0	48.8	20.0	7.0
1992	No data	No data	No data	No data	41.5	—	41.5	9.0 (est.)
1993	No data	No data	No data	No data	No data	—	No data	9.0 (est.)

Source: 1992 Washington State 305(b) report, Tables V-5 to V-8, pp. 183-186.

Ohio River Mile Point	Wastewater Treatment Plant	State	Dollars Spent	Monitoring Station Mile Point	Water Quality Trend	Biological Indicator
138.2	Sistersville	WV	2,221,000			
142.6	Friendly	WV	2,859,598			
155.1	St. Mary's	WV	787,668	161.8	Improving	NA
171.0	Manetta	OH	7,114,580			
172.2	Williamstown	WV	2,523,700			
175.7	Central Boaz	WV	3,131,600			
183.3	Ohio County	WV	4,928,806			
183.3	Parkersburg	WV	19,951,500			
183.3	Vienna	WV	960,867			
185.7	Belpre	OH	2,069,974	203.9	Improving	No trend

NA = Not available (insufficient data).

Source: Adapted from Table 20, pages 40-41, 1992 Ohio Section 305(b) report, Ohio EPA, 1992.

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quality programs alone make up a significant portion (35% to 40%) of the total estimated expenditures for all environmental programs in the United States.

Given the scarcity of State information, it is not possible to develop comprehensive estimates of environmental expenditures for all States. However, several States produced information on the costs of water quality control programs. Two of the more comprehensive presentations were supplied by Pennsylvania's Department of Environmental Resources and Washington's Department of Environmental Conservation (Tables 18-3 and 18-4). The costs demonstrated in these two tables are not necessarily representative of expenditures in other States, but illustrate the variety of Federal, State, local, and privately funded and administered activities aimed at protecting water quality.

Benefits

Like previous State Section 305(b) reports, the 1992 submissions do not fully describe the economic and environmental benefits associated with water quality improvements in the States. States continue to focus their reports on measurable physical, chemical, and biological changes in water quality and estimated changes in physical loadings from point and nonpoint sources of pollution. Few States have used this information in their 305(b) reports to estimate the effects of changes in water quality conditions on economic activities, and fewer still attach values to these economic activities in a manner that allows for a comparison between the economic costs and benefits.

Additional information on costs and benefits related to the Clean Water Act may be found in President Clinton's *Water Initiative: Analysis of Benefits and Costs* (EPA800-R-94-002, March 1994).

Following are three examples that demonstrate how States have responded to requests for information on the economic benefits of their programs. They show the spectrum in the use of information and economic theory in the preparation of State benefit analyses.

■ The Ohio River Commission examined long-term trends in monitoring data for total suspended solids (TSS) and total Kjeldahl nitrogen (TKN) and their relationship with wastewater treatment dollars spent through the Construction Grants Program. In Table 18-5, the category of dollars spent refers to monies allocated from 1977 through 1991 for publicly owned treatment works discharging directly into the Ohio River. The dollar amount may include additional State and local funds as well as monies spent for project planning, collection system improvements, and other areas not directly resulting in improved effluent quality. Further, some monies allocated during this period may not have been spent, while monies allocated prior to 1977 are not reported but may have been spent during the report period. The trend data refer to median decreases in TSS and TKN concentrations measured using the Commission's monitoring program. These data illustrate the relationship between construction expenditures for wastewater treatment and water quality improvements in the Ohio River.

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■ Arizona described a specific water quality action for which the benefits and costs of the decision were not calculated in dollars but were described in qualitative terms. This action demonstrates some of the issues that relate to the weighing of benefits and costs associated with water quality programs. In this particular case, the circumstances revolved around the reclassification of a waterbody as a Unique Water with the adoption of the new State Surface Water Standards in January 1992. The Arizona report indicates that the costs of the actions include, but are not necessarily limited to, the following:

- public acquisition of private land for the preserve
- limitation of land use options on adjoining properties to the preserve
- request to eliminate grazing permits along the waterbody
- cleanup of petroleum-tainted soils in a railroad right-of-way
- development of a maintenance and emergency response plan by the railroad
- restoration of a contaminated well
- plans to develop and implement potential roadway spill runoff from an adjacent highway
- chemical and biological monitoring of surface and ground water quality and flow levels
- State resources to develop site-specific water quality standards
- revegetation of areas damaged by construction, mining, utility corridors, and transportation rights-of-way.

The potential benefits to consider measuring from this action include, but are not necessarily limited to, the following:

- protection of one of two remaining perennial streams in the Tucson area
- maintenance of an area used for geological, ornithological, and botanical research and education
- land management cost savings afforded by consolidation of land holdings
- reduced costs of flood protection insurance
- protection of a rare ecological system and habitat for local and migratory species
- protection of high-quality drinking water sources
- provision of suitable habitat for future reintroduction of endangered native species.

The Arizona report notes that some of the costs were inevitable. In such cases, the benefits should not be solely attributed to the process. In such instances, some means must be developed to correctly attribute both benefits and costs to policy decisions, or the information must be caveated in such a way as to make this known to policymakers and the public.

■ Pennsylvania described the economic value of fishing and boating using information on the number of fishing and boating permits and studies performed by the Pennsylvania State Data Center. In this study an estimated 3,333,000 persons participated in recreational fishing with expenditures totaling $1.35 billion on equipment, supplies,

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food, lodging, fuel, and other goods. In addition, some 2,981,000 State residents participated in boating activities and spent $2.878 billion in this activity.

While these expenditures provide significant revenues and income to the State economy, it would be incorrect to argue that the economic benefits of these activities have been achieved only by improving particular waterbodies. In the absence of these local recreational and boating opportunities, most of these individuals would probably be engaged in some alternative activity or choose to recreate elsewhere, which would also generate expenditures on their part. However, the fact that people choose local waterbodies when they are available reveals that such waterbodies are valued by the citizens.

The Greater Benefits of Water Quality Programs

As the preceding discussion makes clear, information on benefits is rather sparse. Nevertheless, it is also clear that protection of the Nation's waters is important to individual citizens and the economy as a whole. This section provides some perspectives on particular economic sectors dependent on water pollution control efforts to maintain their vitality.*

Recreational Fishing

An estimated 46 million Americans participate in recreational fishing. In 1985, they spent 976 million days on the water. Most of these days (84%) were spent freshwater fishing, with saltwater fishing accounting for 16%. Recreational fishers spend about $32 billion annually on tackle, gear, boats, lodging, transportation, and related expenses.

Clean water is essential to preserving recreational fisheries and local communities that depend on them. An example is the Great Lakes fishery. Sport fishing contributes about $4 billion annually to the economies of the Great Lakes States. However, fishing bans and advisories have adversely affected fishing along 4,808 of the 5,382 miles of Great Lakes shoreline.

Boating

In 1989, one out of three Americans participated in boating, and approximately 16 million boats are registered in the United States. Expenditures on boating were approximately $13.7 billion in 1990. The recreational boating industry employs about 600,000 workers, including 242,000 manufacturing workers, 184,000 workers in marine wholesaling and retailing operations, and about 174,000 workers employed by marine service businesses.

*Information in this section is drawn from *Clean Water and the Economy: An Overview*, Office of Water, EPA, August 1992.

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Although high levels of water quality are not absolutely necessary for safe boating, poor water quality may restrict access. Even where poor water quality does not deter boating, there is little doubt that water pollution such as floatables, odor, and algae growths detract from the pleasures of boating.

Commercial Fishing

Approximately 274,000 Americans are commercial fishers and 90,000 workers are employed in seafood processing and related activities. In 1990, the U.S. catch was valued at $3.6 billion, and this sector's total contribution to GNP was approximately $16.5 billion.

Pollution of the Nation's rivers, lakes, bays, and estuaries has direct and indirect impacts on the commercial fisheries. Short-term effects include fish kills and advisories or bans that limit access. Long-term impacts include adverse impacts on spawning grounds and nurseries. Shellfish are extremely vulnerable to water pollution, which has severely affected much of the country's prime shellfishing grounds. Of the 17 million acres of estuarine waters monitored in 1990, 25% were prohibited for shellfishing and another 12% were in restricted or conditional status.

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Appendix A

Individual State Data
Rivers and Streams

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State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Alabama	7,478	1,373	—	[illegible]	122	89	—	211	923	1,320	—	[illegible]
Alaska	—	1,165	—	1,165	—	—	—	—	251	1,040	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Arizona	467	349	—	816	182	138	—	320	1,061	569	—	[illegible]
Arkansas	2,322	1,315	—	3,637	—	—	—	—	1,366	826	—	[illegible]
California[a]	—	—	713	713	—	—	316	316	—	—	4,367	[illegible]
Colorado	15,725	7,984	—	23,709	—	—	—	—	1,173	193	—	[illegible]
Connecticut	215	172	—	387	90	82	—	172	30	238	—	[illegible]
Delaware	44	43	—	87	3	6	—	9	2	46	—	48
Delaware River Basin	—	—	—	—	—	206	—	206	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	3	—	3
Florida	2,168	2,880	—	5,048	5	247	—	252	669	1,152	—	[illegible]
Georgia	—	1,165	—	1,165	—	—	—	—	251	1,040	—	[illegible]
Gila River Ind. Comm.	—	—	—	—	—	—	—	—	—	—	61	61
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	42	13	—	55	48	2	—	50	—	—	—	—
Idaho	352	282	—	634	179	175	—	354	7,066	1,570	—	8,636
Illinois	2,370	3,568	—	5,938	—	273	—	273	2,400	5,173	—	[illegible]
Indiana[a]	1,153	3,595	—	4,748	281	96	—	377	154	189	—	343
Iowa	—	—	—	—	108	386	—	494	8,609	643	—	[illegible]
Kansas	228	670	—	898	—	—	—	—	62	644	—	[illegible]
Kentucky	3,916	2,572	—	6,488	—	69	—	69	226	762	—	988
Louisiana	1,979	408	—	2,387	1,885	—	—	1,885	116	3,260	—	3,376
Maine	20,620	10,580	—	31,200	—	—	—	—	58	153	—	211
Maryland	14,372	1,317	—	15,689	—	—	—	—	349	911	—	1,260
Massachusetts	200	188	—	388	113	120	—	233	80	183	—	263
Michigan	—	21,299	—	21,299	—	—	—	—	—	—	—	—
Minnesota	99	989	—	1,088	—	—	—	—	476	679	—	1,155
Mississippi	1,958	191	—	2,149	1,021	550	—	1,571	30,002	1,573	—	[illegible]
Missouri	7,398	3,642	—	11,040	—	—	—	—	5,930	3,705	—	[illegible]
Montana	46,732	804	—	47,536	2,620	615	—	3,235	9,144	3,397	—	[illegible]
Nebraska	458	1,660	—	2,118	40	104	—	144	590	3,375	—	[illegible]
Nevada	128	204	—	332	—	—	—	—	—	334	—	[illegible]
New Hampshire	2,073	8,541	—	10,614	—	—	—	—	—	80	—	[illegible]
New Jersey[a]	—	—	—	—	—	—	1,022	1,022	—	—	329	[illegible]
New Mexico	35	278	—	313	—	50	—	50	556	2,400	—	[illegible]
New York	43,978	3,094	—	47,072	1,304	92	—	1,396	2,759	194	—	[illegible]
North Carolina	8,682	4,242	—	12,924	9,866	1,967	—	11,833	6,392	2,215	—	[illegible]
North Dakota	—	180	—	180	4,783	1,926	—	6,709	210	2,074	—	[illegible]
Ohio[a]	1,368	1,244	—	2,612	108	411	—	519	794	901	—	[illegible]
Ohio River Valley	—	—	—	—	—	—	—	—	79	420	—	[illegible]
Oklahoma	537	37	—	574	3,136	386	—	3,522	—	2,175	—	[illegible]
Oregon	12,330	322	—	12,652	—	—	—	—	7,381	1,321	—	[illegible]
Pennsylvania	12,790	7,351	—	20,141	—	—	—	—	364	1,573	—	[illegible]
Puerto Rico	285	3	—	288	577	13	—	590	862	98	—	[illegible]
Rhode Island	—	—	206	206	—	—	282	282	—	—	32	[illegible]
South Carolina	—	—	2,842	2,842	—	—	—	—	—	—	648	[illegible]
South Dakota	66	548	—	614	—	—	—	—	275	672	—	[illegible]
Tennessee	3,432	1,666	—	5,098	921	854	—	1,775	1,408	1,559	—	[illegible]
Texas	—	—	10,381	10,381	—	—	—	—	—	—	1,356	[illegible]
Utah	2,582	1,711	—	4,293	—	—	—	—	915	265	—	[illegible]
Vermont	2,808	305	—	3,113	975	172	—	1,147	687	103	—	[illegible]
Virginia	2,266	12,155	—	14,421	—	—	—	—	94	2,357	—	[illegible]
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	605	1,016	—	1,621	369	—	—	369	535	525	—	[illegible]
West Virginia	126	587	—	713	44	324	—	368	248	3,100	—	[illegible]
Wisconsin	7,818	1,516	—	9,334	92	7	—	99	1,141	185	—	[illegible]
Wyoming	15	747	—	762	826	388	—	1,214	2,285	1,264	—	[illegible]
Totals	232,220	113,921	14,142	[illegible]	29,698	9,748	1,620	[illegible]	97,973	56,259	6,793	[illegible]
% of Assessed Waters	64%	32%	4%	[illegible]	72%	24%	4%	6%	61%	35%	4%	25%

[a]Entered aquatic life use support data in lieu of overall use support data.

— None or not reported.

Source: 1992 State Section 305(b) reports.

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Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
384	653	—	[illegible]	—	—	—	—	8,907	3,385	—	12,292
168	1,430	—	[illegible]	—	—	—	—	419	3,635	—	4,054
—	—	—	[illegible]	—	—	—	—	—	—	—	—
1,070	625	—	[illegible]	—	—	—	—	2,780	1,681	—	4,461
971	662	—	[illegible]	—	—	—	—	4,659	2,803	—	7,462
—	—	283	[illegible]	—	—	—	—	—	—	5,679	5,679
1,703	417	—	[illegible]	—	—	—	—	18,601	8,594	—	27,195
5	58	—	[illegible]	1	2	—	3	341	552	—	893
236	423	—	[illegible]	—	—	—	—	285	518	—	803
—	—	—	[illegible]	—	—	—	—	—	206	—	206
—	35	—	[illegible]	—	—	—	—	—	38	—	38
248	564	—	[illegible]	—	—	—	—	3,090	4,843	—	7,933
168	1,430	—	[illegible]	—	—	—	—	419	3,635	—	4,054
—	—	135	135	—	—	—	—	137	59	—	196
—	—	—	[illegible]	—	—	—	—	—	—	—	—
—	—	—	[illegible]	—	—	—	—	90	15	—	105
2,698	666	—	[illegible]	—	—	—	—	10,295	2,693	—	12,988
73	123	—	196	—	—	—	—	4,843	9,137	—	13,980
60	1,244	—	[illegible]	—	—	77	77	1,648	5,124	77	6,849
22	414	—	436	—	—	—	—	8,739	1,243	—	9,982
7	15,492	—	[illegible]	—	—	—	—	297	16,806	—	17,103
319	1,874	—	[illegible]	—	—	—	—	4,461	5,277	—	9,738
755	686	—	[illegible]	—	—	—	—	4,735	4,354	—	9,089
11	250	—	[illegible]	—	—	—	—	20,689	10,983	—	31,672
21	31	—	[illegible]	—	—	—	—	14,742	2,259	—	17,001
270	418	—	[illegible]	—	—	—	—	663	909	—	1,572
152	1,139	—	[illegible]	—	—	—	—	152	22,438	—	22,590
396	1,994	—	[illegible]	—	—	—	—	971	3,662	—	4,633
125	434	—	[illegible]	—	—	—	—	33,106	2,748	—	35,854
25	315	—	[illegible]	—	—	—	—	13,353	7,662	—	21,015
1,004	361	—	[illegible]	—	—	—	—	59,500	5,177	—	64,677
108	1,726	—	[illegible]	—	—	—	—	1,196	6,865	—	8,061
87	629	—	[illegible]	—	45	—	45	215	1,212	—	1,427
5	142	—	[illegible]	—	—	—	—	2,078	8,763	—	10,841
—	—	164	164	—	—	—	—	—	—	1,515	1,515
5	265	—	[illegible]	—	—	—	—	596	2,993	—	3,589
288	20	—	[illegible]	—	—	—	—	48,329	3,400	—	51,729
1,032	664	—	[illegible]	—	—	—	—	25,972	9,088	—	35,060
—	—	—	[illegible]	—	—	—	—	4,993	4,180	—	9,173
1,910	1,167	—	[illegible]	—	—	—	—	4,180	3,723	—	7,903
40	442	—	[illegible]	—	—	—	—	119	862	—	981
7	768	—	[illegible]	—	—	—	—	3,680	3,366	—	7,046
4,926	2,829	—	[illegible]	—	—	—	—	24,637	4,472	—	29,109
173	2,500	—	[illegible]	—	—	—	—	13,327	11,424	—	24,751
2,605	932	—	[illegible]	—	—	—	—	4,329	1,046	—	5,375
—	—	145	[illegible]	—	—	—	—	376	289	—	665
—	—	464	[illegible]	—	—	—	—	—	—	3,954	3,954
110	1,932	—	[illegible]	—	—	—	—	451	3,152	—	3,603
342	643	—	[illegible]	—	—	—	—	6,103	4,722	—	10,825
—	—	2,370	[illegible]	—	—	—	—	—	—	14,107	14,107
891	1,193	—	[illegible]	—	—	—	—	4,388	3,169	—	7,557
173	42	—	[illegible]	—	—	—	—	4,643	622	—	5,265
21	1,065	—	[illegible]	—	—	—	—	2,381	15,577	—	17,958
—	—	—	[illegible]	—	—	—	—	—	—	—	—
551	2,036	—	[illegible]	—	—	—	—	2,060	3,577	—	5,637
280	577	—	[illegible]	—	—	—	—	698	4,588	—	5,286
391	187	—	[illegible]	—	—	—	—	9,442	1,895	—	11,337
—	488	—	[illegible]	—	—	—	—	3,126	2,887	—	6,013
24,836 31%	51,985 65%	3,561 4%	[illegible]	1 1%	47 38%	77 62%	[illegible] <1%	385,241 60%	232,308 36%	25,332 4%	642,881 18%

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	8,631	221	2,024	939	—	11,815
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	802	793	1,178	1,584	—	4,357
Arkansas	4,019	—	2,119	764	—	6,902
California	713	316	4,367	283	—	5,679
Colorado	22,243	—	1,366	2,166	710	26,485
Connecticut	616	56	182	38	3	895
Delaware	580	3	81	138	—	802
Delaware River Basin	206	—	—	—	—	206
District of Columbia	12	—	3	23	—	38
Florida	5,048	252	1,822	811	—	7,933
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	61	135	82	278
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	490	277	1,761	147	—	2,675
Illinois	5,938	273	7,573	196	—	13,980
Indiana	4,748	377	343	1,304	77	6,849
Iowa	—	508	9,323	141	8	9,980
Kansas	2,829	—	2,152	12,122	—	17,103
Kentucky	7,208	72	1,121	780	—	9,181
Louisiana	—	—	—	—	—	—
Maine	31,514	—	—	158	—	31,672
Maryland	15,698	—	1,141	161	—	17,000
Massachusetts	894	280	146	209	—	1,529
Michigan	21,412	—	—	1,178	—	22,590
Minnesota	1,918	—	430	1,160	—	3,508
Mississippi	2,196	1,003	31,501	435	116	35,251
Missouri	11,037	—	9,638	340	—	21,015
Montana	42,350	3,121	36,058	3,377	—	84,906
Nebraska	1,479	527	3,888	317	—	6,211
Nevada	731	—	354	357	45	1,487
New Hampshire	10,768	—	73	—	—	10,841
New Jersey	—	1,039	216	164	—	1,419
New Mexico	4,022	—	—	251	—	4,273
New York	49,254	809	1,502	164	—	51,729
North Carolina	12,924	11,833	8,607	1,696	—	35,060
North Dakota	238	6,983	1,983	—	—	9,204
Ohio	2,612	518	1,694	3,077	—	7,901
Ohio River Valley	—	—	608	373	—	981
Oklahoma	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Pennsylvania	19,859	282	1,937	2,673	—	24,751
Puerto Rico	751	688	1,577	2,359	—	5,375
Rhode Island	298	227	12	128	—	665
South Carolina	3,347	—	334	309	—	3,990
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	12,941	—	554	579	—	14,074
Utah	4,634	—	1,162	1,761	—	7,557
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	2,298	—	451	276	—	3,025
West Virginia	1,007	368	3,323	592	—	5,290
Wisconsin	9,302	69	1,150	875	13	11,409
Wyoming	—	—	—	—	—	—
Totals	327,567	30,895	143,815	44,540	1,054	547,871
Percent of Assessed Waters	60%	6%	26%	8%	<1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035475

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	8,624	221	2,024	952	—	11,821
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	—	—	—	—	—	—
Arkansas	6,716	—	39	147	—	6,902
California	3,154	230	1,880	68	—	5,332
Colorado	22,243	—	1,366	2,166	710	26,485
Connecticut	9	59	66	2	—	136
Delaware	778	—	—	24	—	802
Delaware River Basin	200	—	—	6	—	206
District of Columbia	—	—	28	—	—	28
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	—	—	—	—	—
Illinois	1,350	—	—	467	—	1,817
Indiana	4,417	—	—	331	—	4,748
Iowa	515	121	—	77	8	721
Kansas	278	—	—	20	—	298
Kentucky	9,057	—	—	125	—	9,182
Louisiana	5,207	—	1,503	2,380	—	9,090
Maine	31,436	—	236	—	—	31,672
Maryland	16,940	—	60	—	—	17,000
Massachusetts	418	9	—	300	—	727
Michigan	21,884	—	—	706	—	22,590
Minnesota	182	—	1,194	485	—	1,861
Mississippi	—	—	—	—	—	—
Missouri	19,959	—	745	312	—	21,016
Montana	—	—	—	—	—	—
Nebraska	95	439	28	—	—	562
Nevada	—	—	—	—	—	—
New Hampshire	10,827	—	13	—	—	10,840
New Jersey	—	—	—	—	—	—
New Mexico	—	—	93	—	—	93
New York	51,457	—	137	135	—	51,729
North Carolina	12,924	11,833	8,607	1,696	—	35,060
North Dakota	—	—	509	—	—	509
Ohio	1,471	332	321	—	—	2,124
Ohio River Valley	—	—	981	—	—	981
Oklahoma	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	14,144	—	—	231	—	14,375
Utah	—	—	—	—	—	—
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	23	—	—	894	—	917
West Virginia	155	—	110	389	—	654
Wisconsin	966	—	122	68	—	1,156
Wyoming	—	—	—	—	—	—
Totals	245,429	13,244	20,062	11,981	718	291,434
Percent of Assessed Waters	84%	5%	7%	4%	<1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035476

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	8,674	140	2,047	943	—	11,804
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	1,295	224	434	399	—	2,352
Arkansas	5,375	—	—	783	—	6,158
California	2,576	8	296	60	—	2,940
Colorado	9,422	—	—	—	—	9,422
Connecticut	557	79	204	50	3	891
Delaware	61	—	37	615	51	764
Delaware River Basin	206	—	—	—	—	206
District of Columbia	—	—	3	35	—	38
Florida	5,048	252	1,822	811	—	7,933
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	61	135	135	331
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	1,131	524	574	89	—	2,318
Illinois	1,617	—	1,478	560	—	3,655
Indiana	937	—	127	3,246	—	4,310
Iowa	—	415	1,761	293	8,173	10,642
Kansas	1,960	—	3,540	11,306	—	16,806
Kentucky	1,543	—	265	1,697	—	3,505
Louisiana	3,408	—	2,409	3,273	—	9,090
Maine	31,544	—	—	128	—	31,672
Maryland	16,999	—	—	2	—	17,001
Massachusetts	649	166	337	365	—	1,517
Michigan	22,188	—	—	402	—	22,590
Minnesota	1,696	—	488	1,324	—	3,508
Mississippi	595	214	1,472	126	—	2,407
Missouri	5,370	—	—	—	15,645	21,015
Montana	68,251	504	14,272	1,773	—	84,800
Nebraska	546	—	479	1,338	13,073	15,436
Nevada	870	—	220	331	45	1,466
New Hampshire	10,694	—	—	147	—	10,841
New Jersey	—	80	40	405	—	525
New Mexico	316	—	6	—	—	322
New York	51,343	82	295	9	—	51,729
North Carolina	800	340	200	30	—	1,370
North Dakota	252	6,645	2,307	—	—	9,204
Ohio	1,247	—	159	2,145	—	3,551
Ohio River Valley	—	—	—	—	—	—
Oklahoma	843	2,141	1,853	587	—	4,624
Oregon	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Puerto Rico	1,094	469	1,316	2,496	—	5,375
Rhode Island	—	—	—	—	—	—
South Carolina	2,000	—	166	120	—	2,286
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	11,221	—	1,141	1,668	—	14,030
Utah	2,022	—	—	12	—	2,034
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	1,230	—	189	624	—	2,043
West Virginia	3,387	124	1,163	463	—	5,137
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	278,967	12,407	40,361	38,790	37,125	407,650
Percent of Assessed Waters	68%	3%	10%	10%	9%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035477

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	8,681	140	2,024	939	—	11,784
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	289	131	389	639	—	1,448
Arkansas	6,902	—	—	—	—	6,902
California	5,112	—	1	—	—	5,113
Colorado	21,743	—	56	—	—	21,799
Connecticut	846	—	38	3	3	890
Delaware	781	—	—	13	—	794
Delaware River Basin	—	—	—	—	—	—
District of Columbia	1	—	—	27	—	28
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Gila River Indian Community	61	—	—	—	—	61
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	1,466	649	225	24	—	2,364
Illinois	24	—	—	—	—	24
Indiana	—	—	—	—	—	—
Iowa	—	—	—	—	—	—
Kansas	9,476	—	5,538	1,791	—	16,805
Kentucky	—	—	—	—	—	—
Louisiana	5,328	—	2,550	1,212	—	9,090
Maine	31,544	—	—	128	—	31,672
Maryland	—	—	—	—	—	—
Massachusetts	1,240	60	116	107	—	1,523
Michigan	22,188	—	—	402	—	22,590
Minnesota	—	—	—	—	—	—
Mississippi	25,115	418	8,827	870	116	35,346
Missouri	—	—	—	—	—	—
Montana	—	—	—	—	—	—
Nebraska	—	—	—	—	—	—
Nevada	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	3,768	—	70	14	—	3,852
New York	50,587	343	799	—	—	51,729
North Carolina	12,924	11,833	8,607	1,696	—	35,060
North Dakota	252	8,952	—	—	—	9,204
Ohio	—	—	—	—	—	—
Ohio River Valley	—	—	—	—	—	—
Oklahoma	—	25	—	—	669	694
Oregon	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Puerto Rico	1,548	454	1,578	1,796	—	5,376
Rhode Island	—	—	—	—	—	—
South Carolina	3,545	—	279	109	—	3,933
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	51	—	6	—	—	57
Utah	2,022	—	—	12	—	2,034
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	1,416	—	358	315	—	2,089
West Virginia	4	—	38	—	—	42
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	216,914	23,005	31,499	10,097	788	282,303
Percent of Assessed Waters	77%	8%	11%	4%	<1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035478

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	818		—	—	—	818
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	211	64	799	139	—	1,213
Arkansas	6,037	—	33	832	—	6,902
California	2,287	12	239	—	—	2,538
Colorado	16,213	—	—	—	15,353	31,566
Connecticut	90	7	—	1	—	98
Delaware	62	13	—	2	—	77
Delaware River Basin	206	—	—	—	—	206
District of Columbia	—	—	—	—	—	—
Florida	244	—	77	4	—	325
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	—	196	196	392
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	—	—	—	—	—
Illinois	665	—	109	—	—	774
Indiana	—	—	—	—	—	—
Iowa	1	5	1	2	10,684	10,693
Kansas	6,192	—	559	10,054	—	16,805
Kentucky	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	—	—	—	—	—	—
Massachusetts	47	15	—	12	—	74
Michigan	22,551	—	—	39	—	22,590
Minnesota	—	—	—	—	—	—
Mississippi	—	83	—	—	—	83
Missouri	3,160	—	—	—	17,855	21,015
Montana	8,770	1,313	6,261	742	—	17,086
Nebraska	339	—	—	—	15,417	15,756
Nevada	11	—	—	33	—	44
New Hampshire	785	—	2	2	—	789
New Jersey	—	—	—	—	—	—
New Mexico	1,026	9	180	13	—	1,228
New York	—	155	221	—	—	376
North Carolina	2,731	2,085	1,233	159	—	6,208
North Dakota	594	1,683	1,867	—	—	4,144
Ohio	—	—	—	—	—	—
Ohio River Valley	257	—	557	167	—	981
Oklahoma	427	51	61	53	—	592
Oregon	29,109	—	—	—	—	29,109
Pennsylvania	—	—	—	—	—	—
Puerto Rico	1,138	504	2,246	1,486	—	5,374
Rhode Island	—	—	—	—	—	—
South Carolina	8,598	—	—	—	—	8,598
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	8,303	—	138	237	—	8,678
Utah	3,800	—	—	11	—	3,811
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	1,842	—	330	237	—	2,409
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	126,514	5,999	14,913	14,421	59,505	221,352
Percent of Assessed Waters	57%	3%	7%	7%	27%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035479

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	79	—	146	133	15	373
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	1,624	717	557	723	—	3,621
Arkansas	6,742	—	—	160	—	6,902
California	3,443	—	40	—	—	3,483
Colorado	31,225	—	—	—	710	31,935
Connecticut	828	5	2	—	1	836
Delaware	702	—	—	—	—	702
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	6	—	—	6
Georgia	—	—	—	—	—	—
Gila River Indian Community	196	—	—	—	—	196
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	2,717	306	35	8	—	3,066
Illinois	—	—	—	—	—	—
Indiana	21,094	—	—	—	—	21,094
Iowa	—	—	—	—	—	—
Kansas	2,141	—	1,900	12,765	—	16,806
Kentucky	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	31,672	—	—	—	—	31,672
Maryland	17,000	—	—	—	—	17,000
Massachusetts	—	—	—	—	—	—
Michigan	22,590	—	—	—	—	22,590
Minnesota	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—
Missouri	—	—	—	—	—	—
Montana	11,598	351	4,729	448	—	17,126
Nebraska	2,103	—	—	56	—	2,159
Nevada	11	—	—	33	—	44
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	3,515	—	538	47	—	4,100
New York	51,729	—	—	—	—	51,729
North Carolina	12,924	11,833	8,607	1,696	—	35,060
North Dakota	4,933	3,592	679	—	—	9,204
Ohio		—	—	—	—	—
Ohio River Valley	—	—	—	—	—	—
Oklahoma	462	89	73	9	—	633
Oregon	29,109	—	—	—	—	29,109
Pennsylvania	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	8,598	—	—	—	—	8,598
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	—	—	—	—	—	—
Utah	5,936	—	114	1,284	—	7,334
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
West Virginia	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	272,971	16,893	17,426	17,362	726	325,378
Percent of Assessed Waters	84%	5%	5%	5%	<1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035480

State	Total Impaired Miles		Saturation (1)				Pollution (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	3,250	382	1,036	—	[illegible]	497	1,446	—	[illegible]
Alaska	2,889	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	[illegible]
Arizona	—	3,325	—	—	—	—	—	402	—	[illegible]
Arkansas	—	3,825	2,277	117	—	2,394	141	649	—	[illegible]
California	—	4,650	327	1,671	—	1,998	312	375	—	[illegible]
Colorado	—	3,486	—	—	—	—	—	—	—	[illegible]
Connecticut	—	331	—	35	—	35	10	47	—	[illegible]
Delaware	—	707	—	1	—	1	410	208	—	[illegible]
Delaware River Basin	—	—	—	—	—	—	—	—	—	[illegible]
District of Columbia	—	38	—	—	—	—	—	—	—	[illegible]
Florida	—	2,633	—	—	—	—	279	408	—	[illegible]
Georgia	—	2,889	—	—	—	—	—	—	—	[illegible]
Gila River Indian Community	196	—	—	—	—	—	—	—	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	—	—	—	—	—	—	—	—	—	[illegible]
Idaho	12,000	—	—	—	—	—	—	—	—	[illegible]
Illinois	—	7,769	181	6,598	—	6,779	982	6,584	—	[illegible]
Indiana	—	1,647	—	40	—	40	—	—	—	[illegible]
Iowa	—	9,488	8,364	1,121	—	9,485	31	9,034	—	[illegible]
Kansas	—	16,205	—	—	—	—	208	—	—	[illegible]
Kentucky	—	3,181	810	109	—	919	270	92	—	[illegible]
Louisiana	—	4,817	97	771	—	868	828	2,008	—	[illegible]
Maine	—	472	—	—	—	—	—	—	—	[illegible]
Maryland	—	1,312	139	831	—	970	374	878	—	[illegible]
Massachusetts	—	951	8	22	—	30	12	243	—	[illegible]
Michigan	—	1,291	169	37	—	206	10	42	—	[illegible]
Minnesota	—	3,545	—	—	—	—	—	1,653	—	[illegible]
Mississippi	—	32,134	340	29,085	—	29,425	834	29,077	—	[illegible]
Missouri	—	9,975	4	7,225	—	7,229	—	—	—	—
Montana	—	13,906	303	6,497	—	6,800	104	5,628	—	[illegible]
Nebraska	—	5,799	—	—	—	—	—	—	—	[illegible]
Nevada	—	1,050	—	66	—	66	89	161	—	[illegible]
New Hampshire	—	227	—	—	—	—	—	—	—	[illegible]
New Jersey	—	493	—	—	—	—	81	—	—	[illegible]
New Mexico	—	3,226	810	1,322	—	2,132	9	614	—	[illegible]
New York	—	3,261	2,302	1,225	—	3,527	553	2,230	—	[illegible]
North Carolina	—	10,303	—	—	3,941	3,941	—	—	518	[illegible]
North Dakota	—	2,284	691	1,129	—	[illegible]	759	1,118	—	[illegible]
Ohio	—	4,772	720	1,040	—	[illegible]	44	97	—	[illegible]
Ohio River Valley	—	981	—	1,142	—	1,142	—	—	—	[illegible]
Oklahoma	—	2,950	725	2,575	—	3,300	147	2,530	—	[illegible]
Oregon	—	16,457	—	—	1,260	1,260	—	—	745	[illegible]
Pennsylvania	—	4,610	—	—	—	—	—	—	582	[illegible]
Puerto Rico	—	4,497	—	—	—	—	695	592	—	[illegible]
Rhode Island	—	177	—	—	—	—	12	20	—	[illegible]
South Carolina	—	1,112	—	—	—	—	—	—	—	[illegible]
South Dakota	—	2,989	110	275	—	385	—	—	—	[illegible]
Tennessee	3,952	—	—	—	—	—	—	—	—	[illegible]
Texas	—	3,726	—	—	—	—	137	236	—	[illegible]
Utah	—	3,264	—	—	—	—	—	—	—	[illegible]
Vermont	—	1,005	463	367	—	830	220	264	—	[illegible]
Virginia	—	3,537	—	90	—	90	163	97	—	[illegible]
Virgin Islands	—	—	—	—	—	—	—	—	—	[illegible]
Washington	—	3,647	37	435	—	472	—	269	—	[illegible]
West Virginia	—	4,205	543	2,880	—	3,423	302	494	—	[illegible]
Wisconsin	—	1,904	493	2,662	—	3,155	514	2,395	—	[illegible]
Wyoming	—	4,037	—	—	3,225	[illegible]	—	—	877	[illegible]
Total River Miles Impaired	19,037	222,370	20,295	70,404	8,426	[illegible]	9,027	69,891	2,722	[illegible]
% of Impaired River Miles[a] Affected by Each Cause			9%	32%	4%	[illegible]	4%	31%	1%	[illegible]
% of Assessed River Miles Affected by Each Cause			3%	11%	1%	15%	1%	11%	<1%	[illegible]
% of Total River Miles Affected by Each Cause			1%	2%	<1%	3%	<1%	2%	<1%	[illegible]

[a]Includes only impaired river miles in States reporting causes affecting rivers and streams.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired River Miles in States Reporting Causes	[illegible] miles
Total Assessed River Miles	[illegible] miles
Estimate of Total River Miles in the Nation	3,357,247 miles

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Pathogen Indicators (3)				Pesticides (4)				Organic Enrich. Low Dissolved Oxygen (5)			
Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
298	377	—	[illegible]	128	243	—	[illegible]	522	796	—	1,318
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
5	219	—	224	—	145	—	145	—	382	—	382
175	157	—	332	—	—	—	—	46	66	—	112
173	1,529	—	1,702	2,040	124	—	2,164	76	82	—	158
30	25	—	55	—	—	—	—	3	10	—	13
94	32	—	126	—	—	—	—	45	52	—	97
669	37	—	706	—	11	—	11	69	80	—	149
—	—	—	—	—	—	—	—	—	—	—	—
18	6	—	24	—	—	—	—	5	14	—	19
32	249	—	281	—	—	—	—	338	557	—	895
1,086	723	—	1,809	78	7	—	85	72	110	—	182
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
157	183	—	340	—	66	—	66	149	1,430	—	1,579
2,644	648	—	3,292	245	116	—	361	653	45	—	698
392	—	—	392	161	8,292	—	8,453	16	59	—	75
11,520	1	—	11,521	2,808	—	—	2,908	2,981	124	—	3,105
1,702	49	—	1,751	—	—	—	—	588	56	—	644
926	2,374	—	3,300	172	1,785	—	1,957	530	2,216	—	2,746
62	64	—	126	—	—	—	—	117	106	—	223
66	956	—	1,022	—	—	—	—	—	106	—	106
334	370	—	704	—	—	—	—	36	225	—	261
62	26	—	88	2	—	—	2	84	25	—	109
166	1,819	—	1,985	—	—	—	—	81	1,231	—	1,312
490	8,880	—	9,370	472	32,479	—	32,951	157	23,774	—	23,931
—	—	—	—	101	572	—	673	22	37	—	59
8	1,600	—	1,608	—	—	—	—	47	932	—	979
1,029	—	—	1,029	606	—	—	606	—	790	—	790
—	—	—	—	—	—	—	—	45	86	—	131
67	78	—	145	—	—	—	—	8	34	—	42
81	—	—	81	—	3	—	3	11	—	—	11
49	240	—	289	3	132	—	135	27	80	—	107
231	1,082	—	1,313	36	811	—	847	131	888	—	1,019
—	—	656	656	—	—	—	—	—	—	507	507
—	608	—	608	—	65	—	65	10	219	—	229
—	—	—	—	37	66	—	103	2,374	781	—	3,155
249	218	—	467	418	492	—	910	—	—	—	—
151	200	—	351	271	2,614	—	2,885	128	915	—	1,043
—	—	885	885	—	—	52	52	—	—	603	603
—	—	155	155	—	—	161	161	—	—	184	184
2,346	1,359	—	3,705	368	380	—	748	611	485	—	1,096
56	27	—	83	—	—	—	—	17	10	—	27
472	243	—	715	—	—	—	—	639	16	—	655
795	796	—	1,591	—	—	—	—	—	679	—	679
—	—	—	—	—	—	—	—	—	—	—	—
1,563	790	—	2,353	71	63	—	134	300	361	—	661
12	—	—	12	—	—	—	—	—	345	—	345
54	345	—	399	—	5	—	5	125	319	—	444
811	1,325	—	2,136	366	56	—	422	119	196	—	315
—	—	—	—	—	—	—	—	—	—	—	—
309	1,395	—	1,704	10	130	—	140	14	589	—	603
—	70	—	70	277	—	—	277	149	399	—	548
93	405	—	498	99	169	—	268	458	1,158	—	1,616
—	—	126	126	—	—	273	273	—	—	516	516
29,477	29,505	1,822	[illegible]	8,769	48,826	486	[illegible]	11,803	40,865	1,810	54,478
13%	13%	1%	[illegible]	4%	22%	<1%	[illegible]	5%	18%	1%	24%
5%	5%	<1%	9%	1%	8%	<1%	9%	2%	6%	<1%	8%
1%	1%	<1%	2%	<1%	1%	—	2%	<1%	1%	<1%	2%

(continued)

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[illegible] (continued)

State	Metals (6)				Suspended Solids (7)				Salinity TDS Chlorides 8			
	Major	Mod Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
Alabama	37	382	—	[illegible]	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	241	950	—	1,191	113	529	—	642	18	563	—	581
Arkansas	—	24	—	24	—	—	—	—	—	—	—	—
California	396	460	—	856	—	74	—	74	34	87	—	121
Colorado	873	706	—	1,579	—	—	—	—	—	—	—	—
Connecticut	70	47	—	117	—	22	—	22	—	23	—	23
Delaware	34	28	—	62	—	—	—	—	—	14	—	14
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	3	16	—	19	—	28	—	28	—	—	—	—
Florida	—	—	—	—	77	195	—	272	—	—	—	—
Georgia	838	92	—	930	—	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Idaho	—	—	—	—	—	—	—	—	—	—	—	—
Illinois	14	1,187	—	1,201	66	715	—	781	—	106	—	106
Indiana	440	130	—	570	53	180	—	233	13	—	—	13
Iowa	165	—	—	165	—	—	—	—	—	—	—	—
Kansas	9,683	—	—	9,683	8,025	124	—	8,149	8,619	—	—	8,619
Kentucky	225	18	—	243	32	4	—	36	178	20	—	198
Louisiana	102	132	—	234	609	2,084	—	2,693	301	1,585	—	1,886
Maine	3	3	—	6	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	54	155	—	209	—	80	—	80	—	15	—	15
Michigan	175	7	—	182	—	7	—	7	1	6	—	7
Minnesota	250	1,801	—	2,051	—	949	—	949	10	653	—	663
Mississippi	204	1,085	—	1,289	331	273	—	604	13	1,324	—	1,337
Missouri	13	45	—	58	—	—	—	—	—	—	—	—
Montana	565	3,979	—	4,544	338	6,747	—	7,085	431	5,449	—	5,880
Nebraska	—	474	—	474	—	48	—	48	—	31	—	31
Nevada	134	—	—	134	60	315	—	375	135	106	—	241
New Hampshire	1	5	—	6	—	—	—	—	—	—	—	—
New Jersey	—	1	—	1	—	—	—	—	—	—	—	—
New Mexico	501	1,199	—	1,700	182	611	—	793	98	250	—	348
New York	41	217	—	258	194	660	—	854	26	429	—	455
North Carolina	—	—	324	324	—	—	11	11	—	—	—	—
North Dakota	—	857	—	857	—	—	—	—	176	495	—	671
Ohio	501	655	—	1,156	1	2	—	3	22	13	—	35
Ohio River Valley	—	1,505	—	1,505	—	—	—	—	—	—	—	—
Oklahoma	73	812	—	885	703	1,651	—	2,354	418	880	—	1,298
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Pennsylvania	—	—	2,061	2,061	—	—	596	596	—	—	28	28
Puerto Rico	450	486	—	936	—	62	—	62	—	3	—	3
Rhode Island	130	3	—	133	—	3	—	3	—	7	—	7
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
South Dakota	18	—	—	18	1,087	772	—	1,859	391	855	—	1,246
Tennessee	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	85	—	85	—	—	—	—	280	63	—	343
Utah	911	30	—	941	—	—	—	—	1,194	124	—	1,318
Vermont	16	45	—	61	32	43	—	75	—	—	—	—
Virginia	234	503	—	737	—	36	—	36	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	50	1,019	—	1,069	—	201	—	201	—	4	—	4
West Virginia	555	1,925	—	2,480	—	19	—	19	—	49	—	49
Wisconsin	97	83	—	180	13	40	—	53	13	—	—	13
Wyoming	—	—	374	374	—	—	299	299	—	—	881	881
Total River Miles Impaired	18,097	21,151	2,759	[illegible]	11,916	16,474	906	[illegible]	12,371	13,154	909	26,434
% of Impaired River Miles[a] Affected by Each Cause	8%	10%	1%	19%	5%	7%	<1%	13%	6%	6%	<1%	12%
% of Assessed River Miles Affected by Each Cause	3%	3%	<1%	7%	2%	3%	<1%	5%	2%	2%	<1%	4%
% of Total River Miles Affected by Each Cause	<1%	<1%	<1%	1%	<1%	<1%	<1%	1%	<1%	<1%	<1%	1%

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Habitat Alterations (9)				Flow Alterations (10)			
Major	Mod./ Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
101	—	—	101	61	227	—	288
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	29	—	29	—	—	—	—
—	—	—	—	—	—	—	—
70	1,500	—	1,570	143	211	—	354
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
449	1,197	—	1,646	28	655	—	683
—	35	—	35	—	—	—	—
212	177	—	389	—	—	—	—
—	—	—	—	83	—	—	83
98	24	—	122	—	—	—	—
320	305	—	625	516	476	—	992
—	—	—	—	4	4	—	8
—	—	—	—	9	—	—	9
—	3	—	3	—	2	—	2
78	31	—	109	102	50	—	152
—	—	—	—	—	—	—	—
—	—	—	—	10	—	—	10
—	4,497	—	4,497	—	—	—	—
314	5,264	—	5,578	552	6,686	—	7,238
—	103	—	103	635	204	—	839
66	—	—	66	—	45	—	45
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
603	1,584	—	2,187	38	—	—	38
—	—	—	—	207	537	—	744
—	—	—	—	—	—	2	2
—	—	—	—	—	89	—	89
639	716	—	1,355	402	272	—	674
—	—	—	—	—	—	—	—
313	277	—	590	15	154	—	169
—	—	1,480	1,480	—	—	1,355	1,355
—	—	—	—	—	—	—	—
18	—	—	18	773	10	—	783
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
211	199	—	410	199	112	—	311
—	222	—	222	—	56	—	56
—	—	—	—	—	—	—	—
88	405	—	493	—	298	—	298
1	62	—	63	24	19	—	43
517	2,482	—	2,999	266	1,231	—	1,497
—	—	485	485	—	—	694	694
4,098	19,112	1,965	25,175	4,067	11,338	2,051	17,456
2%	9%	1%	11%	2%	5%	1%	8%
1%	3%	<1%	4%	1%	2%	<1%	3%
<1%	1%	—	1%	<1%	<1%	<1%	<1%

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State	Total Impaired Miles		Agriculture (general)				Natural			
	States Not Reporting Sources	States Reporting Sources	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	3,280	300	1,018	—	[illegible]	22	103	—	[illegible]
Alaska	2,889	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
Arizona	—	3,325	1,563	—	—	1,563	202	—	—	202
Arkansas	—	3,825	2,509	204	—	2,713	—	—	—	—
California	—	4,650	2,472	2,568	—	5,040	—	—	—	—
Colorado	—	3,486	585	1,503	—	2,088	—	—	—	—
Connecticut	—	331	—	46	—	46	—	—	—	—
Delaware	—	707	20	662	—	682	3	177	—	180
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	38	—	—	—	—	—	10	—	10
Florida	—	2,633	162	1,518	—	1,680	—	—	—	—
Georgia	—	2,889	—	—	—	—	—	—	—	—
Gila River Indian Community	196	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—
Idaho	12,000	—	—	—	—	—	—	—	—	—
Illinois	—	7,769	1,827	5,202	—	7,029	34	—	—	34
Indiana	—	1,647	512	—	—	512	—	—	—	—
Iowa	—	9,488	8,669	773	—	9,442	56	69	—	125
Kansas	—	16,205	—	—	18,742	18,742	9,004	8	—	9,012
Kentucky	—	3,181	1,214	563	—	1,777	—	—	—	—
Louisiana	—	4,817	2,602	2,794	—	5,396	—	—	—	—
Maine	—	472	72	63	—	135	—	—	—	—
Maryland	—	1,312	362	669	—	1,031	215	836	—	1,051
Massachusetts	—	951	4	32	—	36	50	142	—	192
Michigan	—	1,291	148	74	—	222	9	4	—	13
Minnesota	—	3,546	—	—	—	—	—	—	—	—
Mississippi	—	32,134	27,492	1,827	—	29,319	8	3,145	—	3,153
Missouri	—	9,975	—	7,142	—	7,142	—	—	—	—
Montana	—	13,906	—	—	8,108	8,108	427	7,701	—	8,128
Nebraska	—	5,799	4,346	—	—	4,346	—	1,198	—	1,198
Nevada	—	1,050	—	—	822	822	68	123	—	191
New Hampshire	—	227	—	1	—	1	—	—	—	—
New Jersey	493	—	—	—	—	—	—	—	—	—
New Mexico	—	3,226	2,550	367	—	2,917	77	116	—	193
New York	—	3,261	1,264	938	—	2,202	—	—	—	—
North Carolina	—	10,303	—	—	5,777	5,777	—	—	—	—
North Dakota	—	2,284	1,518	3,468	—	4,986	709	870	—	1,579
Ohio	—	4,772	630	1,312	—	1,942	—	—	—	—
Ohio River Valley	—	981	—	1,308	—	[illegible]	—	—	—	—
Oklahoma	—	2,950	—	—	4,015	4,015	57	—	—	[illegible]
Oregon	—	16,457	—	—	9,305	9,305	—	—	4,232	[illegible]
Pennsylvania	—	4,610	—	—	674	674	—	—	137	[illegible]
Puerto Rico	—	4,497	408	601	—	1,009	—	—	—	—
Rhode Island	—	177	—	36	—	36	—	—	—	—
South Carolina	—	1,112	395	213	—	608	—	—	—	—
South Dakota	—	2,989	1,356	1,745	—	3,101	1,192	1,080	—	2,272
Tennessee	3,952	—	—	—	—	—	—	—	—	—
Texas	—	3,726	—	—	151	151	731	20	—	[illegible]
Utah	—	3,264	184	974	—	1,158	2,566	1,274	—	[illegible]
Vermont	—	1,005	446	766	—	1,212	116	181	—	[illegible]
Virginia	—	3,537	432	452	—	884	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—
Washington	—	3,647	214	1,838	—	2,052	9	825	—	834
West Virginia	—	4,205	257	692	—	949	120	162	—	282
Wisconsin	—	1,904	831	2,548	—	3,379	—	—	—	—
Wyoming	—	4,037	—	—	2,478	2,478	—	—	1,854	1,854
Total River Miles Impaired	19,530	221,877	63,801	43,917	51,635	[illegible]	15,473	18,044	6,425	[illegible]
% of Impaired River Miles[a] Affected by Each Source			29%	20%	23%	[illegible]	7%	8%	3%	[illegible]
% of Assessed River Miles Affected by Each Source			10%	7%	8%	25%	2%	3%	1%	6%
% of Total River Miles Affected by Each Source			2%	1%	1%	4%	<1%	<1%	<1%	1%

[a]Includes only impaired river miles in States reporting sources affecting rivers and streams.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired River Miles in States Reporting Sources:	221,877 miles
Total Assessed River Miles:	642,881 miles
Estimate of Total River Miles in the Nation:	3,551,247 miles

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Municipal Point Sources (3)				Urban Runoff Storm Sewers (4)				Resource Extraction (5)			
Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
321	629	—	[illegible]	84	249	—	[illegible]	107	519	—	626
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	341	341	183	—	—	183	932	—	—	932
126	187	—	313	14	126	—	140	245	24	—	269
80	448	—	528	149	591	—	740	282	340	—	622
—	96	—	96	—	151	—	151	271	1,012	—	1,283
113	64	—	177	1	132	—	133	—	23	—	23
—	168	—	168	—	380	—	380	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	15	24	—	39	—	—	—	—
32	675	—	707	67	1,681	—	1,748	—	431	—	431
448	209	—	657	787	382	—	1,169	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
378	2,644	—	3,022	28	1,242	—	1,270	20	1,153	—	1,173
292	507	—	799	77	—	—	77	4	—	—	4
177	201	—	378	110	1,409	—	1,519	—	123	—	123
3,962	—	—	3,962	2,852	—	—	2,852	—	—	—	—
1,287	165	—	1,452	490	73	—	563	952	51	—	1,003
501	1,995	—	2,496	1,201	1,364	—	2,565	190	2,617	—	2,807
14	85	—	99	3	27	—	30	—	—	—	—
1	177	—	178	110	366	—	476	97	59	—	156
49	294	—	343	86	463	—	549	—	11	—	11
55	6	—	61	63	82	—	145	—	—	—	—
383	403	—	786	—	—	—	—	—	—	—	—
231	1,565	—	1,796	234	628	—	862	1,098	—	—	1,098
20	31	—	51	47	530	—	577	34	66	—	100
46	1,373	—	1,419	—	83	—	83	3	671	—	674
—	983	—	983	69	—	—	69	—	—	—	—
—	—	—	—	38	48	—	86	—	—	—	—
9	16	—	25	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
38	129	—	167	22	2	—	24	110	304	—	414
235	185	—	420	313	607	—	920	33	151	—	184
—	—	—	—	—	—	1,352	1,352	—	—	189	189
37	792	—	829	—	32	—	32	—	510	—	510
1,704	645	—	2,349	209	636	—	845	582	270	—	852
—	59	—	59	408	483	—	891	38	777	—	815
—	—	—	—	—	56	—	56	—	275	—	275
—	—	—	—	—	—	—	—	—	—	2,280	2,280
—	—	259	259	—	—	52	52	—	—	2,579	2,579
190	87	—	277	408	218	—	626	14	30	—	44
14	28	—	42	16	133	—	149	—	—	—	—
166	129	—	295	88	256	—	344	—	—	—	—
—	33	—	33	—	150	—	150	2	62	—	64
—	—	—	—	—	—	—	—	—	—	—	—
1,086	442	—	1,528	267	110	—	377	—	—	—	—
—	—	—	—	24	—	—	24	—	491	—	491
53	109	—	162	70	100	—	170	—	1	—	1
107	373	—	480	64	269	—	333	76	24	—	100
—	—	—	—	—	—	—	—	—	—	—	—
19	592	—	611	13	521	—	534	18	86	—	104
129	1,212	—	1,341	122	338	—	460	742	2,674	—	3,416
242	822	—	1,064	98	128	—	226	—	44	—	44
—	—	655	655	—	—	103	103	—	—	—	—
12,546	18,558	1,255	[illegible]	8,647	14,070	1,690	[illegible]	4,918	12,799	5,980	[illegible]
6%	8%	1%	[illegible]	4%	6%	1%	11%	2%	6%	3%	11%
2%	3%	<1%	5%	1%	2%	<1%	4%	1%	2%	1%	4%
<1%	1%	<1%	1%	<1%	<1%	<1%	1%	<1%	<1%	<1%	1%

(continued)

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State	Industrial Point Sources (6)				Silviculture (7)				Hydro/Habitat Modification (8)			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	18	433	—	[illegible]	25	193	—	[illegible]	68	312	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	—	—	210	210	—	—	154	154	—	—	—	—
Arkansas	205	62	—	267	36	157	—	193	—	—	1,563	1,563
California	30	297	—	327	25	1,428	—	1,453	206	209	—	[illegible]
Colorado	117	16	—	133	—	43	—	43	—	16	—	16
Connecticut	—	—	—	—	—	—	—	—	—	—	—	—
Delaware	2	110	—	112	—	—	—	—	—	20	—	20
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	1	2	—	3	—	—	—	—	—	—	—	—
Florida	98	430	—	528	—	154	—	154	20	834	—	854
Georgia	61	47	—	108	—	—	—	—	9	12	—	21
Gila River Indian Comm.	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Idaho	—	—	—	—	—	—	—	—	—	—	—	—
Illinois	25	846	—	871	—	—	—	—	—	—	—	—
Indiana	90	27	—	117	—	—	—	—	9	809	—	818
Iowa	81	—	—	81	—	—	—	—	31	—	—	31
Kansas	1,300	—	—	1,300	—	—	—	—	159	282	—	441
Kentucky	180	25	—	205	—	34	—	34	83	—	—	83
Louisiana	685	1,875	—	2,560	130	1,037	—	1,167	110	69	—	179
Maine	102	169	—	271	—	—	—	—	543	1,932	—	2,475
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	2	1	—	3
Michigan	57	31	—	89	5	18	—	23	—	—	—	—
Minnesota	76	30	—	106	—	—	—	—	29	—	—	29
Mississippi	349	1,821	—	2,170	1,528	523	—	2,051	—	—	—	—
Missouri	10	1	—	11	—	—	—	—	109	75	—	184
Montana	—	339	—	339	2	1,387	—	1,389	—	—	—	—
Nebraska	—	563	—	563	—	—	—	—	—	35	—	35
Nevada	—	—	—	—	—	—	—	—	—	140	—	140
New Hampshire	—	13	—	13	—	—	—	—	44	58	—	102
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—	—	—	—	—	—	—
New York	28	120	—	148	17	104	—	121	144	523	—	667
North Carolina	—	—	—	—	61	156	—	217	1,188	888	—	[illegible]
North Dakota	—	12	—	12	—	—	313	313	—	—	354	354
Ohio	708	405	—	1,113	—	—	—	—	—	—	—	—
Ohio River Valley	—	350	—	350	6	17	—	23	685	926	—	[illegible]
Oklahoma	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	126	—	126	—	—	—	—
Pennsylvania	—	—	194	194	—	—	7,580	7,580	—	—	—	—
Puerto Rico	144	58	—	202	—	—	—	—	—	—	44	44
Rhode Island	—	28	—	28	—	—	—	—	1	—	—	1
South Carolina	44	87	—	131	—	—	—	—	—	—	—	—
South Dakota	11	—	—	11	—	—	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—	—	—	—	—	—	—
Texas	95	12	—	107	—	—	—	—	—	—	—	—
Utah	—	—	—	—	—	—	—	—	—	—	—	—
Vermont	10	23	—	33	2	9	—	11	181	—	—	181
Virginia	94	58	—	152	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	285	842	—	[illegible]	102	473	—	[illegible]	16	1,129	—	1,145
West Virginia	359	449	—	[illegible]	129	262	—	391	14	20	—	34
Wisconsin	119	707	—	[illegible]	—	—	—	—	126	1,065	—	1,191
Wyoming	—	—	263	[illegible]	—	—	—	—	—	—	26	26
Total River Miles Impaired	5,384	10,288	667	[illegible]	2,068	6,121	8,047	[illegible]	3,777	9,355	1,987	15,119
% of Impaired River Miles[a] Affected by Each Source	2%	5%	—	7%	1%	3%	4%	7%	2%	4%	1%	7%
% of Assessed River Miles Affected by Each Source	1%	2%	—	3%	<1%	1%	1%	3%	1%	1%	—	2%
% of Total River Miles Affected by Each Source	—	—	—	—	—	—	—	—	—	—	—	—

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Appendix B

Individual State Data
Lakes, Reservoirs, and Ponds

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State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Alabama	106,302	87,114		[illegible]	—	116,510	—	[illegible]	12,900	65,168		[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	81	5,000	—	5,081	26,962	1,027		27,989	58,688	27,874		86,562
Arkansas	800	354,263	—	355,063	—	—	—	—	—	—	—	—
California	—	—	21,578	21,578	—	—	2,970	2,970	—	—	283,433	283,433
Colorado	94,647	35,523		130,170	—	—	—	—	—	12,930	—	12,930
Connecticut	23,722	13,744	—	37,466	882	1,916	—	2,798	—	3,143	—	3,143
Delaware	441	172	—	613	62	157	—	219	212	693	—	905
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	—
Florida	111,104	183,552	—	294,656	3,264	6,592	—	9,856	37,632	502,912	—	540,544
Georgia	1,788	355,374	—	357,162	—	—	—	—	201	29,134	—	29,335
Gila River Ind. Comm.	—	—	—	—	—	—	—	—	—	—	28	28
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Idaho	—	—	—	—	79,429	158,217	—	237,646	9,073	28,688	—	37,761
Illinois	367	1,406	—	1,773	4,031	13,173	—	17,204	69,708	33,662	—	103,370
Indiana	27,818	74,089	—	101,907	—	—	—	—	88	—	—	88
Iowa	1,353	—	—	1,353	21,904	1,333	—	23,237	22,349	491	—	22,840
Kansas	—	200	—	200	852	2,684	—	3,536	2,075	156,862	—	158,937
Kentucky	—	100,454	—	100,454	—	94,839	—	94,839	—	12,931	—	12,931
Louisiana	238,136	17,651	—	255,787	42,119	—	—	42,119	97,529	214,400	—	311,929
Maine	190,436	511,583	—	702,019	10,293	43,600	—	53,893	—	202,477	—	202,477
Maryland	16,072	—	—	16,072	917	—	—	917	3,906	—	—	3,906
Massachusetts[a]	726	2,050	—	2,776	1,986	3,211	—	3,197	4,744	6,902	—	11,646
Michigan	1,551	462,639	—	464,190	—	—	—	—	—	—	—	—
Minnesota	124,495	206,784	—	331,279	63,474	100,148	—	163,622	178,271	2,017,746	—	2,196,017
Mississippi	12,230	140,599	—	152,829	469	58,764	—	59,233	8,232	106,422	—	114,654
Missouri	12,750	152,802	—	165,552	7,663	81,326	—	85,989	—	4,366	—	4,366
Montana	312,593	58,968	—	371,561	8,270	129,357	—	137,627	98,352	357,242	—	455,594
Nebraska	—	34,401	—	34,401	2,608	26	—	2,634	—	57,390	—	57,390
Nevada	95,912	36,812	—	132,724	—	—	—	—	12,228	12,500	—	24,728
New Hampshire	58,045	72,605	—	130,650	5,779	3,800	—	9,579	5,516	3,195	—	8,711
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New Mexico	85	62	—	147	45	13,390	—	13,435	40,273	89,839	—	130,112
New York	57,778	222,309	—	280,087	5,394	20,756	—	26,150	83,287	320,463	—	403,750
North Carolina	—	—	213,903	213,903	—	—	63,947	63,947	—	—	25,861	25,861
North Dakota	13,031	96	—	13,127	2,306	217,219	—	219,525	4,144	152,544	—	156,688
Ohio	—	—	259	259	—	—	6,265	6,265	—	—	66,835	66,835
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	8,684	90,363	—	99,047	33,587	197,276	—	230,863	25,120	216,522	—	241,642
Oregon	374,303	—	—	374,303	—	—	—	—	43,902	15,016	—	58,918
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	939	668	—	1,607	1,382	967	—	2,349	2,110	1,000	—	3,110
Rhode Island	—	—	1,277	1,277	—	—	11,896	11,896	—	—	3,020	3,020
South Carolina	—	—	305,903	305,903	—	—	—	—	—	—	54,725	54,725
South Dakota	—	—	—	—	6	535,987	—	535,993	15,090	16,871	—	31,961
Tennessee	—	422,221	—	422,221	—	3,909	—	3,909	—	48,540	—	48,540
Texas	—	—	1,334,354	1,334,354	—	—	—	—	—	—	9,411	9,411
Utah	274,083	—	—	274,083	—	—	—	—	142,417	—	—	142,417
Vermont	1,783	17,570	—	19,353	1,157	16,396	—	17,553	167	89,865	—	90,032
Virginia	—	84,392	—	84,392	—	—	—	—	—	6,318	—	6,318
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Washington	9,983	27,391	—	37,374	3,220	591	—	3,811	452	17,601	—	18,053
West Virginia	3	5,729	—	5,732	—	1,775	—	1,775	2	12,283	—	12,285
Wisconsin	30,592	14,914	—	45,506	14,774	30,049	—	44,823	10,729	41,761	—	52,490
Wyoming	—	32,169	—	32,169	1,409	4	—	1,413	29,538	33,822	—	63,360
Totals	2,202,633	3,825,669	1,877,274	[illegible]	344,244	1,874,999	85,078	[illegible]	998,935	4,939,573	443,313	6,381,821
% of Assessed Waters	28%	48%	24%	43%	15%	81%	4%	11%	16%	77%	7%	35%

[a]Does not include Quabbin Reservoir.

— None or not reported.

NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	4,480	—	4,480	—	—	—	—	119,202	273,272	—	392,474
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
722	704	—	1,426	—	—	—	—	86,453	34,605	—	121,058
—	—	—	—	—	—	—	—	800	354,263	—	355,063
—	—	—	—	—	—	—	—	—	—	307,981	307,981
40	—	—	40	—	—	—	—	94,687	48,453	—	143,140
—	—	—	—	—	—	—	—	24,604	18,803	—	43,407
81	987	—	1,068	—	—	—	—	796	2,009	—	2,805
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
—	238	—	238	—	—	—	—	—	238	—	238
27,704	87,360	—	112,064	—	—	—	—	176,704	780,416	—	957,120
—	8,305	—	8,305	—	—	—	—	1,989	392,813	—	394,802
—	—	125	125	—	—	—	—	153	—	—	153
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
142,212	910	—	143,122	—	—	—	—	230,714	187,815	—	418,529
62,977	20,757	—	83,734	—	—	—	—	117,083	88,998	—	206,081
101	—	—	101	—	—	—	—	28,007	74,089	—	102,096
1,300	—	—	1,300	—	—	—	—	46,906	1,824	—	48,730
337	9,119	—	9,456	—	—	—	—	3,264	168,865	—	172,129
—	6,738	—	6,738	—	—	—	—	—	214,962	—	214,962
60	—	—	60	2,393	—	—	2,393	380,237	232,051	—	612,288
—	—	—	—	—	—	—	—	200,729	757,660	—	958,389
106	—	—	106	—	—	—	—	21,001	—	—	21,001
1,137	475	—	1,612	2	14	—	16	8,595	12,652	—	21,247
931	25,334	—	26,265	—	—	—	—	2,482	487,973	—	490,455
86,138	105,762	—	191,900	—	—	—	—	452,378	2,430,440	—	2,882,818
46	82	—	128	—	—	—	—	20,977	305,867	—	326,844
70	28,566	—	28,636	—	—	—	—	20,483	267,060	—	287,543
5,251	9,400	—	14,651	—	—	—	—	424,466	554,967	—	979,433
—	38,523	—	38,523	—	—	—	—	2,608	130,340	—	132,948
39,800	16,005	—	55,805	—	—	—	—	147,940	65,317	—	213,257
4,176	464	—	4,640	—	—	—	—	73,516	80,064	—	153,580
—	—	—	—	—	—	—	—	—	—	—	—
5	19	—	24	—	—	—	—	40,408	103,310	—	143,718
4,208	16,192	—	20,400	—	—	—	—	150,667	579,720	—	730,387
—	—	831	831	—	—	—	—	—	—	304,542	304,542
101,666	120,068	—	221,734	—	—	—	—	121,146	489,927	—	611,074
—	—	5,168	5,168	—	—	—	—	—	—	78,527	78,527
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
—	34,340	—	34,340	—	—	—	—	67,391	538,501	—	605,892
9,679	62,028	—	71,707	—	—	—	—	427,884	77,044	—	504,928
—	—	—	—	—	—	—	—	—	—	—	—
—	3,521	—	3,521	—	—	—	—	4,431	6,156	—	10,587
—	—	556	556	—	—	—	—	—	—	16,749	16,749
—	—	21,400	21,400	—	—	—	—	—	—	382,028	382,028
24,791	70,713	—	95,504	—	—	—	—	39,887	643,571	—	683,458
—	64,656	—	64,656	—	—	—	—	—	539,326	—	539,326
—	—	160,774	160,774	—	—	—	—	—	—	1,504,539	1,504,539
33,578	—	—	33,578	—	—	—	—	450,078	—	—	450,078
81	100,007	—	100,088	—	—	—	—	3,188	223,838	—	227,026
—	52	—	52	—	—	—	—	—	90,762	—	90,762
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
864	20,594	—	21,458	—	—	—	—	14,519	66,177	—	80,696
—	1,730	—	1,730	—	—	—	—	5	21,517	—	21,522
10,884	58,031	—	68,915	—	—	—	—	66,979	144,755	—	211,734
—	28,480	—	28,480	—	—	—	—	30,947	94,475	—	125,422
555,943	944,640	188,854	[illegible]	2,395	14	—	2,[illegible]	4,104,305	11,584,895	2,594,366	18,283,566
33%	56%	11%	9%	99%	1%	—	[illegible]	22%	63%	14%	46%

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	213,492	131,902	1,620	—	—	347,014
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	7,152	40,413	72,117	1,376	—	121,058
Arkansas	355,063	—	—	—	—	355,063
California	21,578	2,970	283,433	—	—	307,981
Colorado	130,170	—	—	40	80	130,290
Connecticut	23,500	276	975	—	—	24,751
Delaware	2,314	—	125	166	—	2,605
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	136	—	—	103	—	239
Florida	294,656	9,856	540,544	112,064	—	957,120
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	28	125	—	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	249,951	38,458	129,732	—	418,141
Illinois	1,773	17,204	103,370	83,734	—	206,081
Indiana	78,818	—	88	101	—	79,007
Iowa	1,484	23,237	23,276	730	3	48,730
Kansas	200	28,914	142,639	376	—	172,129
Kentucky	156,974	49,239	2,469	6,280	—	214,962
Louisiana	—	—	—	—	—	—
Maine	702,095	80,966	175,328	—	—	958,389
Maryland	19,619	—	1,276	106	—	21,001
Massachusetts	9,722	6,869	3,884	477	—	20,952
Michigan	464,190	—	—	26,265	—	490,455
Minnesota	—	—	—	—	—	—
Mississippi	152,829	59,233	114,654	128	—	326,844
Missouri	175,275	110,239	1,959	70	—	287,543
Montana	325,920	—	621,353	26,505	—	973,778
Nebraska	83,215	4,567	9,725	35,972	—	133,479
Nevada	132,674	—	40,733	39,050	—	212,457
New Hampshire	141,243	8,025	3,743	570	—	153,581
New Jersey	—	—	—	—	—	—
New Mexico	674	12,909	130,112	23	—	143,718
New York	657,687	1,600	57,250	13,850	—	730,387
North Carolina	230,183	54,997	18,531	831	—	304,542
North Dakota	101,199	131,453	1,896	376,526	—	611,074
Ohio	259	6,265	66,835	5,168	—	78,527
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	—	—	—	—
Oregon	468,652	—	39,765	76,041	—	584,458
Pennsylvania	—	—	—	—	—	—
Puerto Rico	2,607	2,349	2,110	3,521	—	10,587
Rhode Island	8,448	4,944	2,795	562	—	16,749
South Carolina	318,083	—	42,525	21,400	—	382,008
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	1,504,539	—	—	—	—	1,504,539
Utah	274,083	—	142,417	33,578	—	450,078
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	30,582	591	1,907	953	—	34,033
West Virginia	7,774	1,775	10,244	1,730	—	21,523
Wisconsin	107,920	38,685	7,993	55,354	—	209,952
Wyoming	—	—	—	—	—	—
Totals	7,206,782	1,079,429	2,706,177	1,053,507	83	12,045,978
Percent of Assessed Waters	60%	9%	22%	9%	<1%	

— None or not reported.

NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Assessable	Total Assessed
Alabama	35,200	93,100	56,698	4,480	—	189,478
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	—	—	—	—	—	—
Arkansas	355,063	—	—	—	—	355,063
California	177,785	2,970	127,046	—	—	307,801
Colorado	117,240	—	—	12,930	—	130,170
Connecticut	21,195	33	2,875	—	—	24,103
Delaware	2,447	—	—	158	—	2,605
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	238	—	—	238
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	—	153	—	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	—	—	—	—	—
Illinois	123,264	941	6,965	16,524	—	147,694
Indiana	—	—	—	12	—	12
Iowa	491	722	—	—	3	1,216
Kansas	—	8,551	—	—	—	8,551
Kentucky	214,962	—	—	—	—	214,962
Louisiana	290,597	—	210,886	108,412	—	609,895
Maine	958,389	—	—	—	—	958,389
Maryland	20,901	—	—	100	—	21,001
Massachusetts	1,949	268	—	670	—	2,887
Michigan	467,705	—	—	22,750	—	490,455
Minnesota	44,671	1,132	2,168,357	6,869	—	2,223,029
Mississippi	—	—	—	—	—	—
Missouri	254,089	—	119	33,335	—	287,543
Montana	—	—	—	—	—	—
Nebraska	118,120	300	—	—	—	118,420
Nevada	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	—	—	119,391	—	—	119,391
New York	596,137	—	131,300	2,950	—	730,387
North Carolina	280,672	—	23,530	340	—	304,542
North Dakota	—	—	339,307	—	—	339,307
Ohio	14,337	—	180	—	—	14,517
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	—	—	—	—
Oregon	485,646	—	14,858	4,424	—	504,928
Pennsylvania	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	1,504,539	—	—	500	—	1,505,039
Utah	—	—	—	279	—	279
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	25,167	—	—	—	—	25,167
West Virginia	91	—	—	—	—	91
Wisconsin	117,042	22,930	64,945	6,820	—	211,737
Wyoming	—	—	—	—	—	—
Totals	6,229,699	130,947	3,266,695	221,706	3	9,849,050
Percent of Assessed Waters	63%	1%	33%	2%	<1%	

— None or not reported.
NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	200,100	80,132	18,280	—	—	298,512
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	90,832	23,905	4,428	1,086	—	120,251
Arkansas	355,063	—	—	—	—	355,063
California	117,616	24	70,161	—	—	187,801
Colorado	113,133	—	—	40	—	113,173
Connecticut	15,592	8,890	268	—	—	24,750
Delaware	964	—	739	902	—	2,605
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	238	—	238
Florida	294,656	9,856	540,544	112,064	—	957,120
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	28	125	—	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	377,115	31,711	7	—	408,833
Illinois	49,453	—	88,234	68,394	—	206,081
Indiana	97,372	—	88	89	—	97,549
Iowa	6,743	17,346	21,683	686	2,371	48,829
Kansas	200	143,713	24,722	373	—	169,008
Kentucky	214,743	—	219	—	—	214,962
Louisiana	320,210	—	273,569	16,116	—	609,895
Maine	702,019	207,110	49,260	—	—	958,389
Maryland	21,001	—	—	—	—	21,001
Massachusetts	8,118	2,368	9,522	928	—	20,936
Michigan	490,455	—	—	—	—	490,455
Minnesota	1,167,640	301,814	74,361	185,542	—	1,729,357
Mississippi	186,372	58,500	5,237	—	—	250,109
Missouri	163,200	97,178	5	72	27,088	287,543
Montana	486,238	—	465,238	22,302	—	973,778
Nebraska	88,339	3,217	39,833	1,034	—	132,423
Nevada	133,602	—	39,905	39,750	—	213,257
New Hampshire	141,815	1,554	5,421	4,072	—	152,862
New Jersey	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—
New York	607,587	1,400	116,650	4,750	—	730,387
North Carolina	264,604	—	—	62	—	264,666
North Dakota	2,134	218,294	14,821	375,501	—	610,750
Ohio	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	49,587	275,070	192,351	30,990	—	547,998
Oregon	491,649	—	13,218	61	—	504,928
Pennsylvania	—	—	—	—	—	—
Puerto Rico	2,940	2,016	3,680	1,951	—	10,587
Rhode Island	—	—	—	—	—	—
South Carolina	369,083	—	11,425	—	—	380,508
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	1,486,728	—	9,411	8,400	—	1,504,539
Utah	—	—	—	1,000	—	1,000
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	61,851	—	1,619	112	—	63,582
West Virginia	21,523	—	—	—	—	21,523
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	8,823,162	1,829,502	2,126,631	876,647	29,459	13,685,401
Percent of Assessed Waters	64%	13%	16%	6%	<1%	

— None or not reported.
NA = Not applicable.

Source: 1992 State Section 305(b) reports.

VOL 12

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	200,100	80,132	18,280	—	—	298,512
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	109	—	474	227	—	806
Arkansas	355,041	—	—	—	—	355,063
California	307,801	—	120,000	—	—	427,801
Colorado	32,071	—	—	—	—	32,071
Connecticut	16,277	7,353	1,170	—	—	24,750
Delaware	1,307	245	811	242	—	2,605
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	27	—	—	211	—	238
Florida	291,904	9,856	196,736	112,064	—	610,560
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	153	—	—	—	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	377,176	31,655	2	—	408,833
Illinois	—	—	—	—	—	—
Indiana	—	—	—	—	—	—
Iowa	—	—	—	—	—	—
Kansas	200	144,878	26,625	334	—	172,037
Kentucky	109,810	93,700	5,659	—	—	209,189
Louisiana	317,695	—	288,569	60	—	606,324
Maine	958,389	—	—	—	—	958,389
Maryland	—	—	—	—	—	—
Massachusetts	10,880	3,851	6,070	134	—	20,935
Michigan	490,455	—	—	—	—	490,455
Minnesota	—	—	—	—	—	—
Mississippi	317,881	1,594	7,323	46	—	326,844
Missouri	—	—	—	—	—	—
Montana	140,080	129,382	332,619	11,151	—	613,232
Nebraska	—	—	—	—	—	—
Nevada	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	—	171	137	13	—	321
New York	683,537	2,050	43,000	1,800	—	730,387
North Carolina	230,181	54,997	18,531	831	—	304,542
North Dakota	2,134	233,115	—	375,501	—	610,750
Ohio	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Puerto Rico	4,906	335	3,949	1,397	—	10,587
Rhode Island	—	—	—	—	—	—
South Carolina	381,228	—	800	—	—	382,028
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	—	—	—	—	—	—
Utah	—	—	—	1,000	—	1,000
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	—	—	—	8	—	8
West Virginia	20,837	—	686	—	—	21,523
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	4,872,840	1,138,988	1,103,094	505,021	—	7,619,943
Percent of Assessed Waters	64%	15%	14%	7%	—	

— none or not reported.
NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	28,834	40,266	8,300	—	—	77,400
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	75,843	13,268	18,898	65	—	108,074
Arkansas	—	—	—	—	—	—
California	137,278	118,000	4,510	—	—	259,788
Colorado	109,474	—	—	—	—	109,474
Connecticut	—	—	—	—	—	—
Delaware	296	—	—	—	—	296
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—
Florida	2,752	—	343,808	—	—	346,560
Georgia	—	—	—	—	—	—
Gila River Indian Community	—	—	—	153	—	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	393,120	—	140	—	393,260
Illinois	61,599	—	44,534	—	—	106,133
Indiana	32,000	—	—	—	—	32,000
Iowa	5,914	5,519	7,917	570	27,986	47,906
Kansas	200	47,619	93,941	9,040	—	150,800
Kentucky	80,623	—	5,826	458	—	86,907
Louisiana	—	—	—	—	—	—
Maine	958,313	—	—	76	—	958,389
Maryland	19,324	—	—	—	—	19,324
Massachusetts	—	—	—	—	—	—
Michigan	490,455	—	—	—	—	490,455
Minnesota	—	—	—	—	—	—
Mississippi	84,200	—	—	—	—	84,200
Missouri	27,834	69,203	1,478	288	188,740	287,543
Montana	291,650	—	314,041	12,900	—	618,591
Nebraska	—	—	—	—	—	—
Nevada	90,000	—	—	—	—	90,000
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—
New York	342,107	20,930	54,950	—	—	417,987
North Carolina	158,177	—	—	140	—	158,317
North Dakota	—	363,880	1,191	116,851	—	481,922
Ohio	128	9,389	60,748	9,679	—	79,944
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	56,330	6,306	8,800	—	—	71,436
Oregon	504,838	—	90	—	—	504,928
Pennsylvania	—	—	—	—	—	—
Puerto Rico	2,466	682	3,262	268	—	6,678
Rhode Island	—	—	—	—	—	—
South Carolina	381,228	—	—	—	—	381,228
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	1,332,646	—	—	151,874	—	1,484,520
Utah	450,078	—	—	—	—	450,078
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	—	—	—	—	—	—
West Virginia	5,037	1,750	—	—	—	6,787
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	5,729,624	1,089,932	972,294	302,502	216,726	8,311,078
Percent of Assessed Waters	69%	13%	12%	4%	3%	

— None or not reported.
NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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R0035495

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	—	—	—	440	440	440
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	98,825	15,684	350	667	—	115,526
Arkansas	—	—	—	—	—	—
California	148,175	—	—	—	—	148,175
Colorado	148,943	—	—	—	—	148,943
Connecticut	—	—	—	—	—	—
Delaware	2,605	—	—	—	—	2,605
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Gila River Indian Community	28	—	—	—	125	153
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	—	401,698	388	129,722	—	531,808
Illinois	—	—	—	—	—	—
Indiana	106,203	—	—	—	—	106,203
Iowa	—	—	—	—	—	—
Kansas	—	132,032	15,003	—	—	147,035
Kentucky	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	958,389	—	—	—	—	958,389
Maryland	21,001	—	—	—	—	21,001
Massachusetts	—	—	—	—	—	—
Michigan	490,455	—	—	—	—	490,455
Minnesota	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—
Missouri	—	—	—	—	—	—
Montana	600,297	—	5,394	12,900	—	618,591
Nebraska	89,296	—	41,586	—	—	130,882
Nevada	—	—	11,400	—	—	11,400
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—
New York	730,387	—	—	—	—	730,387
North Carolina	230,183	54,997	18,531	831	—	304,542
North Dakota	—	365,071	—	116,851	—	481,922
Ohio	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	57,347	236	—	—	—	57,583
Oregon	504,928	—	—	—	—	504,928
Pennsylvania	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	381,228	—	—	—	—	381,228
South Dakota	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—
Texas	—	—	—	—	—	—
Utah	450,078	—	—	—	—	450,078
Vermont	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	—	—	—	—	—	—
West Virginia	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—
Totals	5,018,368	969,718	92,652	261,411	565	6,342,714
Percent of Assessed Waters	79%	15%	1%	4%	<1%	

— None or not reported.
NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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State	Total Impaired Acres		Metals (1)				[illegible]			
	States Not Reporting Causes	States Reporting Causes	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	[illegible]
Alabama	—	82,548	—	—	—	—	—	—	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	[illegible]
Arizona	—	87,988	—	15,271	—	15,271	50	65,391	—	[illegible]
Arkansas	—	—	—	—	—	—	—	—	—	[illegible]
California	—	283,433	214,200	34,936	—	249,136	145,800	5,570	—	[illegible]
Colorado	—	12,970	102	9,424	—	9,526	14	7,952	—	[illegible]
Connecticut[a]	—	3,143	—	—	—	—	3,836	2,095	—	[illegible]
Delaware	—	1,973	189	56	—	245	580	1,286	—	[illegible]
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	[illegible]
District of Columbia	—	238	—	103	—	103	—	—	—	[illegible]
Florida	—	652,608	—	—	—	—	27,392	116,608	—	[illegible]
Georgia	—	37,640	7,655	650	—	8,305	—	—	—	[illegible]
Gila River Indian Community	—	153	—	—	—	—	—	—	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	—	—	—	—	—	—	—	—	—	[illegible]
Idaho	—	180,883	—	811	—	811	31,644	146,430	—	[illegible]
Illinois	—	187,104	4,300	21,553	—	25,853	46,044	149,064	—	[illegible]
Indiana	—	189	—	45	—	45	122	12	—	[illegible]
Iowa	—	24,140	—	—	—	—	8,338	15,751	—	[illegible]
Kansas	—	168,393	5	136,701	—	[illegible]	4,077	159,924	—	[illegible]
Kentucky	—	19,669	5,314	—	—	5,314	9,520	—	—	[illegible]
Louisiana	—	311,989	60	—	—	60	22,932	63,410	—	[illegible]
Maine	—	202,477	—	—	—	—	2,463	61,165	—	[illegible]
Maryland	—	4,012	—	—	—	—	265	2,921	—	[illegible]
Massachusetts	—	13,258	572	—	—	572	5,424	3,025	—	[illegible]
Michigan	—	26,265	10,972	3,565	—	14,537	975	—	—	[illegible]
Minnesota	—	2,387,917	834,107	1,332,235	—	2,166,342	212,691	47,212	—	[illegible]
Mississippi	—	114,782	—	200	—	200	7,084	166,905	—	[illegible]
Missouri	—	33,002	—	—	—	—	1,155	178	—	[illegible]
Montana	—	470,245	16,449	302,175	—	[illegible]	—	319,316	—	[illegible]
Nebraska	—	95,913	4,626	74,680	—	[illegible]	—	12,211	—	[illegible]
Nevada	—	80,533	14,800	11,400	—	[illegible]	21,200	—	—	[illegible]
New Hampshire	—	13,351	—	—	—	—	4,728	12	—	[illegible]
New Jersey	—	—	—	—	—	—	—	—	—	[illegible]
New Mexico	—	130,136	—	65,700	—	[illegible]	24	64,702	—	[illegible]
New York	—	424,150	6,500	8,600	—	[illegible]	163,900	103,100	—	[illegible]
North Carolina	—	26,692	9,680	—	—	[illegible]	18,020	90	—	[illegible]
North Dakota	—	378,422	—	339,307	—	[illegible]	7,374	6,294	—	[illegible]
Ohio	—	72,003	307	4,767	—	[illegible]	7,408	25,699	—	[illegible]
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA	NA	[illegible]
Oklahoma	—	275,982	5,813	90,843	—	[illegible]	26,799	229,382	—	[illegible]
Oregon	—	130,625	—	—	—	—	—	—	115,965	[illegible]
Pennsylvania	—	—	—	—	—	—	—	—	—	[illegible]
Puerto Rico	—	6,631	84	125	—	[illegible]	852	1,331	—	[illegible]
Rhode Island	—	3,576	441	371	—	[illegible]	80	1,184	—	[illegible]
South Carolina	—	76,125	—	—	—	—	—	—	—	[illegible]
South Dakota	—	127,465	—	—	—	—	103,468	9,093	—	[illegible]
Tennessee	113,196	—	—	—	—	—	—	—	—	[illegible]
Texas	—	170,185	—	—	—	—	—	—	—	[illegible]
Utah	—	175,995	—	4,909	—	[illegible]	83,163	73,461	—	[illegible]
Vermont	—	190,120	—	2,499	—	[illegible]	121,420	58,785	—	[illegible]
Virginia	—	6,370	—	558	—	[illegible]	—	5,810	—	[illegible]
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA	NA	[illegible]
Washington	—	39,511	—	104	—	[illegible]	635	8,577	—	[illegible]
West Virginia	—	14,015	3,757	2,996	—	[illegible]	—	2,790	—	[illegible]
Wisconsin	—	121,405	71,765	—	—	[illegible]	—	—	57,865	[illegible]
Wyoming	—	91,840	—	—	25,730	[illegible]	—	—	40,618	[illegible]
Total Lake Acres Impaired	113,196	7,958,064	1,211,698	2,464,584	25,730	[illegible]	1,089,477	1,918,736	214,448	[illegible]
% of Impaired Lake Acres[b] Affected by Each Cause			15%	31%	<1%	[illegible]	14%	24%	3%	[illegible]
% of Assessed Lake Acres Affected by Each Cause			7%	13%	<1%	[illegible]	6%	10%	1%	[illegible]
% of Total Lake Acres Affected by Each Cause			3%	6%	<1%	[illegible]	3%	5%	1%	[illegible]

[a]Connecticut assessed some lakes as impaired by nutrients even though the lakes did not meet the Section 319 definition of impaired.

[b]Includes only impaired lake acres in States reporting causes affecting lakes.

— None or not reported.

NA = Not applicable.

Source: 1992 State Section 305(b) reports.

Total Impaired Lakes Acres in States Reporting Causes	[illegible]
Total Assessed Lake Acres	[illegible]
Estimate of Total Lake Acres in the Nation:	39,922,437 acres

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[redacted]

Organic Enrich. Low Dissolved Oxygen (3)				Siltation (4)				Priority Organics (5)			
Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	—	—	—	61,178	—	—	61,178
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	270	—	270	—	11,173	—	11,173	170	6	—	176
—	—	—	—	—	—	—	—	—	—	—	—
13,140	2,600	—	15,740	120,110	18,080	—	138,190	—	—	—	—
160	—	—	160	—	—	—	—	—	—	—	—
475	3,510	—	3,985	326	2,870	—	3,196	2,875	—	—	2,875
86	145	—	231	215	42	—	257	158	—	—	158
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
103	—	—	103	—	103	—	103	—	103	—	103
—	79,296	—	79,296	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
2,145	63,020	—	65,165	—	—	—	—	—	—	—	—
73,704	115,793	—	189,497	67,579	125,693	—	193,272	2,041	2,786	—	4,827
59	63	—	122	—	—	—	—	12	—	—	12
2,387	4,800	—	7,187	12,706	6,242	—	18,948	—	187	—	187
—	—	—	—	3,855	54,885	—	58,740	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
29,716	10,292	—	40,008	2,112	16,307	—	18,419	2,236	44,824	—	47,060
135,312	55,792	—	191,104	—	66,712	—	66,712	—	—	—	—
6	2,405	—	2,411	100	3,860	—	3,960	—	—	—	—
233	7,626	—	7,859	8	96	—	104	—	—	—	—
2,200	—	—	2,200	—	—	—	—	8,562	—	—	8,562
—	—	—	—	—	—	—	—	7,096	1,293,440	—	1,300,536
—	163,126	—	163,126	22	172,086	—	172,108	46	—	—	46
1,730	—	—	1,730	70	—	—	70	—	—	—	—
—	259,702	—	259,702	—	81,822	—	81,822	—	—	—	—
—	7,994	—	7,994	1,526	6,276	—	7,802	—	—	—	—
50,300	950	—	51,250	—	—	—	—	—	—	—	—
1,025	14	—	1,039	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	506	—	506	5	84,865	—	84,870	—	1,240	—	1,240
5,350	85,350	—	90,700	22,800	113,300	—	136,100	102,100	20,450	—	122,550
100	—	—	100	636	540	—	1,176	340	—	—	340
1,608	29,032	—	30,640	1,970	158	—	2,128	—	—	—	—
50,589	2,982	—	53,571	3,378	19,577	—	22,955	—	2,076	—	2,076
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
29,300	156,514	—	185,814	74,729	313,783	—	388,512	11,805	22,468	—	34,273
—	—	69,147	69,147	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
58	898	—	956	—	—	—	—	—	—	—	—
600	—	—	600	109	284	—	393	—	337	—	337
63,925	—	—	63,925	—	—	—	—	—	—	—	—
477	1,404	—	1,881	75,818	65,300	—	141,118	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
156,859	8,728	—	165,587	119,450	8,197	—	127,647	—	—	—	—
2,442	11,882	—	14,324	1,651	18,085	—	19,736	—	—	—	—
—	736	—	736	—	585	—	585	—	—	—	—
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
836	2,036	—	2,872	—	4,630	—	4,630	—	104	—	104
30	32	—	62	370	5,480	—	5,850	—	—	—	—
—	—	55,286	55,286	—	—	—	—	—	—	—	—
—	—	55,259	55,259	—	—	33,743	33,743	—	—	—	—
624,955	1,077,498	179,692	[illegible]	509,545	1,201,031	33,743	[illegible]	198,619	1,388,021	—	1,586,640
8%	14%	2%	24%	6%	15%	<1%	22%	2%	17%	—	20%
3%	6%	1%	10%	3%	7%	<1%	10%	1%	8%	—	9%
2%	3%	—	5%	1%	3%	<1%	4%	<1%	3%	—	4%

(continued)

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State	Suspended Solids (6)				Noxious Aquatic Plants (7)				Flow Alteration (8)			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	—	824	—	824	213	1,037	—	1,250	—	950	—	950
Arkansas	—	—	—	—	—	—	—	—	—	—	—	—
California	—	—	—	—	45,000	2,970	—	47,970	—	—	—	—
Colorado	—	—	—	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	3,430	622	—	4,052	—	—	—	—
Delaware	86	—	—	86	781	868	—	1,649	—	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	—	103	—	103	—	—	—	—	—	—	—	—
Florida	—	216,704	—	216,704	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	573	—	573	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Idaho	1,319	139,620	—	140,939	—	—	—	—	—	—	—	—
Illinois	73,058	121,206	—	194,264	29,129	105,066	—	134,195	1,000	7,740	—	8,740
Indiana	—	—	—	—	—	—	—	—	10	67	—	77
Iowa	—	—	—	—	—	258	—	258	—	—	—	—
Kansas	5	—	—	5	40	—	—	40	3,792	7,788	—	11,580
Kentucky	4,517	—	—	4,517	—	—	—	—	—	—	—	—
Louisiana	6,912	—	—	6,912	9,044	40,333	—	49,377	2,112	3,864	—	5,976
Maine	—	—	—	—	—	—	—	—	—	30	—	30
Maryland	—	—	—	—	—	408	—	408	—	—	—	—
Massachusetts	187	106	—	293	5,119	8,739	—	13,858	—	—	—	—
Michigan	—	—	—	—	—	—	—	—	—	—	—	—
Minnesota	—	—	—	—	—	—	—	—	—	—	—	—
Mississippi	22	—	—	22	—	—	—	—	—	—	—	—
Missouri	—	—	—	—	—	—	—	—	—	—	—	—
Montana	—	310,844	—	310,844	—	306,019	—	306,019	—	363,221	—	363,221
Nebraska	—	16,123	—	16,123	250	—	—	250	—	—	—	—
Nevada	—	—	—	—	14,800	—	—	14,800	—	—	—	—
New Hampshire	—	—	—	—	5,001	440	—	5,441	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New Mexico	—	2,429	—	2,429	41	11,959	—	12,000	—	—	—	—
New York	—	—	—	—	1,650	58,300	—	59,950	47,200	9,400	—	56,600
North Carolina	—	—	—	—	1,416	600	—	2,016	—	—	—	—
North Dakota	—	—	—	—	—	—	—	—	221,568	—	—	221,568
Ohio	—	1,350	—	1,350	—	2,247	—	2,247	—	8,817	—	8,817
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	68,874	183,418	—	252,292	5,680	18,002	—	23,662	40,117	42,063	—	82,180
Oregon	—	—	15,594	15,594	—	—	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	—	—	—	133	3,822	—	3,955	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
South Dakota	359	29,133	—	29,492	102,468	5,483	—	107,951	—	7,868	—	7,868
Tennessee	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Utah	97,232	21	—	97,253	2,826	100,154	—	102,980	—	—	—	—
Vermont	—	—	—	—	21,639	8,444	—	30,083	7,482	441	—	7,923
Virginia	—	—	—	—	—	—	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Washington	—	30	—	30	—	2,413	—	2,413	—	2,858	—	2,858
West Virginia	—	—	—	—	49	—	—	49	—	—	—	—
Wisconsin	—	—	—	—	—	—	86,545	86,545	—	—	—	—
Wyoming	—	—	—	—	—	—	—	—	—	—	9,420	9,420
Total River Miles Impaired	252,571	1,021,911	15,594	1,290,076	248,709	678,757	86,545	1,014,011	323,281	455,107	9,420	787,808
% of Impaired River Miles[a] Affected by Each Cause	3%	13%	<1%	16%	3%	9%	1%	13%	4%	6%	<1%	10%
% of Assessed River Miles Affected by Each Cause	1%	6%	<1%	7%	1%	4%	<1%	6%	2%	2%	<1%	4%
% of Total River Miles Affected by Each Cause	1%	3%	<1%	3%	1%	2%	<1%	3%	1%	1%	—	2%

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Pesticides (9)				Pathogen Indicators (10)			
Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	18,280	—	—	18,280
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
170	—	—	170	50	100	—	150
—	—	—	—	—	—	—	—
210	50	—	260	1,280	6,790	—	8,070
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	1,212	462	—	1,674
NA	NA	NA	NA	NA	NA	NA	NA
—	103	—	103	211	27	—	238
—	—	—	—	4,288	448	—	4,736
—	24,911	—	24,911	—	650	—	650
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	7,579	—	7,579	79	36,181	—	36,260
13,395	598	—	13,993	1,800	4,651	—	6,451
12	—	—	12	45	77	—	122
336	19,693	—	20,029	248	—	—	248
52,065	57,941	—	110,006	9,556	—	—	9,556
—	—	—	—	—	—	—	—
—	25,844	—	25,844	9,248	257,263	—	266,511
—	—	—	—	—	—	—	—
100	—	—	100	6	366	—	372
—	—	—	—	—	266	—	266
—	—	—	—	1	—	—	1
—	—	—	—	—	—	—	—
5,961	165,815	—	171,776	—	7,569	—	7,569
33,622	—	—	33,622	2	70	—	72
—	—	—	—	1,399	13,312	—	14,711
3,365	—	—	3,365	—	38,733	—	38,733
—	—	—	—	—	—	—	—
—	—	—	—	104	79	—	183
—	—	—	—	—	—	—	—
—	326	—	326	—	—	—	—
25,650	43,350	—	71,000	14,550	151,400	—	165,950
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
604	8,734	—	9,338	—	2,022	—	2,022
NA	NA	NA	NA	NA	NA	NA	NA
—	215,663	—	215,663	—	1,820	—	1,820
—	—	—	—	—	—	13,248	13,248
—	—	—	—	—	—	—	—
—	738	—	738	1,325	1,494	—	2,819
—	—	—	—	290	581	—	871
—	—	—	—	12,200	25	—	12,225
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	16,230	1,581	—	17,811
—	—	—	—	1,000	—	—	1,000
—	—	—	—	844	10	—	854
—	210	—	210	52	286	—	338
NA	NA	NA	NA	NA	NA	NA	NA
6,621	—	—	6,621	41	1,818	—	1,859
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
142,111	573,555	—	715,666	94,341	528,081	13,248	635,670
2%	7%	—	9%	1%	7%	<1%	8%
1%	3%	—	4%	1%	3%	<1%	3%
<1%	1%	—	2%	<1%	1%	<1%	2%

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State	Total Impaired Acres		Agriculture (general) (1)				Urban Runoff/Storm Sewers (2)			
	States Not Reporting Sources	States Reporting Sources	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	82,548	620	4,000	—	[illegible]	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
Arizona	—	87,988	—	—	31,876	31,876	—	—	416	416
Arkansas	—	—	—	—	—	—	—	—	—	—
California	—	283,433	25,111	1	—	25,112	120,640	2,781	—	[illegible]
Colorado	—	12,970	1,503	13,976	—	15,479	900	8,552	—	[illegible]
Connecticut	—	3,143	—	—	—	—	—	—	—	—
Delaware	—	1,973	—	2,168	—	2,168	—	1,444	—	1,444
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	—	238	—	—	—	—	211	27	—	[illegible]
Florida	—	652,608	1,920	630,912	—	632,832	—	646,528	—	[illegible]
Georgia	—	37,640	—	—	—	—	—	25,561	—	[illegible]
Gila River Indian Community	—	153	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—
Idaho	—	180,883	5,008	118,243	—	123,251	—	890	—	890
Illinois	—	187,104	141,887	46,057	—	187,944	2,986	83,669	—	86,655
Indiana	—	189	12	—	—	12	35	22	—	57
Iowa	—	24,140	15,612	7,811	—	23,423	5,194	2,209	—	7,403
Kansas	—	168,393	44,335	101,545	—	[illegible]	8,042	7,495	—	15,537
Kentucky	—	19,669	8,093	—	—	[illegible]	—	—	—	—
Louisiana	—	311,989	43,213	25,326	—	[illegible]	20,608	23,416	—	44,024
Maine	—	202,477	1,402	66,805	—	[illegible]	32,805	89,608	—	122,413
Maryland	—	4,012	271	4,647	—	[illegible]	110	384	—	494
Massachusetts	—	13,258	55	537	—	592	1,660	1,019	—	[illegible]
Michigan	—	26,265	—	—	—	—	2,245	—	—	2,245
Minnesota	2,102,552	285,365	—	—	—	—	—	—	—	—
Mississippi	—	114,782	171,758	1,300	—	173,058	22	1,400	—	1,422
Missouri	—	33,002	33,730	—	—	[illegible]	3,535	—	—	3,535
Montana	—	470,245	12,900	302,233	—	[illegible]	—	546	—	546
Nebraska	—	95,913	3,380	6,278	—	[illegible]	100	400	—	500
Nevada	—	80,533	14,800	108,000	—	[illegible]	—	—	—	—
New Hampshire	—	13,351	124	45	—	169	1,260	12	—	1,272
New Jersey	—	—	—	—	—	—	—	—	—	—
New Mexico	—	130,136	5	101,387	—	[illegible]	5	—	—	[illegible]
New York	—	424,150	71,600	74,600	—	[illegible]	19,400	24,400	—	[illegible]
North Carolina	—	26,692	1,149	340	—	[illegible]	715	90	—	[illegible]
North Dakota	—	378,422	4,354	12,810	—	[illegible]	—	22	—	[illegible]
Ohio	—	72,003	2,956	33,879	—	[illegible]	3,306	10,596	—	[illegible]
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA	NA	[illegible]
Oklahoma	—	275,982	45,698	343,104	—	[illegible]	—	81,555	—	[illegible]
Oregon	—	130,625	—	—	98,145	[illegible]	—	—	10,866	[illegible]
Pennsylvania	—	—	—	—	—	—	—	—	—	[illegible]
Puerto Rico	—	6,631	—	1,125	—	[illegible]	112	73	—	[illegible]
Rhode Island	—	3,576	—	562	—	[illegible]	1,057	296	—	[illegible]
South Carolina	—	76,125	11,400	—	—	[illegible]	25	—	—	[illegible]
South Dakota	—	127,465	11,573	29,557	—	41,130	90	—	—	90
Tennessee	113,196	—	—	—	—	—	—	—	—	—
Texas	—	170,185	—	—	—	—	—	—	—	—
Utah	—	175,995	—	—	165,000	[illegible]	46,953	—	—	[illegible]
Vermont	190,120	—	—	—	—	—	—	—	—	—
Virginia	—	6,370	—	2,875	—	[illegible]	21	1,152	—	[illegible]
Virgin Islands	NA	NA	NA	NA	NA	[illegible]	NA	NA	NA	NA
Washington	—	39,511	350	16,259	—	[illegible]	160	11,724	—	[illegible]
West Virginia	—	14,015	40	2,094	—	[illegible]	12	—	—	[illegible]
Wisconsin	121,405	—	—	—	—	—	—	—	—	—
Wyoming	—	91,840	—	—	63,229	[illegible]	—	—	1,434	1,434
Total Lake Acres Impaired	2,527,273	5,543,987	674,859	2,058,476	358,250	[illegible]	272,209	1,025,871	12,716	[illegible]
% of Impaired Lake Acres[a] Affected by Each Source			12%	37%	6%	[illegible]	5%	19%	<1%	[illegible]
% of Assessed Lake Acres Affected by Each Source			4%	11%	2%	[illegible]	1%	6%	<1%	7%
% of Total Lake Acres Affected by Each Source			2%	5%	1%	[illegible]	1%	3%	<1%	3%

[a]Includes only impaired lake acres in States reporting sources affecting lakes.

— None or not reported.

NA = Not applicable.

Source: 1992 State Section 305(b) reports.

Total Impaired Lake Acres in States Reporting Sources:	5,543,987 acres
Total Assessed Lake Acres:	18,283,566 acres
Estimate of Total Lake Acres in the Nation:	39,922,437 acres

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(continued)

Hydro-Habitat Modification (3)				Natural (4)				Municipal Point Sources (5)			
Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	—	—	—	—	4,000	—	4,000
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	81,278	81,278	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	559	559
120,000	640	—	120,640	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
975	—	—	975	—	—	—	—	—	7,172	—	7,172
—	—	—	—	—	—	—	—	—	268	—	268
NA	NA	NA	NA	189	395	—	584	—	93	—	93
				NA	NA	NA	NA	NA	NA	NA	NA
—	103	—	103	—	27	—	27	—	—	—	—
—	454,400	—	454,400	—	—	—	—	1,216	250,560	—	251,776
—	—	—	—	—	—	—	—	—	3,774	—	3,774
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
1,220	7,691	—	8,911	—	4,081	—	4,081	—	811	—	811
29,237	144,004	—	173,241	—	5,831	—	5,831	4,925	90,120	—	95,045
—	40	—	40	—	—	—	—	59	63	—	122
220	156	—	376	3,595	232	—	3,827	12	—	—	12
3,458	5,824	—	9,282	18,939	140,598	—	159,537	20,785	119,813	—	140,598
—	—	—	—	6,474	—	—	6,474	6,445	455	—	6,900
61,632	30,298	—	91,930	—	—	—	—	23,968	15,819	—	39,787
—	8,057	—	8,057	—	—	—	—	76	4,845	—	4,921
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	208	131	—	339	1,008	231	—	1,239
1,270	—	—	1,270	—	—	—	—	906	—	—	906
—	—	—	—	—	—	—	—	285,365	—	—	285,365
—	—	—	—	—	—	—	—	—	—	—	—
1,730	—	—	1,730	—	—	—	—	7	66	—	73
—	—	—	—	22,049	322,945	—	344,994	—	3,100	—	3,100
784	—	—	784	—	—	—	—	—	30,000	—	30,000
108,000	—	—	108,000	828	950	—	1,778	6,400	—	—	6,400
25	—	—	25	575	452	—	1,027	3,632	—	—	3,632
—	—	—	—	—	—	—	—	—	—	—	—
—	196	—	196	—	429	—	429	—	—	—	—
60,300	26,700	—	87,000	—	—	—	—	13,900	63,600	—	77,500
—	—	—	—	—	—	—	—	15,850	1,090	—	16,940
—	—	—	—	—	222,917	—	222,917	—	2,701	—	2,701
—	12,466	—	12,466	334	24,847	—	25,181	—	13,149	—	13,149
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	12,055	6,654	—	18,709	—	—	—	—
—	—	—	—	—	—	111,231	111,231	—	—	485	485
—	—	—	—	—	—	—	—	—	—	—	—
—	36	—	36	—	—	—	—	—	—	—	—
—	—	—	—	1,463	215	—	1,678	—	233	—	233
—	—	—	—	—	—	—	—	—	—	—	—
1,339	7,868	—	9,207	11,674	406	—	12,080	1,870	—	—	1,870
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	35,366	114,208	—	149,574	16,230	—	—	16,230
98,699	3,530	—	102,229	100,326	14,500	—	114,826	97,584	21	—	97,605
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	10	448	—	458
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
—	3,407	—	3,407	—	10,668	—	10,668	—	3,069	—	3,069
—	—	—	—	61	—	—	61	—	4	—	4
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	64,515	64,515	—	—	30,809	30,809
488,689	705,416	81,278	[illegible]	214,136	870,486	175,746	[illegible]	500,248	617,505	31,853	1,149,606
9%	13%	1%	23%	4%	16%	3%	23%	9%	11%	1%	21%
3%	4%	<1%	7%	1%	5%	1%	7%	3%	3%	<1%	6%
1%	2%	<1%	3%	1%	2%	<1%	3%	1%	2%	<1%	3%

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State	Onsite Wastewater Disposal (6)				Flow Modification (7)				Contaminated Sediments (8)			
	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
Arizona	—	—	92	92	—	—	—	—	—	—	—	—
Arkansas	—	—	—	—	—	—	—	—	—	—	—	—
California	25,640	820	—	26,460	—	—	—	—	—	—	—	—
Colorado	—	—	—	0	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—	—	—
Delaware	—	1,267	—	1,267	—	—	—	—	—	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	—
Florida	—	591,488	—	591,488	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Idaho	—	—	—	—	—	—	—	—	—	—	—	—
Illinois	—	—	—	—	—	—	—	—	—	—	—	—
Indiana	—	—	—	0	—	—	—	—	58,190	134,553	—	192,743
Iowa	—	—	—	—	—	—	—	—	—	—	—	—
Kansas	—	—	—	0	—	—	—	—	—	—	—	—
Kentucky	3,109	317	—	3,426	—	—	—	—	334	—	—	334
Louisiana	—	—	—	0	—	—	—	—	—	—	—	—
Maine	—	—	—	0	—	—	—	—	—	18,432	—	18,432
Maryland	—	—	—	0	—	—	—	—	—	—	—	—
Massachusetts	376	984	—	1,360	—	—	—	—	697	5,649	—	6,346
Michigan	—	—	—	0	—	—	—	—	3,660	—	—	3,660
Minnesota	—	—	—	—	—	—	—	—	—	—	—	—
Mississippi	3,422	100	—	3,522	—	—	—	—	—	—	—	—
Missouri	—	—	—	—	—	—	—	—	—	—	—	—
Montana	—	9,708	—	9,708	—	299,629	—	299,629	—	2,066	—	2,066
Nebraska	—	—	—	—	—	—	—	—	—	—	—	—
Nevada	—	—	—	0	50,200	950	—	51,150	—	—	—	—
New Hampshire	—	—	—	0	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—	—	—	—	—	—	—
New York	57,300	96,850	—	154,150	—	—	—	—	23,800	18,100	—	41,900
North Carolina	—	—	—	0	—	—	—	—	9,680	—	—	9,680
North Dakota	—	—	—	0	221,568	—	—	221,568	—	—	—	—
Ohio	1,995	18,140	—	20,135	—	2,540	—	2,540	25	8,957	—	8,982
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	—	35,739	—	35,739	46,019	46,013	—	92,032	17,628	105,751	—	123,379
Oregon	—	—	13,129	13,129	—	—	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	—	—	—	0	—	—	—	—	—	—	—	—
Rhode Island	—	532	—	532	—	—	—	—	—	—	—	—
South Carolina	—	—	—	0	—	—	—	—	—	—	—	—
South Dakota	—	—	—	—	—	—	—	—	—	—	—	—
Tennessee	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Utah	—	4,554	—	4,554	637	733	—	1,370	—	—	—	—
Vermont	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	0	—	—	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Washington	—	8,703	—	8,703	—	2,962	—	2,962	—	790	—	790
West Virginia	—	—	—	0	—	—	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—	—	—	—	—	—	—
Wyoming	—	—	—	0	44,938	—	—	44,938	—	—	—	—
Total Lake Acres Impaired	91,842	769,202	13,221	874,265	363,362	352,827	—	716,189	114,014	294,298	—	408,312
% of Impaired Lake Acres[a] Affected by Each Cause	2%	14%	<1%	16%	7%	6%	—	13%	2%	5%	—	7%
% of Assessed Lake Acres Affected by Each Cause	1%	4%	<1%	5%	2%	2%	—	4%	1%	2%	—	2%
% of Total River Miles Affected by Each Cause	<1%	2%	<1%	2%	1%	1%	—	2%	—	1%	—	1%

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Industrial Point Sources (9)				Resource Extraction (10)			
Major	Mod./Min	Not Specified	Total	Major	Mod./Min	Not Specified	Total
56,698	—	—	[illegible]	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
170	—	—	170	2,832	—	—	2,832
—	—	—	—	—	—	—	—
—	—	—	—	69,200	32,816	—	102,016
262	—	—	262	—	—	—	—
—	—	—	—	—	—	—	—
—	35	—	35	—	—	—	—
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	—	—	—
—	62,720	—	62,720	—	31,872	—	31,872
650	1,223	—	1,873	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	811	—	811	3	811	—	814
2,631	14,500	—	17,131	155	41,777	—	41,932
—	—	—	—	30	—	—	30
—	—	—	—	—	—	—	—
—	—	—	—	190	50	—	240
—	—	—	—	4,871	—	—	4,871
46,976	13,088	—	60,064	44,800	42,643	—	87,443
—	4,288	—	4,288	—	—	—	—
—	—	—	—	—	952	—	952
—	—	—	—	—	—	—	—
4,877	—	—	4,877	—	—	—	—
—	—	—	—	—	—	—	—
—	200	—	200	1,200	—	—	1,200
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
3,961	—	—	3,961	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
43,400	3,300	—	46,700	500	—	—	500
340	—	—	340	—	—	—	—
—	—	—	—	—	—	—	—
—	16,356	—	16,356	212	4,556	—	4,768
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	49,679	—	49,679
895	—	—	895	—	—	—	—
—	—	—	—	—	—	—	—
112	122	—	234				
—	—	—	—	—	—	—	—
800	—	—	800	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
96,900	21	—	96,921	2,815	—	—	2,815
—	—	—	—	—	—	—	—
—	448	—	448	—	—	—	—
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	—	—	—
12,000	—	—	12,000	3,911	8,040	—	11,951
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
270,672	117,112	—	[illegible]	130,719	213,196	—	343,915
5%	2%	—	7%	2%	4%	—	6%
1%	1%	—	2%	1%	1%	—	2%
1%	<1%	—	1%	<1%	1%	—	1%

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Appendix C

Individual State Data
Estuaries and Coastal Waters

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[illegible] Overall Designated Use Support [illegible]

State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Alabama	12	253	—	[illegible]	—	—	—	—	—	75	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	—	—	[illegible]
California	—	—	—	—	—	—	4	4	—	—	85	[illegible]
Connecticut	—	—	361	361	—	—	—	—	—	—	235	[illegible]
Delaware	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Delaware River Basin	—	—	—	—	—	216	—	216	—	—	—	[illegible]
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Florida	730	953	—	1,683	—	25	—	25	97	773	—	[illegible]
Georgia	443	10	—	453	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	718	32	—	750	88	13	—	101	—	3	—	3
Louisiana	851	594	—	1,445	2,614	—	—	2,614	864	—	—	864
Maine	1,423	50	—	1,473	—	—	—	—	—	36	—	36
Maryland	—	—	—	—	87	6	—	93	197	2,133	—	[illegible]
Massachusetts	65	2	—	67	—	1	—	1	5	17	—	22
Mississippi	—	1	—	1	—	13	—	13	—	5	—	5
New Hampshire	—	10	—	10	—	—	—	—	—	—	—	—
New Jersey	—	—	440	440	—	—	—	—	—	—	121	121
New York	—	1,106	—	1,106	—	1	—	1	—	166	—	166
North Carolina	—	—	2,721	2,721	—	—	131	131	—	—	269	269
Oregon	—	—	4	4	—	—	—	—	—	—	38	38
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	—	141	141	—	—	14	14	—	—	21	21
South Carolina	—	—	310	310	—	—	—	—	—	—	101	101
Texas	—	—	1,318	1,318	—	—	—	—	—	—	150	150
Virginia	267	2,130	—	2,397	—	—	—	—	48	567	—	615
Virgin Islands	—	—	3	3	—	—	—	—	—	—	1	1
Washington	17	243	—	260	—	140	—	140	1	104	—	[illegible]
Totals	4,526	5,384	5,298	[illegible]	2,789	415	149	[illegible]	1,212	3,899	1,021	[illegible]
% of Assessed Waters	30%	35%	35%	[illegible]	83%	12%	4%	12%	20%	64%	17%	23%

[a] Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).

— None or not reported.

Source: 1992 State Section 305(b) reports.

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Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	3	—	3	—	—	—	—	12	331	—	343
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	4	4	—	—	—	—	—	—	89	89
—	29	—	29	—	—	—	—	—	—	600	600
—	—	—	—	—	—	—	—	—	29	—	29
—	6	—	6	—	—	—	—	—	216	—	216
3	147	—	152	—	—	—	—	—	6	—	6
237	164	—	401	—	—	—	—	832	1,898	—	2,730
—	—	—	—	—	—	—	—	680	174	—	854
—	20	—	20	—	—	—	—	—	—	—	—
20	—	—	20	—	—	—	—	806	68	—	874
7	118	—	125	—	—	—	—	4,349	594	—	4,943
8	71	—	79	—	—	—	—	1,430	204	—	1,634
42	92	—	134	—	—	—	—	292	2,230	—	2,522
—	—	—	—	—	—	—	—	112	112	—	224
3	14	—	19	—	—	—	—	—	19	—	19
—	—	53	53	—	—	—	—	3	24	—	29
—	258	—	258	—	—	—	—	—	—	614	614
—	—	—	—	—	—	—	—	—	1,531	—	1,531
—	—	19	19	—	—	—	—	—	—	3,121	3,121
—	—	—	—	—	—	—	—	—	—	61	61
—	—	17	17	—	—	—	—	—	—	—	—
—	—	15	15	—	—	—	—	—	—	193	193
—	—	453	453	—	—	71	71	—	—	1,992	1,992
7	88	—	67	—	—	—	—	322	2,757	—	3,079
—	—	1	1	—	—	—	—	—	—	5	5
3	585	—	588	—	—	—	—	21	1,072	—	1,093
334 14%	1,562 64%	562 23%	2,463 9%	— —	— —	71 100%	71 <1%	8,861 33%	11,265 41%	7,101 26%	27,227 74%

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	4	85	—	—	89
Connecticut	375	—	223	2	—	600
Delaware	—	—	17	12	—	29
Delaware River Basin	132	59	25	—	—	216
District of Columbia	—	—	1	4	—	5
Florida	1,683	25	870	152	—	2,730
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	4,673	—	269	—	—	4,942
Maine	1,475	—	36	122	—	1,633
Maryland	—	93	2,350	79	—	2,522
Massachusetts	114	1	31	51	—	197
Mississippi	1	13	5	—	—	19
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,513	—	16	1	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	178	8	—	7	—	193
South Carolina	341	—	97	11	—	449
Texas	1,991	—	—	—	—	1,991
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	490	—	13	32	—	535
Totals	16,043	334	4,307	476	—	21,160
Percent of Assessed Waters	76%	2%	20%	2%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035508

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	7	2	80	—	—	89
Connecticut	600	—	—	—	—	600
Delaware	29	—	—	—	—	29
Delaware River Basin	191	—	—	25	—	216
District of Columbia	—	—	6	—	—	6
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	2,502	—	—	21	—	2,523
Massachusetts	9	—	—	46	—	55
Mississippi	—	—	—	—	—	—
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,415	—	115	—	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	1,947	—	—	44	—	1,991
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	23	—	—	—	23
Totals	9,777	156	470	139	—	10,542
Percent of Assessed Waters	93%	1%	4%	1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035509

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	196	—	75	3	—	274
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	7	2	3	—	—	12
Connecticut	483	—	—	117	—	600
Delaware	—	—	10	—	—	10
Delaware River Basin	—	—	—	42	—	42
District of Columbia	—	—	—	—	—	—
Florida	878	25	472	74	—	1,449
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	281	—	3	139	11	434
Maryland	1,646	6	97	90	—	1,839
Massachusetts	77	—	14	132	—	223
Mississippi	—	—	5	4	—	9
New Hampshire	10	—	—	19	—	29
New Jersey	440	—	121	53	—	614
New York	1,344	1	4	182	—	1,531
North Carolina	—	—	59	—	—	59
Oregon	4	—	38	19	—	61
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	1,308	—	139	453	71	1,971
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	208	139	88	620	—	1,055
Totals	6,882	173	1,128	1,947	82	10,212
Percent of Assessed Waters	67%	2%	11%	19%	1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035510

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	327	—	—	—	—	327
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	9	1	3	—	—	13
Connecticut	538	1	59	3	—	601
Delaware	9	—	17	3	—	29
Delaware River Basin	205	—	—	—	—	205
District of Columbia	—	—	—	5	—	5
Florida	1,683	25	870	152	—	2,730
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	3,299	—	1,063	580	—	4,942
Maine	1,631	—	—	3	—	1,634
Maryland	2,520	—	—	2	—	2,522
Massachusetts	99	8	59	48	—	214
Mississippi	—	—	—	—	—	—
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,456	—	1	73	—	1,530
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	353	—	35	12	—	400
Texas	1,977	—	10	—	—	1,987
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	482	—	15	34	—	531
Totals	14,616	35	2,132	915	—	17,698
Percent of Assessed Waters	83%	<1%	12%	5%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035511

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	89	—	—	—	—	89
Connecticut	538	1	59	3	—	601
Delaware	29	—	—	—	—	29
Delaware River Basin	11	—	—	—	—	11
District of Columbia	—	—	5	1	—	6
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	3,689	—	1,233	20	—	4,942
Maine	—	—	—	—	—	—
Maryland	—	—	—	—	—	—
Massachusetts	192	—	11	2	—	205
Mississippi	6	5	7	—	—	18
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New York	1,519	—	11	—	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	420	—	15	—	—	435
Texas	4	—	—	—	—	4
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	487	—	32	13	—	532
Totals	10,033	137	1,642	42	—	11,854
Percent of Assessed Waters	85%	1%	14%	<1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035512

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R0035513

Table C-[illegible] Leading Causes of Estuarine Impairment (Square Miles)

State	Total Impaired Waters		Nutrients (1)				Pathogen Indicators (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	78	—	—	—	—	78	—	—	78
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	—	85	2	1	—	3	2	—	—	2
Connecticut	—	239	216	15	—	251	13	125	—	138
Delaware	—	29	26	3	—	29	14	15	—	29
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	6	—	1	—	1	1	5	—	6
Florida	—	1,022	95	300	—	395	—	44	—	44
Georgia	—	401	—	—	—	—	85	4	—	89
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	23	—	—	—	—	—	—	—	—	—
Louisiana	—	884	33	808	—	863	—	622	—	622
Maine	—	161	—	—	—	—	38	—	—	38
Maryland	—	2,429	404	2,102	—	2,506	59	638	—	697
Massachusetts	—	156	—	21	—	21	96	51	—	147
Mississippi	—	5	—	14	—	14	—	18	—	18
New Hampshire	—	19	—	—	—	—	19	—	—	19
New Jersey	—	174	70	—	—	70	142	—	—	142
New York	—	424	1	108	—	109	266	35	—	301
North Carolina	—	269	—	—	113	113	—	—	59	59
Oregon	—	57	—	—	—	—	—	—	56	56
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	38	—	14	—	14	28	4	—	32
South Carolina	—	116	—	—	—	—	28	9	—	37
Texas	—	603	—	—	—	—	174	362	—	536
Virginia	—	682	236	127	—	363	—	163	—	163
Virgin Islands	—	2	—	—	—	—	—	—	—	—
Washington	—	693	—	—	—	—	45	301	—	346
Total Estuarine Area Impaired	23	8,572	1,125	3,514	113	4,752	1,088	2,396	115	[illegible]
% of Impaired Estuarine Area[b] Affected by Each Cause			13%	41%	1%	55%	13%	28%	1%	[illegible]
% of Assessed Estuarine Area Affected by Each Cause			4%	13%	—	17%	4%	9%	—	[illegible]
% of Total Estuarine Area Affected by Each Cause			3%	10%	—	13%	3%	6%	—	[illegible]

[a] Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).
[b] Includes only impaired estuarine waters in States reporting causes of estuarine impairments.
— None or not reported.
Source: 1992 State Section 305(b) reports.

Total Impaired Estuarine Miles in States Reporting Causes:	8,572 square miles
Total Assessed Estuarine Miles:	27,227 square miles
Estimate of Total Estuarine Miles in the Nation:	36,890 square miles

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Table C-2 (continued)

Organic Enrich., Low Dissolved Oxygen (3)				Siltation (4)				Suspended Solids (5)			
Major	Mod/ Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	4	—	5	—	—	—	—
7	19	—	26	—	—	—	—	—	—	—	—
13	3	—	16	—	—	—	—	—	12	—	12
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	—	—	1	1	—	—	1
—	29	—	29	—	—	—	—	111	323	—	434
3	102	—	105	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	746	—	746	—	187	—	187	—	187	—	187
1	—	—	1	—	—	—	—	—	—	—	—
293	616	—	909	14	670	—	684	—	—	—	—
—	48	—	48	—	—	—	—	—	—	—	—
—	2	—	2	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	140	—	—	140	—	—	—	—
10	114	—	124	1	26	—	27	15	30	—	45
—	—	32	32	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	7	—	7	—	—	—	—	—	—	—	—
86	—	—	86	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
133	63	—	196	—	—	—	—	229	2	—	231
—	—	—	—	—	—	—	—	—	—	—	—
88	514	—	582	—	—	—	—	—	—	—	—
616	2,263	32	[illegible]	157	887	—	[illegible]	356	554	—	910
7%	26%	<1	34%	2%	10%	—	12%	4%	6%	—	11%
2%	8%	—	11%	1%	3%	—	4%	1%	2%	—	3%
2%	6%	—	8%	—	2%	—	3%	1%	2%	—	3%

[illegible] (continued)

State	Oil and Grease (4)				Pesticides (7)				Salinity, TDS, Chlorides			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
California	—	—	—	—	76	1	—	77	—	—	—	—
Connecticut	1	—	—	1	—	—	—	—	—	—	—	—
Delaware	—	—	—	—	—	—	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	1	—	1	—	1	—	1	—	—	—	—
Florida	—	—	—	—	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	1	—	1	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Louisiana	262	560	—	822	—	187	—	187	20	560	—	580
Maine	—	—	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	27	—	—	27	—	—	—	—
Massachusetts	—	2	—	2	—	—	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	70	—	—	70	—	—	—	—
New York	—	22	—	22	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	21	—	21	158	94	—	252	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	5	—	5	—	—	—	—	—	—	—	—
Total Estuarine Area Impaired	263	611	—	8[illegible]4	331	284	—	6[illegible]5	20	560	—	[illegible]
% of Impaired Estuarine Area[b] Affected by Each Cause	3%	7%	—	10%	4%	3%	—	7%	—	7%	—	[illegible]
% of Assessed Estuarine Area Affected by Each Cause	1%	2%	—	3%	1%	1%	—	2%	—	2%	—	[illegible]
% of Total Estuarine Area Affected by Each Cause	1%	2%	—	2%	1%	1%	—	2%	—	2%	—	[illegible]

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[illegible]				[illegible]			
Major	Mod/ Min	Not Specified	[illegible]	Major	Mod/ Min	Not Specified	[illegible]
—	—	—	[illegible]	—	—	—	[illegible]
—	—	—	[illegible]	—	—	—	[illegible]
—	—	—	[illegible]	—	—	—	[illegible]
1	—	—	[illegible]	77	1	—	[illegible]
1	20	—	[illegible]	—	—	—	—
—	—	—	[illegible]	—	1	—	1
—	—	—	[illegible]	—	—	—	[illegible]
—	1	—	1	—	4	—	4
—	—	—	[illegible]	—	—	—	—
—	18	—	[illegible]	16	68	—	84
—	—	—	[illegible]	—	—	—	—
—	—	—	[illegible]	—	—	—	—
—	20	—	20	—	—	—	—
3	—	—	3	—	—	—	—
—	—	—	[illegible]	—	—	—	—
1	7	—	8	—	30	—	30
1	—	—	1	9	—	—	9
—	—	—	[illegible]	—	—	—	—
70	—	—	70	—	—	—	—
120	6	—	[illegible]	—	32	—	32
—	—	65	[illegible]	—	—	—	—
—	—	—	[illegible]	—	—	—	[illegible]
—	—	—	[illegible]	—	—	—	[illegible]
—	7	—	7	—	7	—	7
—	—	—	[illegible]	—	—	—	—
—	24	—	24	1	—	—	1
—	6	—	6	1	44	—	45
—	—	—	[illegible]	—	—	—	—
—	31	—	[illegible]	—	14	—	14
197	140	65	[illegible]	104	201	—	305
2%	2%	1%	[illegible]	1%	2%	—	4%
1%	1%	—	[illegible]	—	1%	—	1%
1%	—	—	[illegible]	—	1%	—	1%

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State	Total Impaired Waters		Municipal Point Sources (1)				Urban Runoff/Storm Sewers (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod/ Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	78	3	—	—	3	—	75	—	75
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	—	85	75	—	—	75	78	3	—	81
Connecticut	—	239	263	182	—	445	—	340	—	340
Delaware	—	29	—	25	—	25	—	29	—	29
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	6	—	—	—	—	1	2	—	3
Florida	—	1,022	—	744	—	744	3	944	—	947
Georgia	—	401	4	107	—	111	5	—	—	5
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	23	—	—	—	—	—	—	—	—	—
Louisiana	—	884	—	809	—	809	—	621	—	621
Maine	—	161	117	6	—	123	—	—	—	—
Maryland	—	2,429	389	341	—	730	188	238	—	426
Massachusetts	—	156	10	81	—	91	10	105	—	115
Mississippi	—	5	—	9	—	9	—	18	—	18
New Hampshire	—	19	5	—	—	5	—	—	—	—
New Jersey	—	174	140	—	—	140	280	—	—	280
New York	—	424	57	210	—	267	124	69	—	193
North Carolina	269	—	—	—	—	—	—	—	—	—
Oregon	—	57	—	—	53	53	—	—	17	17
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	38	—	30	—	30	7	26	—	33
South Carolina	—	116	—	12	—	12	29	—	—	29
Texas	—	603	134	92	—	226	—	—	—	—
Virginia	—	682	236	110	—	346	4	267	—	271
Virgin Islands	—	2	—	—	—	—	—	—	—	—
Washington	—	693	—	139	—	139	—	104	—	104
Total Estuarine Area Impaired	292	8,303	1,433	2,897	53	4,383	729	2,841	17	3,587
% of Impaired Estuarine Area[b] Affected by Each Source			17%	35%	1%	53%	9%	34%	—	43%
% of Assessed Estuarine Area Affected by Each Source			5%	11%	—	16%	3%	10%	—	13%
% of Total Estuarine Area Affected by Each Source			4%	8%	—	12%	2%	8%	—	10%

[a]Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).
[b]Includes only impaired estuarine waters in States reporting sources of estuarine impairments.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Estuarine Miles in States Reporting Sources:	8,303 sq. mi.
Total Assessed Estuarine Miles:	27,227 sq. mi.
Estimate of Total Estuarine Miles in the Nation:	36,890 sq. mi.

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Agriculture (general) (3)				Industrial Point Sources (4)				Natural (5)			
Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	3	—	—	3	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
79	1	—	80	—	1	—	1	—	—	—	—
—	247	—	247	—	49	—	49	—	231	—	231
13	16	—	29	—	1	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	4	—	4
—	552	—	552	15	280	—	295	—	—	—	—
—	—	—	—	34	130	—	164	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
374	—	—	374	20	747	—	767	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
643	1,046	—	1,689	86	9	—	95	253	212	—	465
—	2	—	2	—	—	—	—	—	11	—	11
—	—	—	—	1	13	—	14	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
70	—	—	70	—	—	—	—	—	—	—	—
—	5	—	5	—	19	—	19	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	53	53	—	—	42	42	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	—	16	—	16	—	—	—	—
—	—	—	—	14	11	—	25	—	—	—	—
—	—	—	—	1	24	—	25	—	—	—	—
236	19	—	255	1	283	—	284	—	183	—	183
—	—	—	—	—	—	—	—	—	—	—	—
4	178	—	192	—	102	—	102	61	264	—	325
1,419	2,067	53	[illegible]	175	1,685	42	[illegible]	314	905	—	1,219
17%	25%	1%	43%	2%	20%	1%	23%	4%	11%	—	15%
5%	8%	—	13%	1%	6%	—	7%	1%	3%	—	4%
4%	6%	—	10%	—	5%	—	5%	1%	2%	—	3%

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State	Resource Extraction (6)				Construction (7)				[illegible]			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
California	75	—	—	75	—	2	—	2	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	1	49	—	[illegible]
Delaware	—	—	—	—	—	—	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	1	—	—	1	—	—	—	—	—	—	—	—
Florida	—	90	—	90	—	482	—	482	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Louisiana	207	615	—	822	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	34	—	34
Mississippi	—	6	—	6	—	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	140	—	—	140	—	—	—	—
New York	—	—	—	—	—	—	—	—	120	36	—	156
North Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—	—	—	—	7	—	7
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	13	—	13	158	94	—	252
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	4	—	4	—	27	—	27	—	35	—	[illegible]
Total Estuarine Area Impaired	283	715	—	[illegible]	140	524	—	[illegible]	279	255	—	[illegible]
% of Impaired Estuarine Area[b] Affected by Each Source	3%	9%	—	12%	2%	6%	—	8%	3%	3%	—	[illegible]
% of Assessed Estuarine Area Affected by Each Source	1%	3%	—	4%	1%	2%	—	2%	1%	1%	—	[illegible]
% of Total Estuarine Area Affected by Each Source	1%	2%	—	3%	—	1%	—	2%	1%	1%	—	[illegible]

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Atmospheric Deposition (9)				Hydrologic/Habitat Modification (10)			
Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
—	—	—	—	—	71	—	71
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	75	4	—	79
—	230	—	230	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	1
—	—	—	—	—	202	—	202
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	2	—	2
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
228	8	—	236	—	20	—	20
—	—	—	—	—	—	—	—
—	—	—	—	—	82	—	82
228	238	—	466	75	382	—	457
3%	3%	—	6%	1%	5%	—	6%
1%	1%	—	2%	—	1%	—	2%
1%	1%	—	1%	—	1%	—	1%

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State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Alabama	50	—	—	[illegible]	—	—	—	—	—	—	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	—	—	[illegible]
California	—	—	628	628	—	—	—	—	—	—	62	[illegible]
Connecticut	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Delaware	25	—	—	25	—	—	—	—	—	—	—	[illegible]
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	[illegible]
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Florida	609	245	—	854	—	—	—	—	19	17	—	[illegible]
Georgia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	476	150	—	626	18	23	—	41	—	27	—	[illegible]
Louisiana	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Maine	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Maryland	—	32	—	32	—	<1	—	<1	—	—	—	[illegible]
Massachusetts	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Mississippi	—	—	—	—	—	10	—	10	—	71	—	[illegible]
New Hampshire	—	18	—	18	—	—	—	—	—	—	—	[illegible]
New Jersey	—	—	107	107	—	—	—	—	—	—	—	[illegible]
New York	—	60	—	60	—	—	—	—	—	57	—	[illegible]
North Carolina	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Oregon	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Puerto Rico	135	56	—	191	112	67	—	179	10	27	—	37
Rhode Island	—	—	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	120	—	—	120	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—	—	—
Totals	1,415	561	735	[illegible]	130	100	—	[illegible]	29	199	62	[illegible]
% of Assessed Waters	52%	21%	27%	[illegible]	57%	43%	—	[illegible]	10%	69%	21%	[illegible]

— None or not reported.

Source: 1992 State Section 305(b) reports.

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Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	—	—	—	—	—	—	—	50	—	—	50
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	10	10	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	700	700
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	25	—	—	25
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	12	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	640	262	—	902
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	80	—	80	—	—	—	—	494	280	—	774
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	32	—	32
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	81	—	81
—	—	39	39	—	—	—	—	—	18	—	18
—	3	—	3	—	—	—	—	—	—	146	146
—	—	—	—	—	—	—	—	—	120	—	120
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	23	—	23	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	257	173	—	430
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	120	—	—	120
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
12 7%	106 63%	49 29%	167 5%	—	—	—	—	1,586 47%	966 28%	846 25%	3,398 17%

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	846	—	35	12	—	893
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	10	—	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	128	—	—	—	—	128
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	346	55	10	9	—	420
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	2,199	55	124	21	—	2,399
Percent of Assessed Waters	92%	2%	5%	1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2694

R0035524

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—
New Hampshire	18	—	—	—	—	18
New Jersey	70	—	50	—	—	120
New York	60	—	60	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	879	—	110	—	—	989
Percent of Assessed Waters	89%	—	11%	—	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035525

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	70	—	—	—	—	70
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	<1	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	—	60	—	—	60
New Hampshire	18	—	—	—	—	18
New Jersey	107	—	—	39	—	146
New York	117	—	—	3	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	1,018	<1	60	42	—	1,120
Percent of Assessed Waters	91%	—	5%	4%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035526

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	10	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	128	—	—	—	—	128
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	286	97	25	20	—	428
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	1,283	107	96	20	—	1,506
Percent of Assessed Waters	85%	7%	6%	1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

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R0035527

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—
Mississippi	10	—	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	—	—	—	—	—	—
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	372	45	—	11	—	428
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	595	45	71	11	—	722
Percent of Assessed Waters	82%	6%	10%	2%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2698

R0035528

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R0035529

State	Total Impaired Waters		Pathogen Indicators (1)				Metals (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	72	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—
Delaware	—	—	—	25	—	25	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	—
Florida	—	48	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	107	—	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—
Mississippi	—	71	41	40	—	81	30	51	—	81
New Hampshire	—	—	—	—	—	—	—	—	—	—
New Jersey	39	—	—	—	—	—	—	—	—	—
New York	—	60	3	—	—	3	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—
Puerto Rico	—	60	25	21	—	46	4	3	—	7
Rhode Island	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—
Total Shoreline Miles Impaired	218	239	69	86	—	[illegible]	34	54	—	[illegible]
% of Impaired Shoreline Miles Affected by Each Cause			29%	36%	—	65%	14%	23%	—	[illegible]
% of Assessed Shoreline Miles Affected by Each Cause			2%	3%	—	5%	1%	2%	—	[illegible]
% of Total Shoreline Miles Affected by Each Cause			—	—	—	1%	—	—	—	—

*Does not include the Alaska coastline.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Coastal Shoreline Miles in States Reporting Causes:	239 miles
Total Assessed Coastal Shoreline Miles:	3,366 miles
Estimate of Total Coastal Shoreline Miles in the Nation:	20,121 miles*

VOL 12

2700

R0035530

Priority Organics (3)				Unknown Toxicity (4)				Nutrients (5)			
Major	Mod./ Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	17	—	—	17
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	11	—	11	—	40	—	40	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
57	3	—	60	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	4	1	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
57	15	—	[illegible]	4	41	—	[illegible]	17	—	—	17
24%	6%	—	[illegible]	2%	17%	—	19%	7%	—	—	7%
2%	—	—	2%	—	1%	—	1%	1%	—	—	1%
—	—	—	—	—	—	—	—	—	—	—	—

(continued)

VOL 12

2701

R0035531

State	Chlorine (6)				Oil and Grease (7)				Thermal Modification			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
California	—	—	—	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—	—	—
Delaware	—	—	—	—	—	—	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	—
Florida	—	—	—	—	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New York	—	—	—	—	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	3	2	—	5	—	3	—	3	1	2	—	3
Rhode Island	—	—	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—	—	—
Total Shoreline Miles Impaired	3	2	—	5	—	3	—	3	1	2	—	3
% of Impaired Shoreline Miles Affected by Each Cause	1%	1%	—	2%	—	1%	—	1%	—	1%	—	1%
% of Assessed Shoreline Miles Affected by Each Cause	—	—	—	—	—	—	—	—	—	—	—	—
% of Total Shoreline Miles Affected by Each Cause	—	—	—	—	—	—	—	—	—	—	—	—

VOL 12

2702

R0035532

[illegible] (continued)

Other Inorganics (9)				pH (10)			
Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
1	1	–	2	–	2	–	2
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
1	1	–	[illegible]	–	2	–	2
–	–	–	1%	–	1%	–	1%
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–

VOL 12

27-03

R0035533

State	Total Impaired Waters		Urban Runoff/Storm Sewers (1)				Land Disposal (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	72	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—
Delaware	—	—	—	25	—	25	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	—
Florida	—	48	—	28	—	28	—	12	—	12
Georgia	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	107	—	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—
Mississippi	—	71	—	81	—	81	—	71	—	71
New Hampshire	—	—	—	—	—	—	—	—	—	—
New Jersey	39	—	—	—	—	—	—	—	—	—
New York	—	60	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—
Puerto Rico	—	60	1	6	—	7	15	3	—	18
Rhode Island	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—
Total Shoreline Miles Impaired	218	239	1	140	—	141	15	86	—	101
% of Impaired Shoreline Miles Affected by Each Source			—	59%	—	59%	6%	36%	—	42%
% of Assessed Shoreline Miles Affected by Each Source			—	4%	—	4%	—	3%	—	3%
% of Total Shoreline Miles Affected by Each Source			—	1%	—	1%	—	—	—	1%

*Does not include the Alaska coastline.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Coastal Shoreline Miles in States Reporting Sources:	239 miles
Total Assessed Coastal Shoreline Miles:	3,366 miles
Estimate of Total Coastal Shoreline Miles in the Nation:	20,121 miles*

VOL 12

2704

R0035534

Industrial Point Sources (9)				Resource Extraction (10)			
Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
56,698	—	—	[illegible]	—	—	—	—
—	—	—	[illegible]	—	—	—	—
—	—	—	—	—	—	—	—
170	—	—	170	2,832	—	—	2,832
—	—	—	—	—	—	—	—
—	—	—	—	69,200	32,816	—	102,016
262	—	—	262	—	—	—	—
—	—	—	—	—	—	—	—
—	35	—	35	—	—	—	—
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	—	—	—
—	62,720	—	62,720	—	31,872	—	31,872
650	1,223	—	1,873	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	811	—	811	3	811	—	814
2,631	14,500	—	17,131	155	41,777	—	41,932
—	—	—	—	30	—	—	30
—	—	—	—	—	—	—	—
—	—	—	—	190	50	—	240
—	—	—	—	4,871	—	—	4,871
44,976	13,088	—	60,064	44,800	42,643	—	87,443
—	4,288	—	4,288	—	—	—	—
—	—	—	—	—	952	—	952
—	—	—	—	—	—	—	—
4,877	—	—	4,877	—	—	—	—
—	—	—	—	—	—	—	—
—	200	—	200	1,200	—	—	1,200
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
3,961	—	—	3,961	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
43,400	3,300	—	46,700	500	—	—	500
340	—	—	340	—	—	—	—
—	—	—	—	—	—	—	—
—	16,356	—	16,356	212	4,556	—	4,768
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	49,679	—	49,679
895	—	—	895	—	—	—	—
—	—	—	—	—	—	—	—
112	122	—	234				
—	—	—	—	—	—	—	—
800	—	—	800	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
96,900	21	—	96,921	2,815	—	—	2,815
—	—	—	—	—	—	—	—
—	448	—	448	—	—	—	—
NA	NA	NA	NA	NA	NA	NA	NA
—	—	—	—	—	—	—	—
12,000	—	—	12,000	3,911	8,040	—	11,951
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
270,672	117,112	—	387,784	130,719	213,196	—	343,915
5%	2%	—	7%	2%	4%	—	6%
1%	1%	—	2%	1%	1%	—	2%
1%	<1%	—	1%	<1%	1%	—	1%

VOL 12

2705

R0035535

Appendix C

Individual State Data
Estuaries and Coastal Waters

VOL 12

27006

R0035536

State	Fully Supporting				Threatened				[illegible]			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Alabama	12	253	—	[illegible]	—	—	—	—	—	75	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	—	—	[illegible]
California	—	—	—	—	—	—	4	4	—	—	85	[illegible]
Connecticut	—	—	361	361	—	—	—	—	—	—	235	[illegible]
Delaware	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Delaware River Basin	—	—	—	—	—	216	—	216	—	—	—	[illegible]
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Florida	730	953	—	1,683	—	25	—	25	97	773	—	[illegible]
Georgia	443	10	—	453	—	—	—	—	—	—	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	718	32	—	750	88	13	—	101	—	3	—	[illegible]
Louisiana	851	594	—	1,445	2,614	—	—	2,614	864	—	—	[illegible]
Maine	1,423	50	—	1,473	—	—	—	—	—	36	—	[illegible]
Maryland	—	—	—	—	87	6	—	93	197	2,153	—	[illegible]
Massachusetts	65	2	—	67	—	1	—	1	5	17	—	[illegible]
Mississippi	—	1	—	1	—	13	—	13	—	5	—	[illegible]
New Hampshire	—	10	—	10	—	—	—	—	—	—	—	[illegible]
New Jersey	—	—	440	440	—	—	—	—	—	—	121	[illegible]
New York	—	1,106	—	1,106	—	1	—	1	—	166	—	[illegible]
North Carolina	—	—	2,721	2,721	—	—	131	131	—	—	269	[illegible]
Oregon	—	—	4	4	—	—	—	—	—	—	38	[illegible]
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Rhode Island	—	—	141	141	—	—	14	14	—	—	21	[illegible]
South Carolina	—	—	310	310	—	—	—	—	—	—	101	[illegible]
Texas	—	—	1,318	1,318	—	—	—	—	—	—	150	[illegible]
Virginia	267	2,130	—	2,397	—	—	—	—	48	567	—	[illegible]
Virgin Islands	—	—	3	3	—	—	—	—	—	—	1	[illegible]
Washington	17	243	—	[illegible]	—	140	—	140	1	104	—	[illegible]
Totals	4,526	5,384	5,298	[illegible]	2,789	415	149	[illegible]	1,212	3,899	1,021	[illegible]
% of Assessed Waters	30%	35%	35%	[illegible]	83%	12%	4%	12%	20%	64%	17%	23%

[a] Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2707

R0035537

Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	3	—	3	—	—	—	—	12	331	—	343
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	89	89
—	—	4	4	—	—	—	—	—	—	600	600
—	29	—	29	—	—	—	—	—	29	—	29
—	—	—	—	—	—	—	—	—	216	—	216
—	6	—	6	—	—	—	—	—	6	—	6
5	147	—	152	—	—	—	—	832	1,898	—	2,730
237	164	—	401	—	—	—	—	680	174	—	854
—	—	—	—	—	—	—	—	—	—	—	—
—	20	—	20	—	—	—	—	806	68	—	874
20	—	—	20	—	—	—	—	4,349	594	—	4,943
7	118	—	125	—	—	—	—	1,430	204	—	1,634
8	71	—	79	—	—	—	—	292	2,230	—	2,522
42	92	—	134	—	—	—	—	112	112	—	224
—	—	—	—	—	—	—	—	—	19	—	19
5	14	—	19	—	—	—	—	5	24	—	29
—	—	53	53	—	—	—	—	—	—	614	614
—	258	—	258	—	—	—	—	—	1,531	—	1,531
—	—	—	—	—	—	—	—	—	—	3,121	3,121
—	—	19	19	—	—	—	—	—	—	61	61
—	—	—	—	—	—	—	—	—	—	—	—
—	—	17	17	—	—	—	—	—	—	193	193
—	—	15	15	—	—	—	—	—	—	426	426
—	—	453	453	—	—	71	71	—	—	1,992	1,992
7	60	—	67	—	—	—	—	322	2,757	—	3,079
—	—	1	1	—	—	—	—	—	—	5	5
3	585	—	588	—	—	—	—	21	1,072	—	1,093
334 14%	1,567 64%	562 23%	2,463 9%	—	—	71 100%	71 <1%	8,861 33%	11,265 41%	7,101 26%	27,227 74%

VOL 12

2708

R0035538

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	4	85	—	—	89
Connecticut	375	—	223	2	—	600
Delaware	—	—	17	12	—	29
Delaware River Basin	132	59	25	—	—	216
District of Columbia	—	—	1	4	—	5
Florida	1,683	25	870	152	—	2,730
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	4,673	—	269	—	—	4,942
Maine	1,475	—	36	122	—	1,633
Maryland	—	93	2,350	79	—	2,522
Massachusetts	114	1	31	51	—	197
Mississippi	1	13	5	—	—	19
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,513	—	16	1	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	178	8	—	7	—	193
South Carolina	341	—	97	11	—	449
Texas	1,991	—	—	—	—	1,991
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	490	—	13	32	—	535
Totals	16,043	334	4,307	476	—	21,160
Percent of Assessed Waters	76%	2%	20%	2%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035539

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	7	2	80	—	—	89
Connecticut	600	—	—	—	—	600
Delaware	29	—	—	—	—	29
Delaware River Basin	191	—	—	25	—	216
District of Columbia	—	—	6	—	—	6
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	2,502	—	—	21	—	2,523
Massachusetts	9	—	—	46	—	55
Mississippi	—	—	—	—	—	—
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,415	—	115	—	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	1,947	—	—	44	—	1,991
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	23	—	—	—	23
Totals	9,777	156	470	139	—	10,542
Percent of Assessed Waters	93%	1%	4%	1%	—	

— None or not reported

Source: 1992 State Section 305(b) reports.

VOL 12

2710

R0035540

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	196	—	75	3	—	274
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	7	2	3	—	—	12
Connecticut	483	—	—	117	—	600
Delaware	—	—	10	—	—	10
Delaware River Basin	—	—	—	42	—	42
District of Columbia	—	—	—	—	—	—
Florida	878	25	472	74	—	1,449
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	281	—	3	139	11	434
Maryland	1,646	6	97	90	—	1,839
Massachusetts	77	—	14	132	—	223
Mississippi	—	—	5	4	—	9
New Hampshire	10	—	—	19	—	29
New Jersey	440	—	121	53	—	614
New York	1,344	1	4	182	—	1,531
North Carolina	—	—	59	—	—	59
Oregon	4	—	38	19	—	61
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	1,308	—	139	453	71	1,971
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	208	139	88	620	—	1,055
Totals	6,882	173	1,128	1,947	82	10,212
Percent of Assessed Waters	67%	2%	11%	19%	1%	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035541

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	327	—	—	—	—	327
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	9	1	3	—	—	13
Connecticut	538	1	59	3	—	601
Delaware	9	—	17	3	—	29
Delaware River Basin	205	—	—	—	—	205
District of Columbia	—	—	—	5	—	5
Florida	1,683	25	870	152	—	2,730
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	3,299	—	1,063	580	—	4,942
Maine	1,631	—	—	3	—	1,634
Maryland	2,520	—	—	2	—	2,522
Massachusetts	99	8	59	48	—	214
Mississippi	—	—	—	—	—	—
New Hampshire	28	—	—	—	—	28
New Jersey	—	—	—	—	—	—
New York	1,456	—	1	73	—	1,530
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	353	—	35	12	—	400
Texas	1,977	—	10	—	—	1,987
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	482	—	15	34	—	531
Totals	14,616	35	2,132	915	—	17,698
Percent of Assessed Waters	83%	<1%	12%	5%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035542

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	328	—	—	3	—	331
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	89	—	—	—	—	89
Connecticut	538	1	59	3	—	601
Delaware	29	—	—	—	—	29
Delaware River Basin	11	—	—	—	—	11
District of Columbia	—	—	5	1	—	6
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	3,689	—	1,233	20	—	4,942
Maine	—	—	—	—	—	—
Maryland	—	—	—	—	—	—
Massachusetts	192	—	11	2	—	205
Mississippi	6	5	7	—	—	18
New Hampshire	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—
New York	1,519	—	11	—	—	1,530
North Carolina	2,721	131	269	—	—	3,121
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	420	—	15	—	—	435
Texas	4	—	—	—	—	4
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	487	—	32	13	—	532
Totals	10,033	137	1,642	42	—	11,854
Percent of Assessed Waters	85%	1%	14%	<1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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R0035543

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R0035544

State	Total Impaired Waters		Nutrients (1)				Pathogen Indicators (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total
Alabama	—	78	—	—	—	—	78	—	—	78
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	—	85	2	1	—	3	2	—	—	2
Connecticut	—	239	236	15	—	251	13	125	—	116
Delaware	—	29	26	3	—	29	14	15	—	29
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	6	—	1	—	1	1	5	—	6
Florida	—	1,022	95	300	—	395	—	44	—	44
Georgia	—	401	—	—	—	—	85	4	—	89
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	23	—	—	—	—	—	—	—	—	—
Louisiana	—	884	55	808	—	863	—	622	—	622
Maine	—	161	—	—	—	—	38	—	—	38
Maryland	—	2,429	404	2,102	—	2,506	59	638	—	697
Massachusetts	—	156	—	21	—	21	96	51	—	147
Mississippi	—	5	—	14	—	14	—	18	—	18
New Hampshire	—	19	—	—	—	—	19	—	—	19
New Jersey	—	174	70	—	—	70	142	—	—	142
New York	—	424	1	108	—	109	266	35	—	301
North Carolina	—	269	—	—	113	113	—	—	59	59
Oregon	—	57	—	—	—	—	—	—	56	56
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	38	—	14	—	14	28	4	—	32
South Carolina	—	116	—	—	—	—	28	9	—	37
Texas	—	603	—	—	—	—	174	362	—	536
Virginia	—	682	236	127	—	363	—	163	—	163
Virgin Islands	—	2	—	—	—	—	—	—	—	—
Washington	—	693	—	—	—	—	45	301	—	345
Total Estuarine Area Impaired	23	8,572	1,125	3,514	113	4,7[illegible]	1,088	2,396	115	3,5[illegible]
% of Impaired Estuarine Area[b] Affected by Each Cause			13%	41%	1%	55%	13%	28%	1%	42%
% of Assessed Estuarine Area Affected by Each Cause			4%	13%	—	17%	4%	9%	—	13%
% of Total Estuarine Area Affected by Each Cause			3%	10%	—	13%	3%	6%	—	10%

[a] Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).
[b] Includes only impaired estuarine waters in States reporting causes of estuarine impairments.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Estuarine Miles in States Reporting Causes:	8,572 square miles
Total Assessed Estuarine Miles	27,227 square miles
Estimate of Total Estuarine Miles in the Nation:	36,890 square miles

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(continued)

Organic Enrich./ Low Dissolved Oxygen (3)				Siltation (4)				Suspended Solids (5)			
Major	Mod/ Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	4	—	5	—	—	—	—
7	19	—	26	—	—	—	—	—	—	—	—
13	3	—	16	—	—	—	—	—	12	—	12
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	—	—	1	1	—	—	1
—	29	—	29	—	—	—	—	111	323	—	434
3	102	—	105	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	746	—	746	—	187	—	187	—	187	—	187
1	—	—	1	—	—	—	—	—	—	—	—
293	616	—	909	14	670	—	684	—	—	—	—
—	48	—	48	—	—	—	—	—	—	—	—
—	2	—	2	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	140	—	—	140	—	—	—	—
10	114	—	124	1	26	—	27	15	30	—	45
—	—	32	32	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	7	—	7	—	—	—	—	—	—	—	—
86	—	—	86	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
133	63	—	196	—	—	—	—	229	2	—	231
—	—	—	—	—	—	—	—	—	—	—	—
68	514	—	582	—	—	—	—	—	—	—	—
616	2,263	32	[illegible]	157	887	—	[illegible]	356	554	—	910
7%	26%	<1	34%	2%	10%	—	12%	4%	6%	—	11%
2%	8%	—	11%	1%	3%	—	4%	1%	2%	—	3%
2%	6%	—	8%	—	2%	—	3%	1%	2%	—	2%

(continued)

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Table C-6 (Continued)

State	Oil and Grease (O)				Pesticides (P)				Salinity (TDS, Chlorides)			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
California	—	—	—	—	76	1	—	77	—	—	—	—
Connecticut	1	—	—	1	—	—	—	—	—	—	—	—
Delaware	—	—	—	—	—	—	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	1	—	1	—	1	—	1	—	—	—	—
Florida	—	—	—	—	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	1	—	1	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Louisiana	262	560	—	822	—	187	—	187	20	560	—	580
Maine	—	—	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	27	—	—	27	—	—	—	—
Massachusetts	—	2	—	2	—	—	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	70	—	—	70	—	—	—	—
New York	—	22	—	22	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	21	—	21	158	94	—	252	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	5	—	5	—	—	—	—	—	—	—	—
Total Estuarine Area Impaired	263	611	—	874	331	284	—	615	20	560	—	[illegible]
% of Impaired Estuarine Area[b] Affected by Each Cause	3%	7%	—	10%	4%	3%	—	7%	—	7%	—	[illegible]
% of Assessed Estuarine Area Affected by Each Cause	1%	2%	—	3%	1%	1%	—	2%	—	2%	—	[illegible]
% of Total Estuarine Area Affected by Each Cause	1%	2%	—	2%	1%	1%	—	2%	—	2%	—	[illegible]

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Priority Organics (%)				Metals (%)			
Major	Mod. Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1	—	—	1	77	1	—	78
1	20	—	21	—	—	—	—
—	—	—	—	—	1	—	1
—	—	—	—	—	—	—	—
—	1	—	1	—	4	—	4
—	—	—	—	—	—	—	—
—	18	—	18	16	68	—	84
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	20	—	20	—	—	—	—
3	—	—	3	—	—	—	—
—	—	—	—	—	—	—	—
1	7	—	8	—	30	—	30
1	—	—	1	9	—	—	9
—	—	—	—	—	—	—	—
70	—	—	70	—	—	—	—
120	6	—	126	—	32	—	32
—	—	65	65	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	7	—	7	—	7	—	7
—	—	—	—	—	—	—	—
—	24	—	24	1	—	—	1
—	6	—	6	1	44	—	45
—	—	—	—	—	—	—	—
—	31	—	31	—	14	—	14
197	140	65	402	104	201	—	305
2%	2%	1%	4%	1%	2%	—	4%
1%	1%	—	2%	—	1%	—	1%
1%	—	—	1%	—	1%	—	1%

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State	Total Impaired Waters		Municipal Point Sources (1)				Urban Runoff: Storm Sewers (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod./ Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	78	3	—	—	3	—	75	—	75
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	—	85	75	—	—	75	78	3	—	81
Connecticut	—	239	263	182	—	445	—	340	—	340
Delaware	—	29	—	25	—	25	—	29	—	29
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	6	—	—	—	—	1	2	—	3
Florida	—	1,022	—	744	—	744	3	944	—	947
Georgia	—	401	4	107	—	111	5	—	—	3
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	23	—	—	—	—	—	—	—	—	—
Louisiana	—	884	—	809	—	809	—	621	—	621
Maine	—	161	117	6	—	123	—	—	—	—
Maryland	—	2,429	389	341	—	730	188	238	—	426
Massachusetts	—	156	10	81	—	91	10	105	—	115
Mississippi	—	5	—	9	—	9	—	18	—	18
New Hampshire	—	19	5	—	—	5	—	—	—	—
New Jersey	—	174	140	—	—	140	280	—	—	280
New York	—	424	57	210	—	267	124	69	—	193
North Carolina	269	—	—	—	—	—	—	—	—	—
Oregon	—	57	—	—	53	53	—	—	17	17
Puerto Rico[a]	—	—	—	—	—	—	—	—	—	—
Rhode Island	—	38	—	30	—	30	7	26	—	33
South Carolina	—	116	—	12	—	12	29	—	—	29
Texas	—	603	134	92	—	226	—	—	—	—
Virginia	—	682	236	110	—	346	4	267	—	271
Virgin Islands	—	2	—	—	—	—	—	—	—	—
Washington	—	693	—	139	—	139	—	104	—	104
Total Estuarine Area Impaired	292	8,303	1,433	2,897	53	4,[illegible]	729	2,841	17	3,[illegible]
% of Impaired Estuarine Area[b] Affected by Each Source			17%	35%	1%	53%	9%	34%	—	43%
% of Assessed Estuarine Area Affected by Each Source			5%	11%	—	16%	3%	10%	—	13%
% of Total Estuarine Area Affected by Each Source			4%	8%	—	12%	2%	8%	—	10%

[a]Puerto Rico reported linear miles of estuarine impairments rather than square miles (see Chapter 8, Individual State Summaries, for more information).
[b]Includes only impaired estuarine waters in States reporting sources of estuarine impairments.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Estuarine Miles in States Reporting Sources:	8,303 sq. mi.
Total Assessed Estuarine Miles:	27,227 sq. mi.
Estimate of Total Estuarine Miles in the Nation:	36,890 sq. mi.

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Agriculture (general) (3)				Industrial Point Sources (4)				Natural (5)			
Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	3	—	—	3	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
79	1	—	80	—	1	—	1	—	—	—	—
—	247	—	247	—	49	—	49	—	231	—	231
13	16	—	29	—	1	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	4	—	4
—	552	—	552	15	280	—	295	—	—	—	—
—	—	—	—	34	130	—	164	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
374	—	—	374	20	747	—	767	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
643	1,046	—	1,689	86	9	—	95	253	212	—	465
—	2	—	2	—	—	—	—	—	11	—	11
—	—	—	—	1	13	—	14	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
70	—	—	70	—	—	—	—	—	—	—	—
—	5	—	5	—	19	—	19	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	53	53	—	—	42	42	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	—	16	—	16	—	—	—	—
—	—	—	—	14	11	—	25	—	—	—	—
—	—	—	—	1	24	—	25	—	—	—	—
236	19	—	255	1	283	—	284	—	183	—	183
—	—	—	—	—	—	—	—	—	—	—	—
4	178	—	182	—	102	—	102	61	264	—	325
1,419	2,067	53	[illegible]	175	1,685	42	[illegible]	314	905	—	1,219
17%	25%	1%	[illegible]	2%	20%	1%	[illegible]	4%	11%	—	15%
5%	8%	—	13%	1%	6%	—	7%	1%	3%	—	4%
4%	6%	—	10%	—	5%	—	5%	1%	2%	—	3%

(continued)

VOL 12

27120

R0035550

State	Resource Extraction (6)				Construction (7)				[illegible]			
	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	—	—	—	—	—	—	—	—	[illegible]
California	75	—	—	75	—	2	—	2	—	—	—	[illegible]
Connecticut	—	—	—	—	—	—	—	—	1	49	—	[illegible]
Delaware	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	[illegible]
District of Columbia	1	—	—	1	—	—	—	—	—	—	—	[illegible]
Florida	—	90	—	90	—	482	—	482	—	—	—	[illegible]
Georgia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Louisiana	207	615	—	822	—	—	—	—	—	—	—	[illegible]
Maine	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Maryland	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Massachusetts	—	—	—	—	—	—	—	—	—	34	—	[illegible]
Mississippi	—	6	—	6	—	—	—	—	—	—	—	[illegible]
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	[illegible]
New Jersey	—	—	—	—	140	—	—	140	—	—	—	[illegible]
New York	—	—	—	—	—	—	—	—	120	36	—	[illegible]
North Carolina	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Oregon	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Puerto Rico[8]	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Rhode Island	—	—	—	—	—	—	—	—	—	7	—	[illegible]
South Carolina	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Texas	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Virginia	—	—	—	—	—	13	—	13	158	94	—	[illegible]
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Washington	—	4	—	4	—	27	—	27	—	35	—	[illegible]
Total Estuarine Area Impaired	283	715	—	998	140	524	—	[illegible]	279	255	—	[illegible]
% of Impaired Estuarine Area[9] Affected by Each Source	3%	9%	—	12%	2%	6%	—	8%	3%	3%	—	[illegible]
% of Assessed Estuarine Area Affected by Each Source	1%	3%	—	4%	1%	2%	—	2%	1%	1%	—	[illegible]
% of Total Estuarine Area Affected by Each Source	1%	2%	—	3%	—	1%	—	2%	1%	1%	—	[illegible]

VOL 12

2721

R0035551

[illegible]				Hydrologic/Habitat Modification (110)			
Major	Mod/Min	Not Specified	Total	Major	Mod/Min	Not Specified	Total
—	—	—	—	—	71	—	71
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	75	4	—	79
—	210	—	210	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	1
—	—	—	—	—	202	—	202
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	2	—	2
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
228	8	—	236	—	20	—	20
—	—	—	—	—	—	—	—
—	—	—	—	—	82	—	82
228	238	—	466	75	382	—	457
3%	3%	—	6%	1%	5%	—	6%
1%	1%	—	2%	—	1%	—	2%
1%	1%	—	1%	—	1%	—	1%

VOL 12

2 7 2 2 2

R0035552

State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	[illegible]	Evaluated	Monitored	Not Specified	[illegible]	Evaluated	Monitored	Not Specified	[illegible]
Alabama	50	—	—	[illegible]	—	—	—	[illegible]	—	—	—	[illegible]
Alaska	—	—	—	—	—	—	—	—	—	—	—	[illegible]
American Samoa	—	—	—	[illegible]	—	—	—	—	—	—	—	[illegible]
California	—	—	628	628	—	—	—	—	—	—	—	[illegible]
Connecticut	—	—	—	[illegible]	—	—	—	—	—	—	62	[illegible]
Delaware	25	—	—	[illegible]	—	—	—	—	—	—	—	[illegible]
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	[illegible]
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Florida	609	245	—	854	—	—	—	—	—	—	—	[illegible]
Georgia	—	—	—	—	—	—	—	—	19	17	—	[illegible]
Guam	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Hawaii	476	150	—	626	18	23	—	41	—	—	—	[illegible]
Louisiana	—	—	—	—	—	—	—	—	—	27	—	27
Maine	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Maryland	—	32	—	32	—	<1	—	<1	—	—	—	[illegible]
Massachusetts	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Mississippi	—	—	—	—	—	10	—	10	—	—	—	[illegible]
New Hampshire	—	18	—	18	—	—	—	—	—	71	—	71
New Jersey	—	—	107	107	—	—	—	—	—	—	—	[illegible]
New York	—	60	—	60	—	—	—	—	—	—	—	[illegible]
North Carolina	—	—	—	—	—	—	—	—	—	57	—	57
Oregon	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Puerto Rico	135	56	—	191	112	67	—	179	—	—	—	[illegible]
Rhode Island	—	—	—	—	—	—	—	—	10	27	—	[illegible]
South Carolina	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Texas	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Virginia	120	—	—	120	—	—	—	—	—	—	—	[illegible]
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Washington	—	—	—	—	—	—	—	—	—	—	—	[illegible]
Totals	1,415	561	735	[illegible]	130	100	—	[illegible]	29	199	62	[illegible]
% of Assessed Waters	52%	21%	27%	[illegible]	57%	43%	—	[illegible]	10%	69%	21%	[illegible]

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

27223

R0035553

Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	—	—	—	—	—	—	—	50	—	—	50
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	10	10	—	—	—	—	—	—	700	700
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	25	—	—	25
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	12	—	—	—	—	640	262	—	902
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	80	—	80	—	—	—	—	494	280	—	774
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	32	—	32
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	81	—	81
—	—	—	—	—	—	—	—	—	18	—	18
—	—	39	39	—	—	—	—	—	—	146	146
—	3	—	3	—	—	—	—	—	120	—	120
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	23	—	23	—	—	—	—	257	173	—	430
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	120	—	—	120
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
12	106	49	167	—	—	—	—	1,586	966	846	3,398
7%	63%	29%	5%	—	—	—	—	47%	28%	25%	17%

VOL 12

2724

R0035554

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	846	—	35	12	—	893
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	10	—	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	128	—	—	—	—	128
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	346	55	18	9	—	428
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	2,199	55	124	21	—	2,399
Percent of Assessed Waters	92%	2%	5%	1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2725

R0035555

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—
New Hampshire	18	—	—	—	—	18
New Jersey	70	—	50	—	—	120
New York	60	—	60	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	879	—	110	—	—	989
Percent of Assessed Waters	89%	—	11%	—	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2726

R0035556

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	70	—	—	—	—	70
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	<1	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	—	60	—	—	60
New Hampshire	18	—	—	—	—	18
New Jersey	107	—	—	39	—	146
New York	117	—	—	3	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	1,018	<1	60	42	—	1,120
Percent of Assessed Waters	91%	—	5%	4%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

2727

R0035557

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	32	—	—	—	—	32
Massachusetts	—	—	—	—	—	—
Mississippi	—	10	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	128	—	—	—	—	128
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	286	97	25	20	—	428
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	624	—	—	—	—	624
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	1,283	107	96	20	—	1,506
Percent of Assessed Waters	85%	7%	6%	1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

27128

R0035558

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Alabama	50	—	—	—	—	50
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
California	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—
Delaware	25	—	—	—	—	25
Delaware River Basin	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—
Florida	—	—	—	—	—	—
Georgia	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	—	—	—	—	—	—
Maryland	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—
Mississippi	10	—	71	—	—	81
New Hampshire	18	—	—	—	—	18
New Jersey	—	—	—	—	—	—
New York	120	—	—	—	—	120
North Carolina	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Puerto Rico	372	45	—	11	—	428
Rhode Island	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—
Texas	—	—	—	—	—	—
Virginia	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—
Washington	—	—	—	—	—	—
Totals	595	45	71	11	—	722
Percent of Assessed Waters	82%	6%	10%	2%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

VOL 12

27129

R0035559

VOL 12

2730

R0035560

State	Total Impaired Waters		Pathogen Indicators (1)				Metals (2)			
	States not Reporting Causes	States Reporting Causes	Major	Mod Min	not Specified	Total	Major	Mod/ Min	Not Specified	
Alabama	—	—	—	—	—	—	—	—	—	
Alaska	—	—	—	—	—	—	—	—	—	
American Samoa	—	—	—	—	—	—	—	—	—	
California	72	—	—	—	—	—	—	—	—	
Connecticut	—	—	—	—	—	—	—	—	—	
Delaware	—	—	—	25	—	25	—	—	—	
Delaware River Basin	—	—	—	—	—	—	—	—	—	
District of Columbia	—	—	—	—	—	—	—	—	—	
Florida	—	48	—	—	—	—	—	—	—	
Georgia	—	—	—	—	—	—	—	—	—	
Guam	—	—	—	—	—	—	—	—	—	
Hawaii	107	—	—	—	—	—	—	—	—	
Louisiana	—	—	—	—	—	—	—	—	—	
Maine	—	—	—	—	—	—	—	—	—	
Maryland	—	—	—	—	—	—	—	—	—	
Massachusetts	—	—	—	—	—	—	—	—	—	
Mississippi	—	71	41	40	—	81	30	51	—	81
New Hampshire	—	—	—	—	—	—	—	—	—	
New Jersey	39	—	—	—	—	—	—	—	—	
New York	—	60	3	—	—	3	—	—	—	
North Carolina	—	—	—	—	—	—	—	—	—	
Oregon	—	—	—	—	—	—	—	—	—	
Puerto Rico	—	60	25	21	—	46	4	3	—	
Rhode Island	—	—	—	—	—	—	—	—	—	
South Carolina	—	—	—	—	—	—	—	—	—	
Texas	—	—	—	—	—	—	—	—	—	
Virginia	—	—	—	—	—	—	—	—	—	
Virgin Islands	—	—	—	—	—	—	—	—	—	
Washington	—	—	—	—	—	—	—	—	—	
Total Shoreline Miles Impaired	218	239	69	86	—	[illegible]	34	54	—	
% of Impaired Shoreline Miles Affected by Each Cause			29%	36%	—	65%	14%	23%	—	
% of Assessed Shoreline Miles Affected by Each Cause			2%	3%	—	5%	1%	2%	—	
% of Total Shoreline Miles Affected by Each Cause			—	—	—	1%	—	—	—	

*Does not include the Alaska coastline.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Coastal Shoreline Miles in States Reporting Causes:	239 miles
Total Assessed Coastal Shoreline Miles:	3,366 miles
Estimate of Total Coastal Shoreline Miles in the Nation:	20,121 miles*

VOL 12

2731

R0035561

Priority Organics (3)				Unknown Toxicity (4)				Nutrients (5)			
Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total
—	—	—		—	—	—		—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	17	—	—	17
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
57	15	—	[illegible]	4	41	—	[illegible]	17	—	—	17
24%	6%	—	[illegible]	2%	17%	—	[illegible]	7%	—	—	7%
2%	—	—	2%	—	1%	—	1%	1%	—	—	1%
—	—	—	—	—	—	—	—	—	—	—	—

(continued)

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State	Chlorine (6)				Oil and Grease (7)				Thermal Modification			
	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total	Major	Mod. Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—	—	—
California	—	—	—	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—	—	—
Delaware	—	—	—	—	—	—	—	—	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	—	—	—
Florida	—	—	—	—	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—	—	—	—	—
New York	—	—	—	—	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—	—	—
Puerto Rico	3	2	—	5	—	3	—	3	1	2	—	3
Rhode Island	—	—	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—	—	—
Total Shoreline Miles Impaired	3	2	—	5	—	3	—	3	1	2	—	3
% of Impaired Shoreline Miles Affected by Each Cause	1%	1%	—	2%	—	1%	—	1%	—	1%	—	1%
% of Assessed Shoreline Miles Affected by Each Cause	—	—	—	—	—	—	—	—	—	—	—	—
% of Total Shoreline Miles Affected by Each Cause	—	—	—	—	—	—	—	—	—	—	—	—

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Other Inorganics (9)				pH (10)			
Major	Mod Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
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1	1	–	2	–	2	–	2
–	–	–	1%	–	1%	–	1%
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State	Total Impaired Waters		Urban Runoff/Storm Sewers (1)				Land Disposal (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod/Min	Not Specified	Total	Major	Mod/Min	Not Specified	Total
Alabama	—	—	—	—	—	—	—	—	—	—
Alaska	—	—	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—	—
California	72	—	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	—	—	—	—	—	—
Delaware	—	—	—	25	—	25	—	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—	—	—	—
Florida	—	48	—	28	—	28	—	12	—	12
Georgia	—	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—	—
Hawaii	107	—	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	—	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—	—
Maryland	—	—	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—	—
Mississippi	—	71	—	81	—	81	—	71	—	71
New Hampshire	—	—	—	—	—	—	—	—	—	—
New Jersey	39	—	—	—	—	—	—	—	—	—
New York	—	60	—	—	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—	—	—
Puerto Rico	—	60	1	6	—	7	15	3	—	18
Rhode Island	—	—	—	—	—	—	—	—	—	—
South Carolina	—	—	—	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—	—
Total Shoreline Miles Impaired	218	239	1	140	—	141	15	86	—	[illegible]
% of Impaired Shoreline Miles Affected by Each Source			—	59%	—	59%	6%	36%	—	42%
% of Assessed Shoreline Miles Affected by Each Source			—	4%	—	4%	—	3%	—	3%
% of Total Shoreline Miles Affected by Each Source			—	1%	—	1%	—	—	—	1%

*Does not include the Alaska coastline.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Coastal Shoreline Miles in States Reporting Sources:	239 miles
Total Assessed Coastal Shoreline Miles:	3,366 miles
Estimate of Total Coastal Shoreline Miles in the Nation:	20,121 miles*

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Unspecified Organics	Siltation/ Sediment	Metals	Priority Organics
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11	10	9	4

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State	Natural	Agriculture	Industrial Discharges	Municipal Discharges	Other Spills	Pesticide Application	Hydro-modification	Low Flows	Drinking Supply Discharges
Alabama	—	2	—	4	1	—	—	—	—
Alaska	—	—	3	1	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	1	—	—	—
Arkansas	—	2	4	—	2	—	—	—	—
California	—	—	—	—	—	—	—	—	—
Colorado	—	—	1	—	—	—	—	—	—
Connecticut	8	1	5	—	1	2	—	4	—
Delaware	3	—	—	—	—	1	—	—	—
Delaware River Basin	—	—	—	—	—	—	—	—	—
District of Columbia	—	—	—	1	—	—	—	—	—
Florida	—	3	—	1	—	1	—	1	—
Georgia	—	8	10	9	2	2	2	—	1
Gila River Indian Community	—	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—	—
Idaho	—	2	—	—	2	1	1	1	—
Illinois	—	3	3	2	—	—	—	—	—
Indiana	—	—	—	—	—	—	—	—	—
Iowa	11	14	5	2	—	—	—	—	—
Kansas	16	20	3	2	—	—	—	—	—
Kentucky	2	6	—	10	3	1	—	1	—
Louisiana	42	25	16	3	—	—	—	—	—
Maine	—	—	—	—	—	—	—	—	—
Maryland	54	5	1	3	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—	—
Michigan	—	4	2	—	—	—	1	—	1
Minnesota	—	—	—	—	—	—	—	—	—
Mississippi	11	3	2	3	—	—	—	3	—
Missouri	—	—	—	—	—	—	—	—	—
Montana	—	1	—	—	—	—	—	—	—
Nebraska	23	10	—	—	1	—	4	—	—
Nevada	—	—	—	—	—	—	—	3	—
New Hampshire	—	—	—	—	—	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—	—
New Mexico	1	—	1	—	1	—	—	2	1
New York	—	4	2	4	3	3	—	—	1
North Carolina	—	—	—	—	—	—	—	—	—
North Dakota	—	—	—	—	—	—	—	—	—
Ohio	—	19	4	6	—	—	—	—	—
Ohio River Valley	—	—	—	—	—	—	—	—	—
Oklahoma	—	6	1	5	11	1	—	—	—
Oregon	—	—	3	1	3	—	5	—	—
Pennsylvania	—	6	—	2	3	—	—	—	3
Puerto Rico	—	1	—	1	—	2	—	—	—
Rhode Island	—	—	—	—	—	1	—	—	—
South Carolina	—	1	—	1	—	12	—	—	—
South Dakota	7	—	—	—	—	—	—	—	1
Tennessee	5	4	14	2	8	1	—	—	1
Texas	—	1	7	2	3	2	—	—	—
Utah	1	1	—	1	1	1	—	2	—
Vermont	—	1	—	—	—	—	1	—	—
Virginia	—	2	10	3	—	—	—	—	—
Virgin Islands	—	—	—	—	—	—	—	—	—
Washington	—	—	—	—	—	—	—	—	—
West Virginia	—	—	—	—	—	—	—	—	—
Wisconsin	4	2	5	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—	—	—	—
Totals	188	157	102	69	45	32	14	17	9

— None or not reported.

Source: 1992 State Section 305(b) reports.

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Resource Extraction	Swimming Pools	Construction	Urban Runoff/ Storm Sewers
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9	6	5	3

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State	Number of Sites	Contaminants of Concern	Sources of Contaminants
Alabama	5	Metals, organics	
Alaska	18	Oil, metals	Oil spills, resource extraction
American Samoa	1	PCBs, metals, oil and grease	
Arizona	1	Pesticides (DDE and toxaphene)	Agricultural runoff, irrigation, landfills
Arkansas	—	DDT, DDE, DDD, chlordane, pesticides	
California	—		
Colorado	—		
Connecticut	9	PCBs, lead, mercury, PAHs, and miscellaneous toxicity	Industrial activity, shooting range, runoff, municipal activity
Delaware	5	Metals and priority organics	Runoff, industry, ground water contamination, Superfund site
Delaware River Basin	—	Cadmium, zinc, copper, nickel, DDT, dieldrin, lindane	
District of Columbia	12	PCBs, chlordane, DDT byproducts, copper, lead, zinc, phenols	Combined sewer overflows
Florida	25	Cadmium, copper, mercury, lead, zinc, chromium, arsenic	
Georgia	—		
Guam	—		
Hawaii	—		
Idaho	—		
Illinois	195	Arsenic, cadmium, chromium, copper, lead, mercury, zinc, chlordane, DDT, dieldrin, PCBs, heptachlor epoxides	Point sources and urban runoff
Indiana	13	PCBs, metals, pesticides, PAHs, cyanide, phthalates	Unknown, multiple
Iowa	1	PCBs	Industry
Kansas	—		
Kentucky	—		
Louisiana	13	Petroleum hydrocarbons, halogenated hydrocarbons, priority pollutants, dioxin, PCBs, heavy metals, creosote, halogenated aliphatic aromatics	Industrial discharges, industrial runoff, and industrial spills
Maine	8	Cadmium, copper, dioxin, toluene, TCE, PCBs, tris, dimethyl formamide, chlorinated solvents	Landfill, salvage yard, industry
Maryland	7	Metals, organics	Industry, urban runoff
Massachusetts	—		
Michigan	17	PCBs, metals	Combined sewer overflows, industrial discharges
Minnesota			
Mississippi	14	Metals, organic toxics	Industrial discharges, industrial nonpoint sources, and industrial spills
Missouri	11	*Chlordane, PCBs, lead, zinc, radioactivity	Urban runoff, agricultural runoff, USDOE plant, lead mill tailing, industry
Montana	—		
Nebraska	—		
Nevada	7	Mercury, pesticides, organics	Mercury mill, irrigation flows

(continued)

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State	Number of Sites	Contaminants of Concern	Sources of Contaminants
New Hampshire	—		
New Jersey	—		
New Mexico			
New York	28	Priority organics and heavy metals	
North Carolina	105		Industrial discharges, hazardous waste disposal, agriculture, urban stormwater runoff
North Dakota	—		
Ohio	124	Arsenic, cadmium, copper, chromium, lead, zinc	
ORSANCO	—		
Oklahoma	16	DDT, heptachlor, cadmium, lead, arsenic, copper	
Oregon	17	Priority pollutants	Unknown
Pennsylvania	—		
Puerto Rico	—		
Rhode Island	6	Metals, PCBs, petroleum, hydrocarbon	
South Carolina	3	Mercury, PCBs, dioxin	Historical, industrial impacts (no longer discharging)
South Dakota	—		Discontinued point sources
Tennessee	30	PCBs, chlordane, lead, mercury, dioxin	
Texas	—		
Utah	—		Historical industrial discharges and spills, current industrial discharges
Vermont	—		
Virginia	—		
Virgin Islands	—		
Washington	—		
West Virginia	—		
Wisconsin	79	PCBs, dioxin, PCP, PBB, arsenic, cadmium, mercury, zinc, chromium, oil and grease, pesticides, PAHs	
Wyoming			Industry, agriculture, landfills, municipal discharges, in-place contaminants, wood treatment plant
Total	770		

Source: 1992 State Section 305(b) reports.

— Not reported.

PAH = Polycyclic aromatic hydrocarbons.
PCB = Polychlorinated biphenyls.
PBB = Polybrominated biphenyls.
TCE = Trichloroethylene.
USDOE = U. S. Department of Energy.

* Missouri also reports that chlordane contaminates sediments at approximately half of their 3,200 waterbodies.

R0035570

State	Rivers and Streams		Lakes and Reservoirs		Estuaries		Oceans	
	Monitored for Toxics	Elevated Toxics	Monitored for Toxics	Elevated Toxics	Monitored for Toxics	Elevated Toxics	Monitored for Toxics	Elevated Toxics
Alabama	886	281	61,178	61,178	—	—	—	—
Alaska	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—
Arizona	2,690	2,441	61,509	32,941	—	—	—	—
Arkansas	355	84	155,344	22,666	—	—	—	—
California	5,339	3,152	329,174	228,174	91	86	—	—
Colorado	9,315	1,265	51,606	12,930	—	—	—	—
Connecticut	573	158	11,268	2,875	558	49	—	—
Delaware	231	99	620	403	14	1	25	—
Delaware River Basin	120	6	—	—	53	25	—	—
District of Columbia	38	14	238	103	6	3	—	—
Florida	1,072	678	142,720	74,880	481	235	99	99
Georgia	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—
Hawaii	18	—	—	—	100	—	10	—
Idaho	1,225	1,225	32,000	32,000	—	—	—	—
Illinois	8,181	1,929	147,800	36,222	—	—	—	—
Indiana	5,335	1,845	23,500	815	—	—	—	—
Iowa	1,669	218	5,638	320	—	—	—	—
Kansas	16,006	706	172,129	—	—	—	—	—
Kentucky	—	—	—	—	—	—	—	—
Louisiana	307	59	—	9,118	—	—	—	—
Maine	865	237	38,106	400	10	10	—	—
Maryland	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—
Michigan	6,098	746	290,633	23,090	—	—	—	—
Minnesota	3,662	1,652	2,223,029	2,175,226	—	—	—	—
Mississippi	2,330	758	60,235	6,007	18	10	81	81
Missouri	3,432	761	236,873	7,824	—	—	—	—
Montana	43,674	4,502	615,935	270,847	—	—	—	—
Nebraska	1,602	587	92,585	46,885	—	—	—	—
Nevada	1,487	134	227,427	77,550	—	—	—	—
New Hampshire	8,763	13	5,635	137	—	—	—	—
New Jersey	—	—	—	—	—	—	—	—
New Mexico	—	3,618	—	122,338	—	—	—	—
New York	3,400	538	668,000	135,000	1,530	120	120	60
North Carolina	*	*	294,107	10,020	—	—	—	—
North Dakota	5,826	764	437,671	339,307	—	—	—	—
Ohio	7,901	2,127	98,445	13,941	—	—	—	—
Ohio River Valley	954	954	—	—	—	—	—	—
Oklahoma	400,472	1,844	569,038	201,265	—	—	—	—
Oregon	—	741	19,282	19,282	21	21	—	—
Pennsylvania	7,284	2,305	—	—	—	—	—	—
Puerto Rico	1,047	1,017	3,616	1,981	1	1	171	50
Rhode Island	256	123	647	441	23	7	—	—
South Carolina	3,739	30	509,438	—	694	<1	—	—
South Dakota	3,080	163	548,000	—	—	—	—	—
Tennessee	10,834	883	501,427	75,067	—	—	—	—
Texas	3,802	309	157,236	500	919	58	—	—
Utah	4,994	780	450,078	4,909	—	—	—	—
Vermont	—	—	—	—	—	—	—	—
Virginia	10,633	935	—	—	1,384	228	—	—
Virgin Islands	—	—	—	—	3	1	—	—
Washington	2,040	1,116	58,994	2,535	1,402	94	—	—
West Virginia	2,169	1,895	16,186	8,464	—	—	—	—
Wisconsin	1,234	508	601,594	214,164	—	—	—	—
Wyoming	2,113	595	70,069	2,750	—	—	—	—
Totals	597,051	44,795	9,989,009	4,274,554	7,307	948	506	290
Percentages	17%	8%	25%	43%	20%	13%	3%*	57%

* North Carolina monitors toxics at 350 ambient monitoring sites, but the State does not relate the data to waterbodies.
* Excluding the Alaska shoreline.

— None or not reported.

Source: 1992 State Section 305(b) reports.

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Great Lakes		Total Wetlands	
Monitored for Toxics	Elevated Toxics	Monitored for Toxics	Elevated Toxics
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	106,753	79,041
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
63	63	—	—
43	43	—	—
—	—	—	—
—	—	34,256	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
3,288	3,288	—	—
272	272	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	26,169	26,169
—	—	—	—
—	—	—	—
—	—	—	—
377	492	—	—
—	—	—	—
—	—	—	—
236	236	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
840	840	—	—
—	—	—	—
5,319 99%	5,234 98%	167,178 <1%	105,210 63%

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Appendix F

Individual State Data
Great Lakes

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State	Fully Supporting				Threatened				Partially Supporting			
	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
Illinois	—	—	—	—	—	63	—	63	—	—	—	—
Indiana[a]	—	—	—	—	—	—	—	—	—	43	—	43
Michigan[b]	—	—	—	—	—	—	—	—	—	—	—	—
Minnesota	—	—	—	—	—	—	—	—	—	—	—	—
New York	—	85	—	85	—	—	—	—	—	492	—	492
Ohio	—	—	—	—	—	—	—	—	—	236	—	236
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—	—	—	630	210	—	840
Totals	—	85	—	85	—	63	—	63	630	981	—	1,611
% of Assessed Waters	0%	100%	—	2%	0%	100%	—	1%	39%	61%	—	97%

[a] Entered aquatic life support data in lieu of overall use support data.
[b] Michigan classifies all of its waters as either fully supporting or not supporting designated uses.
— None or not reported.
Source: 1997 State Section 305(b) reports.

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Not Supporting				Not Attainable				Total Assessed			
Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total	Evaluated	Monitored	Not Specified	Total
—	—	—	—	—	—	—	—	—	63	—	63
—	—	—	—	—	—	—	—	—	43	—	43
—	3,288	—	3,288	—	—	—	—	—	3,288	—	3,288
—	272	—	272	—	—	—	—	—	272	—	272
—	—	—	—	—	—	—	—	—	577	—	577
—	—	—	—	—	—	—	—	—	236	—	236
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	630	210	—	840
—	3,560	—	3,560	—	—	—	—	630	4,689	—	5,319
0%	100%	—	67%	0%	0%	—	0%	12%	88%	—	99%

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	—	63	—	—	—	63
Indiana	—	—	43	—	—	43
Michigan	—	—	—	3,288	—	3,288
Minnesota	—	—	—	23	—	23
New York	577	—	—	—	—	577
Ohio	—	—	236	—	—	236
Pennsylvania	—	—	—	—	—	—
Wisconsin	—	720	120	—	—	840
Totals	577	783	399	3,311	—	5,070
Percent of Assessed Waters	11%	15%	8%	65%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

Table F-2b: Fish Consumption Use Support in the Great Lakes (shore miles)

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	—	—	—	63	—	63
Indiana	—	—	—	43	—	43
Michigan	—	—	—	3,288	—	3,288
Minnesota	—	—	—	272	—	272
New York	85	—	492	—	—	577
Ohio	—	—	236	—	—	236
Pennsylvania	—	—	—	—	—	—
Wisconsin	—	—	840	—	—	840
Totals	85	—	1,568	3,666	—	5,319
Percent of Assessed Waters	2%	—	29%	69%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

Table F-2c: Aquatic Life Support in the Great Lakes (shore miles)

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	62	—	1	—	—	63
Indiana	43	—	43	—	—	86
Michigan	3,287	—	—	1	—	3,288
Minnesota	23	—	—	—	—	23
New York	483	—	94	—	—	577
Ohio	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Wisconsin	780	—	40	20	—	840
Totals	4,678	—	178	21	—	4,877
Percent of Assessed Waters	96%	—	4%	<1%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	—	—	—	—	—	—
Indiana	—	—	—	—	—	—
Michigan	3,288	—	—	—	—	3,288
Minnesota	—	—	—	—	—	—
New York	572	—	5	—	—	577
Ohio	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Wisconsin	780	—	60	—	—	840
Totals	4,640	—	65	—	—	4,705
Percent of Assessed Waters	99%	—	1%	—	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

Table [illegible] Drinking Water Supply Use Support in the Great Lakes (shore miles) [illegible]

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	63	—	—	—	—	63
Indiana	43	—	—	—	—	43
Michigan	3,208	—	—	80	—	3,288
Minnesota	—	—	—	—	—	—
New York	576	—	1	—	—	577
Ohio	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Wisconsin	820	—	20	—	—	840
Totals	4,710	—	21	80	—	4,811
Percent of Assessed Waters	98%	—	<1%	2%	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

Table [illegible] Agriculture Use Support in the Great Lakes (shore miles) [illegible]

State	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable	Total Assessed
Illinois	—	—	—	—	—	—
Indiana	43	—	—	—	—	43
Michigan	3,288	—	—	—	—	3,288
Minnesota	—	—	—	—	—	—
New York	577	—	—	—	—	577
Ohio	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—
Wisconsin	800	—	40	—	—	840
Totals	4,708	—	40	—	—	4,748
Percent of Assessed Waters	99%	—	1%	—	—	

— None or not reported.

Source: 1992 State Section 305(b) reports.

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State	Total Impaired Waters		Priority Organics (1)				Metals (2)			
	States Not Reporting Causes	States Reporting Causes	Major	Mod./ Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
Illinois	—	—	63	—	—	63	—	—	—	—
Indiana	—	43	—	—	—	—	—	—	—	—
Michigan	—	3,288	3,288	—	—	3,288	—	—	—	—
Minnesota	—	272	—	272	—	272	—	272	—	272
New York	—	492	388	104	—	492	—	—	—	—
Ohio	—	236	4	186	—	190	86	129	—	215
Pennsylvania	—	—	—	—	—	—	—	—	—	—
Wisconsin	—	840	840	—	—	840	—	100	—	100
Total Shore Miles Impaired	—	5,171	4,583	562	—	5,145	86	501	—	587
% of Impaired Shore Miles* Affected by Each Cause			89%	11%	—	99%	2%	9%	—	11%
% of Assessed Shore Miles Affected by Each Cause			86%	11%	—	97%	2%	9%	—	11%
% of Total Shore Miles Affected by Each Cause			85%	10%	—	96%	2%	9%	—	11%

* Includes only impaired shore miles in States reporting causes affecting the Great Lakes.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Great Lakes Shore Miles in States Reporting Causes:	5,171 shore miles
Total Assessed Great Lakes Shore Miles:	5,319 shore miles
Estimate of Total Great Lakes Shore Miles in the Nation:	5,382 shore miles

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Organic Enrich./ Low Dissolved Oxygen (3)				Nutrients (4)				Salinity (5)			
Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	44	—	44	77	21	—	98	6	63	—	69
75	46	—	121	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
75	100	—	175	75	100	—	175	—	75	—	75
150	190	—	340	152	121	—	273	6	138	—	144
3%	4%	—	7%	3%	2%	—	5%	<1%	3%	—	3%
3%	4%	—	7%	3%	2%	—	5%	<1%	3%	—	3%
3%	3%	—	6%	3%	2%	—	5%	<1%	3%	—	3%

(continued)

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State	Pathogen Indicators (1)				Nutrients Aquatic Weeds (2)				Taste and Odor (3)			
	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total	Major	Mod Min	Not Specified	Total
Illinois	—	—	—	—	—	—	—	—	—	—	—	—
Indiana	—	—	—	—	—	—	—	—	—	—	—	—
Michigan	—	—	—	—	—	—	—	—	1	—	—	—
Minnesota	—	—	—	—	—	—	—	—	—	—	—	—
New York	21	23	—	44	—	23	—	23	—	—	—	—
Ohio	—	—	—	—	—	—	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—	—	—	—	—	—
Wisconsin	—	80	—	[illegible]	75	—	—	[illegible]	—	40	—	[illegible]
Total Shore Miles Impaired	21	103	—	[illegible]	75	23	—	[illegible]	1	40	—	[illegible]
% of Impaired Shore Miles[a] Affected by Each Cause	<1%	2%	—	2%	1%	<1%	—	2%	<1%	1%	—	1%
% of Assessed Shore Miles Affected by Each Cause	<1%	2%	—	2%	1%	<1%	—	2%	<1%	1%	—	1%
% of Total Shore Miles Affected by Each Cause	<1%	2%	—	2%	1%	<1%	—	2%	<1%	1%	—	1%

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Ammonia (9)				Chlorine (10)			
Major	Mod. Min	Not Specified	Total	Major	Mod./ Min	Not Specified	Total
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	20	—	20	—	20	—	20
—	20	—	20	—	20	—	20
—	<1%	—	<1%	0%	<1%	—	<1%
—	<1%	—	<1%	0%	<1%	—	<1%
—	<1%	—	<1%	0%	<1%	—	<1%

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State	[illegible]		[illegible]				[illegible]			
	States Not Reporting Causes	States Reporting Causes	Major	Mod Min	Not Specified	[illegible]	Major	Mod. Min	Not Specified	[illegible]
Illinois	—	—	63	—	—	[illegible]	4	—	—	[illegible]
Indiana	—	43	—	43	—	43	—	—	—	[illegible]
Michigan	3,287	1	—	—	—	—	—	—	—	[illegible]
Minnesota	—	272	—	—	—	—	—	—	—	[illegible]
New York	—	492	—	—	—	—	388	58	—	[illegible]
Ohio	—	236	—	—	—	—	—	—	—	[illegible]
Pennsylvania	—	—	—	—	—	—	—	—	—	[illegible]
Wisconsin	—	840	—	840	—	[illegible]	310	—	—	[illegible]
Total Shore Miles Impaired	3,287	1,884	63	883	—	[illegible]	702	58	—	[illegible]
% of Impaired Shore Miles[a] Affected by Each Source			3%	47%	—	[illegible]	37%	3%	—	[illegible]
% of Assessed Shore Miles Affected by Each Source			1%	17%	—	[illegible]	13%	1%	—	[illegible]
% of Total Shore Miles Affected by Each Source			1%	16%	—	[illegible]	13%	1%	—	[illegible]

[a] Includes only impaired shore miles in States reporting sources affecting the Great Lakes.

— None or not reported.

Source: 1992 State Section 305(b) reports.

Total Impaired Great Lakes Shore Miles in States Reporting Sources	1,884 shore miles
Total Assessed Great Lakes Shore Miles	[illegible] shore miles
Estimate of Total Great Lakes Shore Miles in the Nation	[illegible] shore miles

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[illegible] (continued)

Land Disposal (3)				Urban Runoff: Storm Sewers (4)				Combined Sewer Overflow (5)			
Major	Mod. Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total	Major	Mod/ Min	Not Specified	Total
—	—	—	—	—	63	—	[illegible]	—	10	—	10
—	—	—	—	—	—	—	—	—	43	—	43
—	—	—	—	—	—	—	—	1	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—
—	492	—	492	14	21	—	35	21	14	—	35
20	4	—	24	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	60	—	60	—	100	—	100	—	60	—	60
20	556	—	[illegible]	14	184	—	[illegible]	22	127	—	149
1%	30%	—	31%	1%	10%	—	11%	1%	7%	—	8%
<1%	10%	—	11%	<1%	3%	—	4%	<1%	2%	—	3%
<1%	10%	—	11%	<1%	3%	—	4%	<1%	2%	—	3%

(continued)

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Table F-4 (continued)

State	Construction (6)			
	Major	Mod/ Min	Not Specified	Total
Illinois	—	—	—	—
Indiana	—	—	—	—
Michigan	—	—	—	—
Minnesota	—	—	—	—
New York	6	35	—	41
Ohio	—	—	—	—
Pennsylvania	—	—	—	—
Wisconsin	—	—	—	—
Total Shore Miles Impaired	6	35	—	41
% of Impaired Shore Miles[a] Affected by Each Source	<1%	2%	—	2%
% of Assessed Shore Miles Affected by Each Source	<1%	1%	—	1%
% of Total Shore Miles Affected by Each Source	<1%	1%	—	1%

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Appendix G

Individual State Data
Section 314 Clean Lakes Data

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Table G-1. Trophic Status of Significant Publicly Owned Lakes

State	Total		Assessed		Oligotrophic		Mesotrophic	
	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes
Alabama	43	469,653	22	392,474	—	—	7	82,762
Alaska	—	—	2	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—
Arizona[a]	235	128,436	10	—	1	—	2	—
Arkansas[b]	77	355,063	—	—	—	—	—	—
California	—	—	—	—	—	—	—	—
Colorado	176	149,023	87	102,623	11	8,223	30	42,454
Connecticut	105	24,941	105	24,941	7	1,549	61	16,165
Delaware	47	2,973	—	—	—	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	1	103	1	103	—	—	—	—
Florida[c]	145	968,320	106	—	38	—	25	—
Georgia	27	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—
Idaho	2,557	515,510	30	397,147	7	173,801	7	29,932
Illinois	298	155,433	298	155,433	3	75	23	6,185
Indiana	—	—	186	74,144	59	30,773	106	30,598
Iowa	115	42,974	115	42,974	—	—	—	—
Kansas	230	172,129	220	171,857	—	—	46	80,883
Kentucky	—	—	102	214,962	11	63,513	30	42,444
Louisiana	75	699,722	30	455,476	—	—	—	—
Maine	2,312	958,499	1,732	926,593	143	103,841	1,017	667,387
Maryland	62	21,001	62	21,001	3	1,339	14	6,559
Massachusetts	—	—	320	54,846	9	25,549	84	10,662
Michigan	704	489,407	704	489,407	111	174,068	364	176,715
Minnesota	11,842	3,290,101	1,730	—	236	—	500	—
Mississippi	127	313,538	34	298,652	—	—	—	—
Missouri	—	—	108	262,020	3	293	34	84,082
Montana	—	—	1,370	643,146	452	254,692	428	348,522
Nebraska	—	—	64	127,517	—	—	4	37,970
Nevada	—	—	12	—	3	—	7	—
New Hampshire	830	161,890	507	152,862	161	118,586	223	34,030
New Jersey	—	—	—	—	—	—	—	—
New Mexico	174	151,320	66	145,042	12	10,027	19	70,108
New York	7,648	730,387	1,896	349,842	398	62,150	375	208,360
North Carolina	145	304,542	145	304,542	38	73,395	32	106,081
North Dakota	216	619,088	149	604,292	—	—	12	369,339
Ohio	—	—	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	149	—	22	—	66	—
Oregon	—	—	202	—	59	—	72	—
Pennsylvania	125	—	54	—	1	—	41	—
Puerto Rico	18	—	18	—	1	—	6	—
Rhode Island	58	7,035	58	7,035	5	388	42	5,810
South Carolina	43	476,001	40	474,651	—	—	6	28,807
South Dakota	—	—	120	—	—	—	8	—
Tennessee	123	539,326	123	539,326	20	97,044	36	115,842
Texas	108	—	—	—	—	—	—	—
Utah	139	450,078	139	450,078	23	76,323	72	225,222
Vermont	—	—	—	215,469	—	9,306	—	178,985
Virginia	248	161,554	62	90,763	3	5,348	20	4,285
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA
Washington	—	—	148	—	25	—	81	—
West Virginia[d]	93	21,522	—	—	—	—	—	—
Wisconsin	14,973	—	127	—	30	—	40	—
Wyoming	—	—	—	—	—	—	—	—
Totals	44,127	12,378,769	11,477	8,189,226	1,915	1,290,283	4,046	3,010,209
Percentages					17%	16%	35%	37%

[a] Arizona's significant public lakes do not include lakes under the jurisdiction of American Indian Tribes.
[b] Arkansas calculated and ranked all 77 significant public lakes by a trophic index, but did not assign a trophic class to each index.
[c] Florida reports the number of lake reaches in each trophic category. The State has 101 significant public lakes comprised of 145 lake reaches.
[d] West Virginia reports total number of publicly owned lakes, some of which may not be "significant."

— None or not reported.
NA = Not applicable.
Source: 1992 State Section 305(b) reports.

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Table G-1 (continued)

Eutrophic		Hypereutrophic		Dystrophic		Unknown	
Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes
15	309,712	—	—	—	—	21	77,179
2	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
39	46,900	7	5,046	—	—	—	—
21	5,901	16	1,326	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1	103	—	—	—	—	—	—
23	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
24	193,414	—	—	—	—	25	21,382
141	60,453	131	88,720	—	—	—	—
21	4,773	—	—	—	—	—	—
115	42,974	—	—	—	—	—	—
101	80,486	73	10,488	—	—	18	272
58	108,877	3	128	—	—	—	—
30	455,476	—	—	—	—	—	—
572	155,365	—	—	—	—	6	110
45	13,103	—	—	—	—	—	—
169	15,428	57	3,170	1	37	2,547	96,327
229	138,624	—	—	—	—	—	—
506	—	318	—	—	—	—	—
34	298,652	—	—	—	—	—	—
66	176,949	5	704	—	—	249	25,515
371	39,262	—	—	127	670	502	20,217
46	81,886	14	8,461	—	—	—	—
2	—	—	—	—	—	11	—
123	8,246	—	—	—	—	—	—
—	—	—	—	—	—	—	—
34	64,902	—	—	1	5	—	—
282	54,195	—	—	841	25,137	5,692	270,692
57	108,340	8	1,470	10	15,256	—	—
58	150,298	79	84,654	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
28	—	33	—	—	—	—	—
61	—	10	—	—	—	—	—
12	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—
10	817	—	—	1	20	—	—
34	445,844	—	—	—	—	—	—
27	—	85	—	—	—	7	—
48	309,443	19	16,977	—	—	—	—
—	—	—	—	—	—	—	—
40	44,104	4	104,429	—	—	—	—
—	26,810	—	—	—	368	—	12,994
39	81,130	—	—	—	—	—	—
—	—	—	—	—	—	—	—
41	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—
47	—	2	—	—	—	511	—
—	—	—	—	—	—	—	—
3,670	3,521,667	865	325,573	981	41,493	9,589	524,688
32%	43%	8%	4%	9%	0.5%	84%	6%

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Table G-2. Acidity in Significant Publicly Owned Lakes

State	Number of Lakes Assessed for Acidity	Acreage of Lakes Assessed for Acidity	Number of Lakes Exhibiting High Acidity[a]	Acreage of Lakes Exhibiting High Acidity[a]
Alabama	—	—	—	—
Alaska	—	—	1	1,830
American Samoa	—	—	—	—
Arizona	—	—	—	—
Arkansas	77	—	8	—
California	—	—	—	—
Colorado	—	—	—	—
Connecticut	105	24,941	12	1,828
Delaware	30	—	8	—
Delaware River Basin	NA	NA	NA	NA
District of Columbia	—	—	—	—
Florida	7	—	4	—
Georgia	—	—	—	—
Gila River Indian Comm.	—	—	—	—
Guam	—	—	—	—
Hawaii	—	—	—	—
Idaho	—	—	—	—
Illinois	—	—	—	—
Indiana	—	—	—	—
Iowa	9	2,445	—	—
Kansas	—	168,877	—	—
Kentucky	—	—	—	—
Louisiana	8	43,465	8	43,465
Maine	1,004	713,387	59	697
Maryland	62	21,801	—	—
Massachusetts	—	—	12	—
Michigan	704	489,487	—	—
Minnesota	1,153	—	218	—
Mississippi	—	—	—	—
Missouri	107	263,124	—	—
Montana	—	—	—	—
Nebraska	—	—	—	—
Nevada	—	—	—	—
New Hampshire	549	153,581	40	3,277
New Jersey	—	—	—	—
New Mexico	—	—	—	—
New York	1,526	97,825	642	23,462
North Carolina	145	304,542	—	—
North Dakota	192	611,074	—	—
Ohio	—	—	—	—
Ohio River Valley	NA	NA	NA	NA
Oklahoma	—	—	—	—
Oregon	—	—	—	—
Pennsylvania	—	—	—	—
Puerto Rico	—	—	—	—
Rhode Island	58	7,035	10	1,097
South Carolina	—	—	—	—
South Dakota	—	—	—	—
Tennessee	123	539,326	3	2,864
Texas	4	—	—	—
Utah	—	—	—	—
Vermont	200	—	7	114
Virginia	62	90,762	—	—
Virgin Islands	NA	NA	NA	NA
Washington	—	—	—	—
West Virginia	—	—	—	—
Wisconsin	698	211,735	6	—
Wyoming	—	—	—	—
Totals	6,823	3,742,527	1,038	78,654
Percentages			15%	2%

[a] Includes lakes threatened by high acidity (i.e., low pH) due to natural causes.

— None or not reported.

NA = Not applicable.

Source: 1992 State Section 305(b) reports.

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Table G-2. Sources of High Acidity in Lakes

State	Acid Deposition		Acid Mine Drainage		Natural Sources		Other	
	Number of Lakes Impacted	Acreage Lakes Impacted	Number of Lakes Impacted	Acreage Lakes Impacted	Number of Lakes Impacted	Acreage Lakes Impacted	Number of Lakes Impacted	Acreage Lakes Impacted
Alabama	—	—	1	1,830	—	—	—	—
Alaska	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—
Arizona	—	—	—	—	—	—	—	—
Arkansas	—	—	—	—	8	—	—	—
California	—	—	—	—	—	—	—	—
Colorado	—	—	—	—	—	—	—	—
Connecticut	—	—	—	—	12	1,828	—	—
Delaware	—	—	—	—	8	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—	—	—
Florida	—	—	—	—	—	—	—	—
Georgia	—	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—
Idaho	—	—	—	—	—	—	—	—
Illinois	—	—	—	—	—	—	—	—
Indiana	—	—	—	—	—	—	—	—
Iowa	—	—	—	—	—	—	—	—
Kansas	—	—	—	—	—	—	—	—
Kentucky	—	—	—	—	—	—	—	—
Louisiana	—	—	—	—	8	43,465	—	—
Maine	41	—	—	—	24	—	—	—
Maryland	—	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—
Michigan	—	—	—	—	—	—	—	—
Minnesota	—	—	—	—	—	—	—	—
Mississippi	—	—	—	—	—	—	—	—
Missouri	—	—	—	—	—	—	—	—
Montana	—	—	—	—	—	—	—	—
Nebraska	—	—	—	—	—	—	—	—
Nevada	—	—	—	—	—	—	—	—
New Hampshire	19	1,681	—	—	21	1,596	—	—
New Jersey	—	—	—	—	—	—	—	—
New Mexico	—	—	—	—	—	—	—	—
New York	397	17,550	—	—	—	—	—	—
North Carolina	—	—	—	—	—	—	—	—
North Dakota	—	—	—	—	—	—	—	—
Ohio	—	—	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—
Pennsylvania	—	—	—	—	—	—	—	—
Puerto Rico	—	—	—	—	—	—	—	—
Rhode Island	10	1,097	—	—	10	1,097	—	—
South Carolina	—	—	—	—	—	—	—	—
South Dakota	—	—	—	—	—	—	—	—
Tennessee	—	—	3	2,864	—	—	—	—
Texas	—	—	—	—	—	—	—	—
Utah	—	—	—	—	—	—	—	—
Vermont	7	114	—	—	—	—	—	—
Virginia	—	—	—	—	—	—	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA
Washington	—	—	—	—	—	—	—	—
West Virginia	—	—	—	—	—	—	—	—
Wisconsin	—	—	—	—	—	—	—	—
Wyoming	—	—	—	—	—	—	—	—
Totals	474	20,442	4	4,714	91	47,986	—	—

— None or not reported.
NA = Not applicable.
Source: 1992 State Section 305(b) reports.

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Table G-4. Trends in Significant Publicly Owned Lakes

State	Total		Assessed		Improving		Stable	
	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes	Number of Significant Public Lakes	Acreage of Significant Public Lakes
Alabama	43	469,653	43	469,653	1	440	42	469,213
Alaska	—	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—	—
Arizona	235	128,436	—	—	—	—	—	—
Arkansas	77	353,063	11	167,550	1	—	10	—
California	—	—	—	—	—	—	—	—
Colorado	176	149,023	7	8,553	—	—	7	8,553
Connecticut	105	24,941	105	24,940	10	10,519	89	13,609
Delaware	47	2,973	—	—	—	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA	NA	NA
District of Columbia	1	103	—	—	—	—	36	707
Florida	145	988,320	36	914	15	173	—	—
Georgia	27	—	—	—	—	—	—	—
Gila River Indian Comm.	—	—	—	—	—	—	—	—
Guam	—	—	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—	—	—
Idaho	2,337	313,510	13	159,999	6	7,457	5	57,897
Illinois	298	153,433	98	—	25	—	27	—
Indiana	—	—	106	—	59	—	106	—
Iowa	115	42,974	114	42,939	5	1,793	90	38,319
Kansas	238	172,129	123	164,288	5	19,042	93	121,482
Kentucky	—	—	91	214,962	3	294	88	211,993
Louisiana	75	699,722	—	—	—	—	—	—
Maine	2,312	958,499	223	—	12	—	190	—
Maryland	62	21,001	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—	—
Michigan	704	488,407	210	299,942	48	58,283	143	205,801
Minnesota	11,842	3,290,101	161	—	26	—	129	—
Mississippi	127	313,538	—	—	—	—	—	—
Missouri	—	—	—	—	—	—	—	—
Montana	—	—	1	122,535	—	—	—	—
Nebraska	—	—	12	34,499	1	288	9	33,491
Nevada	—	—	61	—	1	—	54	—
New Hampshire	830	161,080	316	128,377	134	45,935	14	765
New Jersey	—	—	—	—	—	—	—	—
New Mexico	174	151,320	—	—	—	—	—	—
New York	7,648	730,387	—	—	—	—	—	—
North Carolina*	145	304,542	94	286,065	16	54,307	65	212,156
North Dakota	216	619,088	189	487,858	1	412	162	64,099
Ohio	—	—	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA	NA	NA
Oklahoma	—	—	—	—	—	—	—	—
Oregon	—	—	—	—	—	—	—	—
Pennsylvania	125	—	—	—	—	—	—	—
Puerto Rico	18	—	—	—	—	—	—	—
Rhode Island	58	7,035	—	—	—	—	—	—
South Carolina	43	476,001	40	474,651	8	161,975	30	260,796
South Dakota	—	—	97	657,289	24	37,245	46	58,668
Tennessee	123	539,326	123	539,326	6	6,643	87	522,699
Texas	108	—	—	—	—	—	—	—
Utah	139	450,078	89	165,056	27	9,087	44	149,360
Vermont	—	—	—	—	—	—	—	—
Virginia	248	161,554	62	90,862	5	20,217	55	70,389
Virgin Islands	NA	NA	NA	NA	NA	NA	NA	NA
Washington	—	—	104	—	20	—	70	—
West Virginia	93	21,522	—	—	—	—	—	—
Wisconsin	14,973	—	49	48,880	20	22,287	24	23,150
Wyoming	—	—	—	—	—	—	—	—
Totals	44,127	12,378,769	2,678	4,588,568	471	456,317	1,707	2,523,146
Percentages					18%	10%	64%	55%

* North Carolina counted High Rock Lake as both improving and degrading because fish consumption use improved on 1,900 acres but 13,850 acres became more degraded by eutrophication.

— None or not reported.

NA - Not applicable.

Source: 1992 State Section 305(b) reports.

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Tables G-1 to G-5 (continued)

Degrading	
Number of Significant Public Lakes	Acreage of Significant Public Lakes
—	—
—	—
—	—
—	—
—	—
—	—
—	—
6	812
—	—
NA	NA
3	34
—	—
—	—
—	—
—	—
—	—
2	94,605
46	—
21	—
19	2,827
25	23,764
8	2,145
—	—
21	—
—	—
—	—
27	35,858
6	—
—	—
—	—
1	122,535
2	800
6	—
168	81,677
—	—
—	—
—	—
13	19,602
26	422,827
—	—
NA	NA
—	—
—	—
—	—
—	—
—	—
2	51,880
27	561,376
30	9,984
—	—
18	6,609
—	—
2	257
NA	NA
14	—
—	—
5	3,443
—	—
500	1,441,034
19%	31%

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Table G-5. Clean Lakes Program Projects

State	Phase 1 Projects		Phase 2 Projects		Phase 3 Projects	
	Number of Projects Initiated	Number of Projects Completed	Number of Projects Initiated	Number of Projects Completed	Number of Projects Initiated	Number of Projects Completed
Alabama	2	—	—	—	—	—
Alaska	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—
Arizona	3	—	—	—	—	—
Arkansas	—	—	—	—	—	—
California	—	—	—	—	—	—
Colorado	—	1	—	1	—	—
Connecticut	7	7	3	3	—	—
Delaware	4	—	1	—	—	—
Delaware River Basin	NA	NA	NA	NA	NA	NA
District of Columbia	—	—	—	—	—	—
Florida	2	1	1	—	—	—
Georgia	6	—	—	—	—	—
Gila River Indian Community	—	—	—	—	—	—
Guam	—	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Idaho	3	4	3	—	—	—
Illinois	18	11	8	5	2	—
Indiana	3	—	—	—	—	—
Iowa	2	5	4	5	1	—
Kansas	—	6	1	1	—	—
Kentucky	1	1	—	—	—	—
Louisiana	—	—	—	—	—	—
Maine	1	—	2	2	1	—
Maryland	3	1	7	3	—	—
Massachusetts	—	—	—	—	—	—
Michigan	6	—	2	—	1	—
Minnesota	21	—	13	—	1	—
Mississippi	—	3	—	—	—	—
Missouri	4	4	1	3	—	—
Montana	4	2	1	1	—	—
Nebraska	—	—	—	—	—	—
Nevada	—	—	—	—	—	—
New Hampshire	9	7	1	1	1	—
New Jersey	2	—	5	3	—	—
New Mexico	—	1	—	—	—	—
New York	3	10	3	7	—	—
North Carolina	2	—	—	—	—	—
North Dakota	2	2	2	2	—	—
Ohio	—	—	—	—	—	—
Ohio River Valley	NA	NA	NA	NA	NA	NA
Oklahoma	17	—	4	—	1	—
Oregon	1	—	—	—	—	—
Pennsylvania	5	—	2	—	—	—
Puerto Rico	—	—	—	—	—	—
Rhode Island	1	2	—	—	—	—
South Carolina	3	1	1	1	—	—
South Dakota	8	8	1	1	1	—
Tennessee	5	2	—	—	—	—
Texas	3	1	1	—	—	—
Utah	3	6	3	1	—	—
Vermont	—	—	—	—	—	—
Virginia	—	1	1	2	—	—
Virgin Islands	NA	NA	NA	NA	NA	NA
Washington	4	—	14	14	—	—
West Virginia	—	—	—	—	—	—
Wisconsin	3	1	1	—	several	
Wyoming	—	—	—	—	—	—
Totals	161	88	86	56	9	—

— None or not reported.
NA = Not applicable.
Source: 1992 State Section 305(b) reports.

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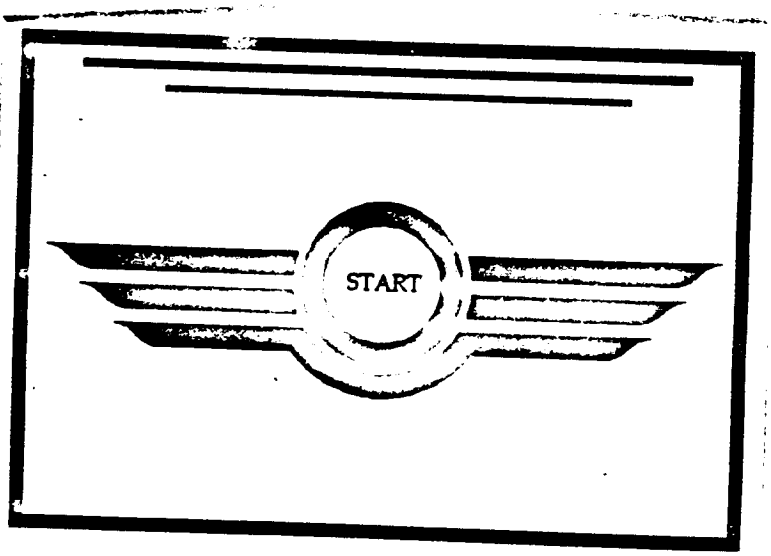

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FINAL REPORT
OF THE
NATIONWIDE URBAN RUNOFF PROGRAM

2055

WATER PLANNING DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

R0035595

FINAL REPORT
OF THE
NATIONWIDE URBAN RUNOFF PROGRAM

December 30, 1983

WATER PLANNING DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about environmental quality. The complexity of our environment and the interplay among its components require concentrated and integrated approaches to pollution problems.

The possible deleterious water quality effects of nonpoint sources in general, and urban runoff in particular, were recognized by the Water Pollution Control Act Amendments of 1972. Because of uncertainties about the true significance of urban runoff as a contributor to receiving water quality problems, Congress made treatment of separate stormwater discharges ineligible for Federal funding when it enacted the Clean Water Act in 1977. To obtain information that would help resolve these uncertainties, the Agency established the Nationwide Urban Runoff Program in (NURP) 1978. This five-year program was designed to examine such issues as:

- The quality characteristics of urban runoff, and similarities or differences at different urban locations;
- The extent to which urban runoff is a significant contributor to water quality problems across the nation; and
- The performance characteristics and the overall effectiveness and utility of management practices for the control of pollutant loads from urban runoff.

The interim NURP report, published in March 1982, presented preliminary findings of the program. This document is the final report covering the overall NURP program. Several specialized technical reports are published under separate cover.

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PREFACE

The Nationwide Urban Runoff Program (NURP) was conducted by the EPA and many cooperating federal, state, regional, and local agencies, distributed widely across the United States. The individual project studies, which were conducted over the past five years, were designed and overseen using a common technical team from EPA headquarters. This approach was taken to assure a desired level of commonality and consistency in the overall program, while allowing each individual project to specially tailor its effort to focus on local concerns.

The program has yielded a great deal of information which will be useful for a broad spectrum of planning activities for many years. Furthermore, it has fostered valuable cooperative relationships among planning and regulatory agencies. The most tangible products of the program are this report, the reports of various grantees (available under separate cover), and several technical reports which focus on specialized aspects of the program, its techniques, and its findings. In addition, a considerable number of individual articles drawing on information developed under the NURP program have already appeared in the technical literature and address specific technical or planning aspects of urban runoff.

At the time of publication of this Final Report, the main technical effort of the NURP program is complete; the field studies and the analysis of most of the resultant data are complete enough that the findings reported herein can be taken with confidence. However, there is still some work in progress to make certain details of the program available for future use. The products of this on-going work include:

- A summary database which has been compiled to make technical information from the 28 projects available for review and use (DECEMBER 1985);
- A technical report which focuses on the program's studies and findings relative to detention and recharge devices (MAY 1984);
- A technical report on urban runoff effects on the water quality of rivers and streams (MARCH 1984); and
- A technical report on the effectiveness of street sweeping as a potential "best management practice" for water pollution control (MAY 1984).

This report and the supplementary technical documents identified above, supersede the earlier NURP publications, which represented preliminary results. Information presented in these earlier reports has been expanded, updated, and in some cases revised.

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ACKNOWLEDGEMENTS

The Nationwide Urban Runoff Program was unusual in its large scale, covering a broad spectrum of technical and planning issues at many geographic locations. Because the program placed such emphasis on tailoring the results to support the planning process, it involved many participants - some from EPA, some from other federal agencies, and many from state, regional, and local planning agencies and other consultants.

The program was developed, implemented, and managed by the Water Planning Division at EPA Headquarters, Washington, D.C. Principal contributors were:

- Dennis N. Athayde, Program Manager
- Patrice M. Bubar, Project Officer
- Norman A. Whalen, Project Officer
- Stuart S. Tuller, Project Officer
- Phillip H. Graham, Project Officer

Additional contributions from EPA personnel came from Richard Field (Storm and Combined Sewer Section, EPA Office of Research and Development), and many project officers and staff in the various EPA Regional Offices.

As described elsewhere, much of the field work, water quality analysis, and data analysis was performed by the U.S. Geological Survey (USGS), under a Memorandum of Agreement with EPA. Both District Offices and National Headquarters participated actively. The contributions of Messrs. Ernest Cobb and David Lystrom are especially acknowledged.

Members of the project team which provided essential strategic, technical and management assistance to the EPA Water Planning Division through a contract with Woodward-Clyde Consultants were:

- Gail B. Boyd (Woodward-Clyde Consultants)
- Eugene D. Driscoll (E. D. Driscoll and Associates)
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CHAPTER 1
INTRODUCTION

Rain falling on an urban area results in both benefits and problems. The benefits range from watering vegetation to area cleansing. Many of the problems are associated with urban runoff, that portion of rainfall which drains from the urban surfaces and flows via natural or man-made drainage systems into receiving waters.

The historical concern with urban runoff has been focused primarily on flooding. Urban development has the general effect of reducing pervious land surface area and increasing the impervious area (such as roof tops, streets, and sidewalks) where water cannot infiltrate. In comparison with an undeveloped area (for a given storm event), an urban area will yield more runoff, and it will occur more quickly. Such increases in the rate of flow and total volume often have a decided effect on erosion rates and flooding. It is not surprising, therefore, that at the local level the quantity aspect continues to be a principal concern.

In recent years, however, concern with urban runoff as a contributor to receiving water quality problems has been expressed. Section 62 of the Water Quality Act of 1965 (P.L. 89-234) authorized the Federal government to make grants for the purpose of "assisting in the development of any project which will demonstrate a new or improved method of controlling the discharge into any water of untreated or inadequately treated sewage or other waste from sewerage which carry storm water or both storm water and sewage or other waste ..." The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) signaled a heightened national awareness of the degraded state of the nation's surface waters and a Congressional intent that national water quality goals be pursued. The scarcely two-year old Environmental Protection Agency built upon its predecessors' activities by taking up the challenge and implementing this far reaching legislation.

As a result of Section 208 of The Act, State and local water quality management agencies were designated to integrate water quality activities. As point source discharges were increasingly brought under control and funds for the construction and upgrading of municipal sewage treatment plants were granted, the awareness of nonpoint sources (including urban runoff) as potential contributors to water quality degradation was heightened. Uncertainties associated with the local nature and extent of urban runoff water quality problems, the effectiveness of possible management and control measures, and their affordability in terms of benefits to be derived mounted as water quality management plans were developed. The unknowns were so great and certain control cost estimates were so high that the Clean Water Act of 1977 (P.L. 95-217) deleted Federal funding for the treatment of separate stormwater discharges. The Congress stated that there was simply not enough

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known about urban runoff loads, impacts, and controls to warrant making major investments in physical control systems.

In 1978, EPA Headquarters reviewed the results of work on urban runoff by the technical community and the various 208 Areawide Agencies and determined that additional, consistent data were needed. The NURP program was implemented to build upon pertinent prior work and to provide practical information and insights to guide the planning process, including policy and program development and implementation. The NURP program included 28 projects, conducted separately at the local level, but centrally reviewed, coordinated, and guided. While these projects were separate and distinct, most share certain commonalities. All were involved with one or more of the following elements: characterizing pollutant types, loads, and effects on receiving water quality; determining the need for control; and evaluating various alternatives for the control of stormwater pollution. Their emphasis was on answering the basic questions underlying the NURP program and providing practical information needed for planning.

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CHAPTER 2
BACKGROUND

EARLY PERCEPTIONS

As noted earlier, drainage is perhaps the single most important factor of the urban hydrologic cycle. Nuisance flooding, more than anything else, gives Public Works directors concern, as complaints are received from unhappy motorists, residents, and business. Drainage has typically been considered a local responsibility, usually that of the City or County Public Works Department. Rarely does this responsibility go to the State or Federal level, except in cases of catastrophic flooding involving risk to human life and extensive property damage.

By 1964, the U.S. Public Health Service had begun to be concerned about identified pollutants in urban runoff and concluded that there may be significant water quality problems associated with stormwater runoff. In 1969, the Urban Water Resources Research Committee of the American Society of Civil Engineers (directed by M. B. McPherson and sponsored by the U.S. Geological Survey) recognized the potential threat of pollution from urban runoff and described a research program intended to obtain needed information to characterize urban stormwater quality.

In the late 1960's, the Federal Water Quality Administration (FWQA) conducted a study in an area of Tulsa, Oklahoma which was served by separate storm sewers. This first attempt at using regression analysis on urban runoff indicated that there was only a very poor correlation between stormwater runoff quantity and water quality constituents (except for suspended solids). Comparing the concentrations of various pollutants examined by this study (separate storm sewers) with previous data on combined sewer overflows indicated that storm runoff from areas having separate sewers had much lower values for BOD, fecal coliform, and most other pollutant concentrations. The study concluded that the largest portion of pollutants resulted from (1) washoff of material from impervious surfaces and (2) the erosion of drainage channels (caused by high volumes of runoff from the impervious surfaces). Control of urban runoff was recommended to reduce both runoff volume and rates.

Atlanta, Georgia is an example of a city that has both a combined sewer system and a separate system. In 1971, EPA conducted a study which compared the contribution of various sources of pollutants. It was concluded that, on an annual basis, 64 percent of the BOD load came from separate storm sewers, and 19 percent came from combined sewers, the balance coming from treatment plants.

In 1971, EPA also conducted a study in Oakland and Berkeley, California, to assess the infiltration of stormwater into sanitary sewers. While only four

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percent of the study area had combined sewerage and the remaining 96 percent separate, the study made it clear that infiltration can cause a separate system to function as though it were combined.

Studies in Sacramento, California, which has both combined and separate storm sewers, indicated that the stormwater was comparable to the average strength of domestic wastewater. However, the concentrations for BOD were found to be so unrealistically high, that contamination of the runoff by raw sanitary sewage was considered to be a distinct possibility.

In 1973, the Council on Environmental Quality published a report titled, "Total Urban Pollutant Loads: Sources and Abatement Strategies." The primary conclusion was that much pollution was coming from urban runoff and that, unless it was taken care of, the goals of the Act would not be met.

CONCLUSIONS FROM SECTION 208 EFFORTS

EPA guidance for conducting the early 208 planning efforts designated 17 topic areas (including urban runoff) that were to be addressed by all Water Quality Management agencies in developing their 208-funded plans. Although all topic areas were to be covered, the degree of emphasis to place on each was left to the individual agencies to decide. As a result, the amount of the 208 efforts spent in the area of urban runoff varied greatly (but was rarely a major portion).

Many of the 208 agencies began their studies with the assumption that urban runoff was an important cause of water quality problems. Although the studies developed much information on runoff and receiving waters, not enough basic information was known to assess urban runoff's role as a major cause of problems. This was partly because of interferences by other sources and complex relationships within the receiving waters. It was also due to the difficulties in deciding what constitutes a "problem." In some cases, "problems" were synonymous with criteria violations; in others, "problems" were synonymous with an impairment or denial of beneficial uses. In many cases, "problems" were concluded to exist, simply on the basis of the possible presence of certain contaminants in urban runoff, based solely on values taken from literature regarding studies conducted elsewhere. The practical implication of these differences (which were differences in viewpoints rather than differences in physical conditions, in many cases) was that local agencies were very reluctant to commit to implementing urban runoff controls in the absence of a clear problem definition.

Furthermore, in the early years of the 208 program, EPA's guidance on how to address urban runoff was vague. As a result, local agencies took a wait-and-see attitude on the stormwater portion of their plans. They simply did not know what EPA would eventually do on the issue of stormwater control.

Another major obstacle to implementation resulted from the uncertainties regarding the effectiveness of controls. Many of the measures proposed for controlling urban runoff are either new or special applications of conventional practices developed for other purposes. Little was known about how

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well they would work in urban runoff applications. Engineers, planners, public works personnel, and other decision makers have been understandably reluctant to invest large amounts of time and money in controls which may not perform as hoped.

Another obstacle to implementation of controls was a lack of basic data on sources, transport mechanisms, and receiving water characteristics (hydrologic and water quality aspects). Some of the more important topic areas where knowledge was lacking are summarized below:

- Sources - Not enough was known about where pollutants originate. Major sources certainly include vehicles, vegetation, erosion, fertilizer and pesticide application, litter, animals, and air pollution. However, a better understanding of source contributions could enhance control opportunities.

- Washoff/transport mechanisms - Not enough was known about how pollutants get from the sources to the receiving waters. Models could be better used for simulating runoff in problem definition and control evaluation, if they more accurately reflected washoff and transport mechanisms.

- Impacts - It was difficult to go beyond speculation in assigning urban runoff its proper share of responsibility for problems in cases where several pollutant sources contribute. In cases where other sources create obvious problems, it was difficult to determine the appropriate degree to which urban runoff should be controlled.

- Relative benefits - Planners had difficulty deciding whether the various benefits of controlling urban runoff quality justify the costs involved. There was considerable controversy over the present dry weather standards' relationship to beneficial uses, given the time and space scales of storm events and their intermittent nature. Many plans failed to be implemented because of uncertainties regarding: How much control is enough? Who benefits? Who should pay? Who should decide?

- Controls - Both cost and effectiveness data on full-scale control programs were lacking. Some of the control measures cited for typical 208 plans were plausible candidates, but their application for the purpose of urban runoff pollution control had not been studied quantitatively.

EPA'S ORD EFFORT

During the past 15 years, EPA's Office of Research and Development (ORD) has conducted over 250 studies on the characterization and control of stormwater discharges and combined sewer overflows, with particular emphasis on the latter due to their greater pollution potential. Consistent with overall Agency policies, ORD has deemphasized studies on receiving water impacts and effects (although it has done some such work). Rather, ORD has focussed principally on multi-purpose analyses and controls, because it is nearly

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impossible to segregate benefits and strategies of urban stormwater runoff pollution control from drainage, flood, and erosion control. Many significant results have been obtained by ORD's effort, which has dramatically increased the technical literature in the area.

Data from ORD studies indicate the high variability of pollutant concentrations in urban runoff. Based on loading projections, it is safe to conclude that urban stormwater can contribute significant pollutant loads to receiving waters, in many cases having pollutant concentrations on the order of secondary treatment plant effluent for some constituents. Nonetheless, in its efforts to find direct urban runoff generated receiving water impacts (using the conventional dissolved oxygen parameter as the indicator) ORD has been only partly successful. However, this was only one study and was not intended to be the final word. Nonetheless, based on the size of the load coming from urban runoff, a significant pollution potential is there for at least some types of receiving waters. For example, a small urban lake could receive nutrient loads sufficient to increase algal productivity and accelerate the eutrophication process. The existence of heavy metals and certain organics (mostly of petroleum origin) in urban runoff have also been documented by the ORD program.

In addition to studying urban runoff loads, the ORD program has investigated a number of management and control approaches. This effort has been very successful, and many innovative techniques have been proposed and tested. The results of such research, development, and demonstrations have been presented in reports which document many of these potential controls, thereby allowing the technology to be utilized in other programs and at other locations. Included have been such control measures as on-site (upstream) storage; porous pavement; the swirl concentrator, helical bend, tube settler, and fine mesh screens for grit and settleable solids removal; street sweeping; disinfection; and high rate filtration, dissolved air flotation, and microscreening for suspended solids and BOD removal. Most of these controls were developed principally to deal with combined sewer overflow problems. However, some may also have application in urban runoff control, once their effectiveness has been conclusively demonstrated and initial and operating cost data are available to allow the necessary trade-off studies to be made.

The ORD program's reports constitute an invaluable source of data and information that was used to design and guide the development of the emerging NURP program. Also, three of the NURP projects were joint efforts with ORD (i.e., West Roxbury, Massachusetts, Bellevue, Washington, and Lansing, Michigan).

OTHER PRIOR/ONGOING EFFORTS

The Clean Water Act requires EPA to provide Congress with a needs assessment every two years in the six categories of the construction grant funds program. In 1974, the Needs Survey for Separate Storm Sewer Discharges (Category VI) was done by each state. Using the goals of the Act as the criteria to be met, they identified a cost of about $235 billion (June 1973 dollars). One state alone identified $80 billion in needs to control separate storm sewer discharges. In 1976, the Needs Survey was conducted by the Agency, and it was found that Category VI would require $66 billion to meet the goals of

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the Act. This survey broke the goals into three categories or levels of pollution abatement; (1) aesthetics, (2) fish and wildlife, and (3) recreation. Costs to meet each category were determined.

As noted previously, the ASCE defined a program in 1969 to identify the causes and effects of urban stormwater pollution. The recommendations were not followed, so in 1974 at the Rindge, New Hampshire, Engineering Foundation Conference (jointly sponsored with ASCE's Urban Water Resources Research Council), a similar program was again recommended. A similar scenario occurred at the Easton, Maryland, conference of 1976 sponsored by the same group.

DISCUSSION

In the past (ca 1890), dilution was considered to be the appropriate way to control combined sewer overflows, since the primary concern was odor and related nuisances. Between 1890 and 1960 little concern was shown for stormwater pollution. Stormwater concerns were primarily related to drainage problems. As time progressed, water quality began to be considered, and workers began to characterize problems in terms of concentrations of certain pollutants and loads of these pollutants. In the 1970's, problems were being defined in terms of pounds of pollutants needing to be removed from overflows, in the interest of preventing pollution.

Past work, reported by EPA and published in professional journals, tended to focus on determining (a) the type and amount of pollutants involved and/or (b) methods to reduce the loads. However, such reports and articles did not consider either the level of improvement attainable or the need to improve quality of the receiving water body associated with the study. A conclusion common to all such reports was that not enough was known about stormwater to adequately understand cause and effect relationships. Also common to such reports were recommendations for further study and more data. A tangible result of the lack of belief and uncertain attitude in this area is the fact that stormwater controls for water quality have been implemented in so few places throughout the nation. Thus, there has been a critical need to objectively examine the situation.

Many factors led to the development of NURP, one being a legally-mandated necessity. As implementation of P.L. 92-500 moved into full swing, the lack of progress in the area of urban runoff was becoming apparent. In 1974 EPA lost a court case, which led to the decision that EPA should issue permits for separate storm sewer discharges. In 1976 EPA requested that the Areawide Waste Management Planning Program focus on the three or four most important of the 17 items required by the regulations. Many of the 208 Areawide Agencies cited urban runoff as an important item.

Two years later, EPA reviewed ninety-three 208 Areawide Agencies' work plans to assess their basis for having identified urban runoff as an element upon which they would focus. Review of these projects' methods and findings did not provide much to further our understanding of the pollution aspects of urban runoff. If one reason can be identified, it was the lack of site-specific data to define the local conditions.

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As mentioned earlier, the Rindge Conference recommended a candidate program for obtaining the data necessary to provide a good understanding of storm-water pollution (EFC/ASCE, 1974). It is not coincidental that the NURP program is quite similar in design to those recommendations.

THE NATIONWIDE URBAN RUNOFF PROGRAM

Program Design

NURP was not intended to be a research program, per se, and was not designed as such. Rather, the program was intended to provide a support function to water quality planning efforts. Conduct of the program provided direction and assistance to 28 separate and distinct planning projects, whose locations are shown in Figure 2-1 and listed in Table 2-1, but the results will be of value to many other planning efforts. NURP also acted as a clearinghouse and, in that capacity, provided a common communication link to and among the 28 projects.

The NURP effort began with a careful review of what was known about urban runoff mechanisms, problems, and controls, and then built upon this base. The overall objective of the program was to provide credible information on which to base decisions.

An early step in implementing the NURP program involved identifying a limited number of locations where intensive data gathering and study could be done. Candidate locations were assessed relative to three basic selection criteria:

- Meeting program objectives;
- Developing implementation plans for those areas; and
- Demonstrating transferability, so that solutions and knowledge gained in the study area could be applied in other areas, without need for intensive, duplicative data gathering efforts.

The program design used for NURP included providing a full range of technical and management assistance to each project as the needs arose. Several forums for the communication of experience and sharing of data were provided through semi-annual meetings involving participants from all projects. The roles and responsibilities of the various State, local, and regional agencies and participating Federal agencies were clearly defined and communicated at the outset. These were reviewed and revised where warranted as the projects progressed.

The program design recognized the need for many forms and levels of coordination, within EPA and among the numerous participants, to maximize the benefit from limited resources and to minimize conflict and overlap.

The 28 NURP projects were managed by designated State, county, city, or regional governmental associations. The U.S. Geological Survey (USGS) was involved with EPA as a cooperator, through an inter-agency agreement, on 11 of the NURP projects. USGS involvement included funding support and also typically included technical support in the form of data collection, data

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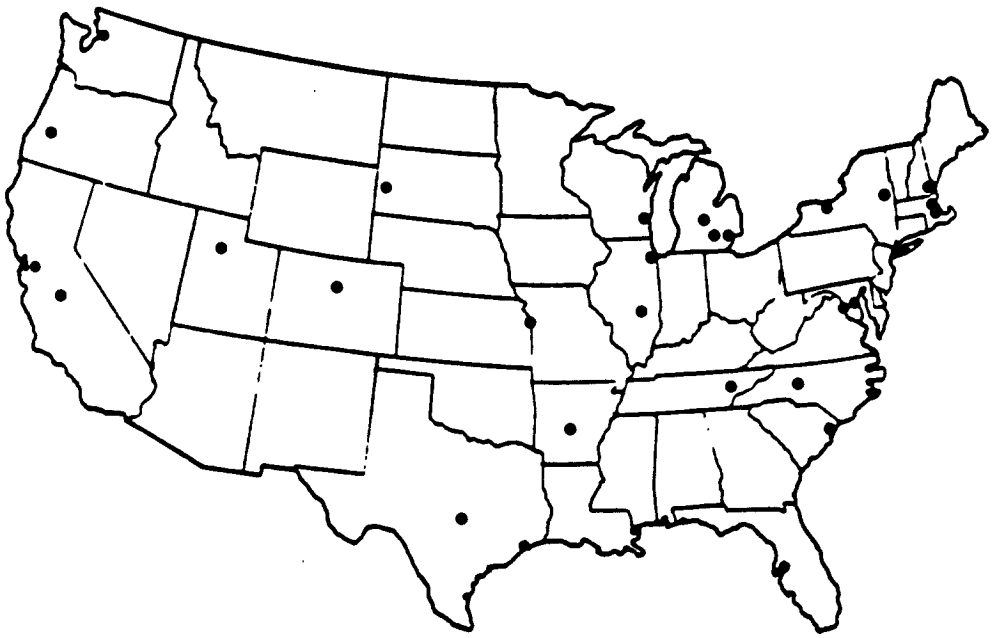

Figure 2-1. Locations of the 28 NURP Projects

TABLE 2-1. NURP PROJECT LOCATIONS

EPA Region	NURP Code	Project Name/Location	EPA Region	NURP Code	Project Name/Location
I	MA1	Lake Quinsigamond (Boston Area)	V	IL1	Champaign-Urbana, Illinois
	MA2	Upper Mystic (Boston Area)		IL2	Lake Ellyn (Chicago Area)
	NH1	Durham, New Hampshire		MI1	Lansing, Michigan
II	NY1	Long Island (Nassau and Suffolk Counties)		MI2	SEMCOG (Detroit Area)
	NY2	Lake George		MI3	Ann Arbor, Michigan
	NY3	Irondequoit Bay (Rochester Area)		WI1	Milwaukee, Wisconsin
III	DC1	WASMCOG (Washington, D.C. Metropolitan Area)	VI	AR1	Little Rock, Arkansas
	MD1	Baltimore, Maryland		TX1	Austin, Texas
IV	FL1	Tampa, Florida	VII	KS1	Kansas City
	NC1	Winston-Salem, North Carolina	VIII	CO1	Denver, Colorado
	SC1	Myrtle Beach, South Carolina		SD1	Rapid City, South Dakota
	TN1	Knoxville, Tennessee		UT1	Salt Lake City, Utah
			IX	CA1	Coyote Creek (San Francisco Area)
				CA2	Fresno, California
			X	OR1	Springfield-Eugene, Oregon
				WA1	Bellevue (Seattle Area)

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analysis, and (in some projects) the evaluation of potential controls. The Tennessee Valley Authority was also involved in one project, providing data collection, analysis, and evaluation of controls.

A major objective of the program was the acquisition of data. Because these data will be used for several years to characterize problems, evaluate receiving water impacts from urban runoff, and evaluate management practices, consistent methods of data collection had to be developed and rigorously employed.

Selection

Projects were selected from among the 93 Areawide Agencies that had identified urban runoff as one of their significant problems. The intention was to build upon what these agencies had already accomplished in their earlier programs. Also, projects that would be a part of this program were screened to be sure that they represented a broad range of certain characteristics (e.g., hydrologic regimes, land uses, populations, drainage system types). Actual selection of projects was a joint effort among the States, local governments, and Regional EPA offices. The five major criteria used to screen candidate projects were as follows:

1. Problem Identified. Had a problem relative to urban runoff actually been identified? Could that problem be directly related to separate storm sewer discharges? What pollutant or pollutants were thought to be causing the problem? Using the NURP problem identification categories, what was the "problem" (i.e., denying a beneficial use, violating a State water quality standard, or public concern)?

2. Type of Receiving Water. The effects of stormwater runoff on receiving water quality were the NURP program's ultimate concern. Because flowing streams, tidal rivers, estuaries, oceans, impoundments, and lakes all have different hydrologic and water quality responses, the types of receiving waters associated with each candidate project had to be examined to ensure that an appropriately representative mix was included in the overall NURP program.

3. Hydrologic Characteristics. The pattern of rainfall in the study area is perhaps the single most important factor in studying urban runoff phenomena, because it provides the means of conveyance of pollutants from their source to the receiving water. For this reason, projects in locations having in different hydrologic regimes were chosen for the program.

4. Urban Characteristics. Characteristics such as population density, age of community, and land use were considered as possible indicators of the waste loads and ultimately the rainfall-runoff water quality relationship. The type of sewerage system was another factor considered (e.g., whether it is combined, separate, or mixed; how severe the infiltration and inflow problems may be). Such factors have different effects

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on the quantity and quality of storm runoff, and were balanced as well as possible in selecting projects.

5. Beneficial Use of Receiving Water. Because this factor greatly affects the type of control measure that would be appropriate, attempts were made to include a wide range in selecting projects.

Although these were the primary criteria used to identify potential projects, other factors also had to be considered (e.g., the applicant agencies' willingness to participate, the State's acceptance of the project, the experience of the proposed project teams). Because the NURP program used planning grants (not research funds) a major consideration was the anticipated working relationships with local public agencies and the applicants' ability to raise local matching funds.

Program Assistance

Technical expertise and resources available for urban runoff planning varied among the various projects participating in NURP. Therefore, the program strategy called for providing a broad spectrum of technical assistance to each project as needed and for intercommunication of experiences and sharing of data in a timely manner.

Assistance was also provided to the applicants in developing their final work plans. This was done to ensure that there would be consistency among methods, especially in the collection of data. If there were to be differences in data from city to city, they must be due to the characteristics of each city and not a result of how the data were obtained.

Assistance with instrumentation was provided during the program in the form of information on available equipment, installation, calibration, etc. Because one of the more important elements of a data collection program is the "goodness" or quality of the data themselves, questionable data would be of little use. Accordingly, a quality assurance and quality control element was required in the plans for each project.

Periodic visits were made to each project site to ensure that the participants were provided opportunities to discuss any problems, technical or administrative. The visiting team typically included an EPA Regional Office representative, an EPA Headquarters representative, and one or two experienced consultants. All interested parties, including representatives from State or local governments, were requested to attend those visits.

As the projects moved farther into their planned activities and the time for data analysis approached, each project was required to describe how they were going to analyze their data. No single method was recommended for each project, because it was believed that a broad diversity of available methods would be suitable, if used properly. Guidance on proper use was provided as a part of technical assistance through project visits and special workshops for this purpose.

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Communication

It was intended that the entire group of NURP participants function as a single team. Accordingly, a communication program was developed. National meetings were conducted semi-annually so that key personnel from the individual projects would have an opportunity to discuss their experiences and findings.

Reports were required of each project quarterly. EPA Headquarters also provided composite quarterly reports summarizing the status of each project and discussing problems encountered and solutions found.

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CHAPTER 3
URBAN RUNOFF PERSPECTIVES

In evaluating the impacts of urban runoff, one's perspective may be influenced by one's concerns and priorities - and what one defines to be a "problem". Recognizing this, the following discussion covers several such perspectives, including concerns over runoff quantity, water quality, and control possibilities.

RUNOFF QUANTITY

The following discussion covers a major cause and two major effects of runoff problems related to "quantity" (i.e., increased urbanization as a cause; flooding and erosion/sedimentation as effects).

Flooding Problems

As noted earlier, drainage has historically been the principal local-level concern regarding urban runoff. Concerns over quantity can be divided into two basic categories: nuisance flooding and major flooding. Nuisance flooding (e.g., temporary ponding of water on streets, road closings, minor basement flooding), although hardly tolerable to those immediately affected, rarely affects an entire urban populance. Nonetheless, the concerns of the (often vocal) minority of affected citizens commonly reach the point where local action is taken to minimize the recurrence of such events. Such mitigation activities are usually locally determined, funded, and implemented because both the affected public and government decision makers perceive and concur that such flooding constitutes a "problem".

Catastrophic flood events, on the other hand, have to be thought about differently for several reasons:

- They typically affect the majority of the urban populace.

- Mitigation measures often involve engineering improvements extending well beyond local jurisdictions.

- Mitigation measures often cost more than the local community could afford. Historically, the Federal government has become involved, in major flood control efforts through a number of related programs. In such cases, water quantity problems are relatively easy to define because the extent of flooding is readily observable, the degree of damage is easily determined, and the benefits of proposed flood control projects can be estimated. Thus, decision makers face a relatively low risk in prescribing courses of action and justifying the associated

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costs in light of benefits. As will be discussed later, decision making in the case of water quality concerns is less straightforward.

Erosion and Sedimentation Problems

Erosion results from rainfall and runoff when soil and other particles are removed from the land surface and transported into conveyance systems and water bodies. Since land surface erosion is the principle source of stream sediment, the type of soil, land cover, and hydrologic conditions are major factors in determining the severity and extent of sedimentation problems. Although erosion is a natural process, it is frequently exacerbated by the activities of man, in both urban and rural environments.

When addressing the broad spectrum of receiving water problems which result from sedimentation, it is convenient to divide cases into two categories; (1) those that respond to control measures directed at nuisance flood prevention, and (2) those that are not controlled by such measures. When natural loads are discharged into receiving waters, the effects are primarily physical and only secondarily chemical (because the mineral constituents which make up the primary sediment load are relatively benign in most cases). Among the physical problems imposed upon the receiving waters are:

- Excess turbidity reduces light penetration, thereby interfering with sight feeding and photosynthesis;

- Particulate matter clogs gills and filter systems in aquatic organisms, resulting, for example, in retarded growth, systemic disfunction, or asphyxiation in extreme cases; and

- Benthal deposition can bury bottom dwelling organisms, reduce habitat for juveniles, and interfere with egg deposition and hatching.

Although sedimentation is storm-event related, its resultant problems are not exclusively either "quantity" problems or water "quality" problems. Being hybrid problems, sedimentation control has received a mixed approach. The organizations involved range widely, from Federal agencies (e.g., the Army Corps of Engineers, the Soil Conservation Service) to local drainage and sedimentation control officials, frequently with involvement from State and county governmental agencies.

Urbanization as a Cause of Problems

Urbanization accelerates erosion through alteration of the land surface. Disturbing the land cover, altering natural drainage patterns, and increasing impervious area all increase the quantity and rate of runoff, thereby increasing both erosion and flooding potential. Also, the sedimentation products which result from urban activities are generally not as benign as the natural mineral sediments which result from soil erosion. Atmospheric deposition (associated with industrial, energy, and agricultural production activities) and added surface particulates (resulting from tire wear, auto

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exhaust, and road surface decomposition) fall in this latter category. Their effects on receiving waters tend to be more "chemical" than "physical". They may contain toxic substances and/or other compounds which can have adverse impacts upon receiving water quality and the associated ecological communities.

WATER QUALITY CONCERNS

The notion that urban runoff can be a significant contributor to the impairment or degradation of the quality of receiving waters has formed only recently and is not universally shared. It is the totality of receiving water characteristics (e.g., flow rate, size or volume, and physical and chemical characteristics) that determines its use, although some characteristics are more important than others (e.g., there must be present an appropriate rate of flow and/or volume in the receiving water to support the desired use).

In addressing the water quality needed to support a designated use, one must consider specific requisite characteristics. For example, in the case of swimming, total dissolved solids and dissolved oxygen levels are far less important than pathogenic organisms. For irrigation, the biochemical oxygen demand of the water is of little concern to the farmer, whereas the total dissolved solids level is of immense concern (to minimize salt buildup). Although high nutrient levels may be detrimental to the quality of impounded waters (by hastening eutrophication processes), a farmer may welcome nutrients in irrigation water.

It is also important to note that it is the concentration, rather than the mere presence of a water quality constituent, that affects use. The relationship between pollutant concentration and resultant impacts on receiving water use are quite non-linear, with plateau effects not uncommon. For example, consider dissolved oxygen and its effect upon fin fish. Down to a certain level below saturation, there are virtually no important effects (upon a given species). As dissolved oxygen levels fall below this threshold, the more sensitive members of the species begin to be affected. As levels continue to fall, the affected percentage of the population will increase until a level is reached at which the entire population can no longer survive. Obviously, any further reduction of dissolved oxygen level would have no further effect upon the community, since it no longer exists. It is important to keep this plateau effect in mind when considering the practical impacts of increased pollution and the practical value of remedial measures to restore beneficial uses, since limited removal of a polluting substance may do nothing to alleviate the problem. In the example given above, if one were to somehow reduce the input of oxygen demanding substances to the receiving water, the result might be that the dissolved oxygen level of the receiving water would rise from 1.0 mg/l to 3 mg/l. If the species of concern were trout, they still could not survive. Even though polluting substances were removed and money was spent, the desired benefit would not be achieved.

WATER QUANTITY AND QUALITY CONTROL

There is no question that excessive urban runoff causes problems. Remedial costs may be high, but the benefits are obvious. Currently, there is a growing national awareness that, if steps are taken during the planning phase

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of development, excessive stormwater discharges can be prevented, at least from typical events (large infrequent storms will always present a greater threat).

Past And Current Work

During the past two decades attention has been focused on reducing runoff rates and volumes and reducing flood damage. During the early 1970's, a manual of practices was prepared under grants from the Office of Water Research and Technology sponsored by the American Public Works Association stressing detention (Poertner, 1974). The University of Delaware also issued a manual of practices on methods to control rates and volumes of urban runoff (Toubier and Westmacott, 1974).

Work done by the ASCE Urban Water Resources Research Council during the sixties stressed the concept of natural easements for drainage, observing that there were two drainage ways; major routes for large events and minor routes for smaller more frequent events (Jones, 1968). It was claimed that money could be saved by using natural channels, swales, etc., thus reducing the need for more expensive concrete conveyances.

The idea of intentionally using natural runoff courses, green belts, and the like was new to engineers who had long been trying to control runoff through more artificial conveyances. In 1970, EPA's Office of Research and Development initiated work on a development known as the Woodlands project in Texas near Houston. Studies were conducted to determine how storm flows could be managed and water quality could be protected or improved by the use of natural drainage ways, detention facilities, porous pavements, increased infiltration rates, and a decrease in runoff rates (Characklis, 1979).

Federal Involvement

As part of its national effort to control erosion from agricultural lands, the Soil Conservation Service (SCS) (Department of Agriculture) provides technical assistance in developing erosion control plans. During the past decade or so, the methods they have developed have been applied much more widely than just to agricultural situations. SCS has become increasingly involved in erosion control in urban areas and has produced a useful document for assessing urban hydrology in small watersheds (SCS, 1975).

Other Federal agencies that have an interest in urban runoff and its control include the U.S. Geological Survey, the Federal Highway Administration, the Federal Housing Administration, the Tennessee Valley Authority, and others too numerous to mention.

State And Local Involvement

Although some 27 states have adopted floodplain management legislation to protect property, the control of urban drainage has traditionally been a local matter. Some states have some form of erosion control laws in force; however few states have runoff rate/quantity legislation. This situation has begun to change over the last decade, and Maryland is one example where the statewide legislation for stormwater management is implemented at the county level.

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The methods used tend to be preventive, wherein erosion is controlled by prescribing certain proven design practices and conventions. Many local agencies are developing control plans along these lines, so this report will not cover this aspect of control.

PROBLEM DEFINITION

As pointed out earlier, water quantity problems are relatively easy to identify and describe. Water quality problems, on the other hand, tend to be more elusive because their definition often involves some subjective considerations, including experiential aspects and expectations of the populace. They are not immediately obvious and are usually less dramatic than, for example, floods. They also tend to vary markedly with locality and geographic regions within the country. For example, a northwestern resident may want to upgrade stream quality to support some highly-prized species of game fish, while a northeastern resident contemplating the river flowing by the local factory might be grateful to see any game fish at all. Thus, a methodological approach to the determination of water quality problems is essential if one is to consider the relative role of urban runoff as a contributor. An important finding of the work conducted during this NURP program has been to learn to avoid the following simplistic logic train: (a) water quality problems are caused by pollutants, (b) there are pollutants in urban runoff, therefore, (c) urban runoff causes "problems". The unspoken implication is that a "problem" by definition requires action, and any type of "problem" warrants equally vigorous action. It becomes clear that a more fundamental and more precise definition of a water quality "problem" from urban runoff is necessary. For this purpose, the NURP has adopted the following three-level definition:

- Impairment or denial of beneficial uses;
- Water quality criterion violation; and
- Local public perception.

The first of these levels refers to cases of impairment or denial of a designated use. An example would be a case where a determination has been made that some specific beneficial use should be attained; however, present water quality characteristics are such that attainment of the use cannot be fully realized.

The second level of problem definition refers to violations of a designated water quality criterion. An example would be a case where some measure or measures of water quality characteristics have been found to violate recommended or mandatory levels for the receiving water classification. Some of the subtle distinctions between this and the preceding problem definition arise in the fact that receiving water classification may not be appropriate, the beneficial use may not be impaired or denied, and the water quality criteria associated with that classification may or may not be overly conservative or directly related to the desired use.

The third level of problem definition involves public perception. This may be expressed in a number of ways, such as telephone calls to public officials

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complaining about receiving water color, odor, or general aesthetic appearance. Public perception of receiving water body problems is highly variable also. Some people enjoy fishing for carp or gar, children will play in almost any creek, and so on. This level of problem definition can also include one concept of anti-degradation. Here the thought is that no polluting substances of any kind in any quantity should be discharged into the receiving water regardless of its natural assimilative capacity. This concern has its ultimate expression in the "zero discharge" concept. EPA's concept of anti-degradation, on the other hand, refers to degradation of use; a subtle but essential difference.

The foregoing levels of problem definition provide an essential framework within which to discuss water quality problems associated with urban runoff. However, it is important to understand that when one is dealing at a local level all three elements are typically present. Thus, it is up to the local decision makers, influenced by other levels of support and concern, to carefully weigh each, prior to making a final decision about the existence and extent of a problem and how it is to be defined. It follows that, if this step of problem definition is done carelessly, it will be difficult, if not impossible, to plan an effective control strategy and establish a means for assessing its effectiveness.

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CHAPTER 4
STORMWATER MANAGEMENT

INTRODUCTION

This chapter is included for those who wish to know more about how to plan and implement stormwater management programs. Most of the information contained herein was developed through several related programs that were proceeding in parallel with the NURP program.

- The Southeast Michigan Council of Governments (SEMCOG), a NURP grantee, was developing stormwater management procedures.
- The Midwest Research Institute (MRI) was collecting cost information on control practices from selected NURP projects.
- A related EPA Water Planning Division program, the Financial Management Assistance Program (FMAP), was developing financial and institutional planning procedures designed to be helpful in the implementation of stormwater management plans.

STORMWATER MANAGEMENT PLANNING[1]

Stormwater management planning develops policies, regulations, and programs for the control of runoff from the land. Stormwater management planning is normally directed toward either or both of two primary goals: the reduction of local flooding and/or the protection of water quality. However, stormwater management planning is also generally used to insure that stormwater programs and regulations provide multiple benefits to the affected communities and do so in a way that does not create additional problems.

Stormwater management planning need not involve expensive technical studies. Available data and maps, the experience of other communities, and advice from experts can be used to develop an effective planning program. Detailed technical studies can then be targeted toward specific issues and problems. Effective local planning can alleviate the need for costly remedial public works projects.

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[1] The material in this section of the chapter is largely from Technical Bulletin No. 1: Stormwater Management Planning: Cost-Saving Methods for Program Development, the first of a seven-part bulletin series on water quality management prepared by the Southeast Michigan Council of Governments and available from Information Service, SEMCOG, 8th Floor, Book Building, Detroit, Michigan 48226.

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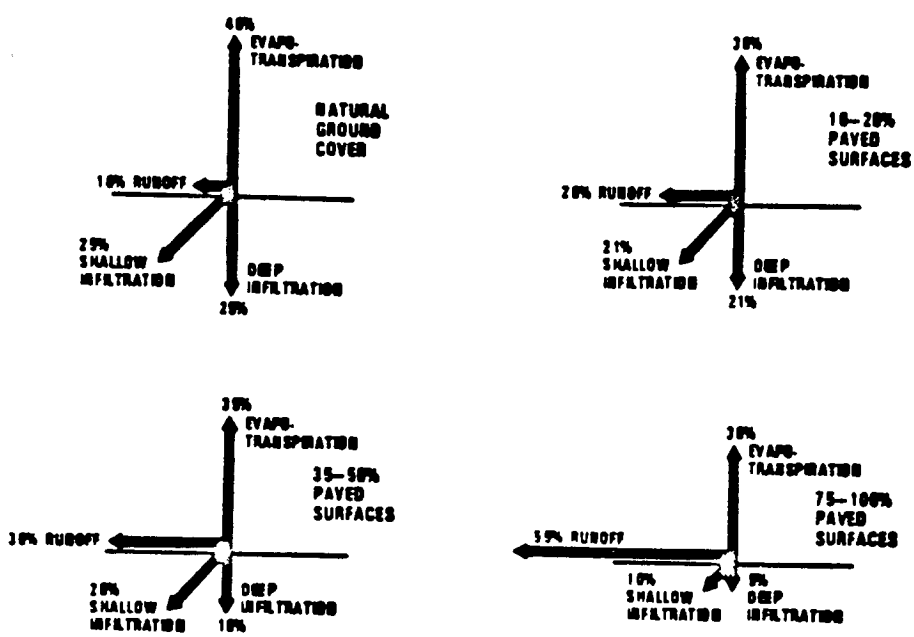
The Need

Stormwater runoff cannot be ignored in developing communities. As urban development occurs, the volume of stormwater and its rate of discharge increase. These increases are caused when pavement and structures cover soils and destroy vegetation which otherwise would slow and absorb runoff. Pollutants, washed from the land surface and carried by runoff into lakes and streams, may add to existing water quality problems.

Figure 4-1 illustrates the effects of paved surfaces on stormwater runoff volumes. When natural ground cover is present over the entire site, normally less than 10 percent of the stormwater runs off the land into nearby creeks, rivers, and lakes. When paved surfaces cover 10 to 30 percent of the site area, approximately 20 percent of the stormwater can be expected to run off. As paved surfaces increase, both the volume and the rate of runoff increase. Furthermore, paved surfaces prevent natural infiltration of stormwater into the ground, and increased runoff volumes and rates increase soil erosion and pollutant runoff. Stormwater management planning can be used to develop programs to reduce adverse affects and even to provide community benefits.



Source: J.T. Tourbier and R. Westmacott, *Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development*, p. 3.

Figure 4-1. Typical Changes in Runoff Flows Resulting from Paved Surfaces

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Stormwater management can and should be directed toward two goals: the control of runoff flows (i.e., volumes and rates) and the control of pollutants in stormwater. Control measures which emphasize the storage of runoff rather than the immediate conveyance from the site and from the community often provide benefits which meet both goals. Stormwater storage and conveyance measures, however, affect the community in a variety of ways. Through stormwater management planning the effects of alternative policies, programs, control measures, and financing schemes can be evaluated.

Stormwater management planning is directed toward basic policy questions, such as:

- What should be done with runoff from the land?
- Is the temporary (detention) or permanent (retention) storage of stormwater runoff desirable?
- Under the circumstances, should retention basins, detention basins, natural infiltrstion areas, or dished parking lots be used to store runoff?
- What requirements should be placed on new developments?
- Do stormwater runoff problems in developed areas warrant special attention?
- Should communal retention or detention facilities be provided by the local jurisdiction? If so, how can such areas be financed?
- Who should pay for retention and detention facilities on private property?
- Are the local jurisdictions already carrying out programs (such as parkland acquisition programs or wetlands regulation) which affect stormwater runoff? Can programs and/or regulations be coordinated to achieve multiple purposes?
- Should enclosed drains or natural channels be used to convey stormwater to and from storage areas?
- Can routing and storage be provided for major storms (e.g., 100-year frequency) as well as minor storms (e.g., 10-year frequency)?
- Who should be responsible for facility maintenance?

The specific questions to be addressed in a local government planning program will vary among local jurisdictions, reflecting varying problems and community objectives. The answers to these questions may take the form of policy statements, changes in regulations or engineering design standards, technical assistance materials for landowners or consulting engineers, revisions to existing programs, or a written plan document.

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Because stormwater management planning for quantity and quality control is relatively new, and because community stormwater concerns differ, there are no easy formulas for preparing stormwater management plans.

Stormwater Runoff as a Community Resource

Although, stormwater management programs are typically undertaken to avoid problems (e.g., flooding, pollution, lawsuits), effective planning can also be used to pursue potential community benefits. When effectively managed, stormwater can provide benefits such as:

- Recharge of groundwater supplies;
- Water quality enhancement;
- Recreational opportunities (e.g., use of large retention areas for boating, fishing, or nature study);
- Replenishment of wetlands which serve as wildlife habitats, absorb peak floods, and naturally break down certain pollutants;
- Maintenance of summertime lake levels and stream flows; and
- Enhancement of community appearance and image when facilities are attractively designed.

The Role of Local Governments

In some cases, the institutional systems for stormwater management may need to be complex, largely because State, county, and local agencies' policies, regulations, and procedures may all affect stormwater control within a particular development. For example, in Michigan, the following roles apply:

- County drain commissioners construct and manage county drains and also review subdivision plans to assure adequate drainage.
- County highway departments affect drainage in new developments by regulating connections to roadside drains and ditches.
- The State Department of Natural Resources regulates wetlands, dam construction, and floodplain alterations.
- The State Water Resource Commission issues permits for certain stormwater discharges when known water quality problems can be linked with a particular activity, (e.g., certain storm drains, animal feeding operations, industrial parking lots).
- Both the State Department of Public Health and county drain commissioners regulate drainage in proposed mobile home parks.
- County agencies and certain local governments issue erosion and sediment control permits for certain development sites.

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Furthermore, there has been increasing emphasis upon the consideration of environmental factors in land use decisions. Recent amendments to the City or Village Zoning Act and the Township Rural Zoning Act have clarified the legal authority of local governments to complete site plan reviews for environmental management purposes. Standards for the review of land uses must be included in local ordinances and take natural resource preservation into account. The Michigan Environmental Protection Act (MEPA) (Act 127, P.A. of 1970) places a duty on all government agencies to prevent or minimize water pollution and other environmental problems while carrying on regular activities. Section 5(2) of MEPA addresses the actions of local officials in the following terms:

> In any ... administrative, licensing or other proceedings, and in any judicial review thereof, any alleged pollution impairment or destruction of the air, water or other natural resources or the public trust therein, shall be determined, and no conduct shall be authorized or approved which does, or is likely to have such effect so long as there is a feasible and prudent alternative consistent with the reasonable requirements of the public health, safety and welfare.

Environmental aspects of stormwater runoff may be addressed by local officials in response to MEPA.

None of the above laws specifically require local governments to undertake stormwater management programs. Instead, local governments have a wide range of possible roles available to them. Stormwater management planning programs can be directed toward the review of existing State and county programs affecting stormwater runoff and toward the evaluation of alternative roles for the local government.

Possible roles for local governments in stormwater management include the following:

- Planning - The term "stormwater management planning" refers to the process of developing policies, programs, regulations, and other recommendations to chart the future course of the community in terms of stormwater management. Such planning can address existing problems or help to avoid future problems and community expenses.

- Regulations - Stormwater runoff control for each site plan and subdivision plan can be reviewed and approved by the local government.

- Design and Construction - Storm drainage facilities (e.g., pipes, basins, areas for retention) can be designed and constructed by the local government. Purchase of lands to serve as community stormwater retention areas may also be undertaken.

- Inspection and Maintenance - Requirements for regular inspection and maintenance of stormwater facilities, including drains and retention or detention basins, may be enforced by

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local governments. Requirements for easements are usually part of maintenance programs. Local governments may choose to undertake maintenance as a community service (such as a utility) or may require maintenance through contractual agreements with property owners.

The types of programs developed and the role assumed by a local government should, of course, reflect available financing options as well as program needs and management gaps.

FINANCIAL AND INSTITUTIONAL CONSIDERATIONS[2]

The traditional planning approach would ideally culminate in the successful implementation of a detailed design. In many cases, however, this objective is not accomplished due to financial and institutional constraints. Often a study team will fail to adequately consider such institutional and financial issues as who will manage the system and how will it be financed, thus creating a gap between technical planning and implementation. This omission is illustrated in Figure 4-2.

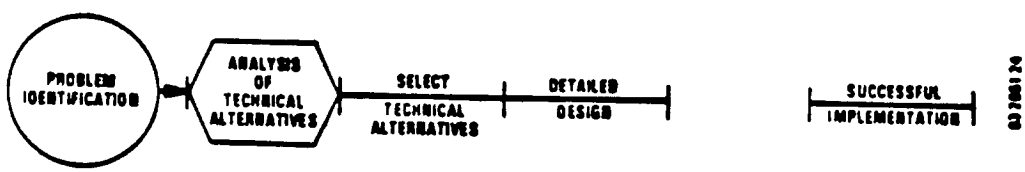

Figure 4-2. Incomplete Water Quality Planning

The implementation gap that results from the traditional planning approach has occurred all too often in attempts to control urban runoff.

As an illustration of the need to integrate financial and technical planning, consider the traditional process for developing a program to control construction runoff. A typical outcome of the process is a new ordinance. To reach this outcome, some of the issues that are normally considered from the technical perspective include:

- What are the technical construction requirements to be set out in the ordinance?
- What control measures will be required?
- How will compliance be monitored?

[2] This material is largely from the draft document, Planning for Urban Runoff Control: Financial and Institutional Issues, December 1981, prepared for FMAP by the Government Finance Research Center of the Municipal Finance Officers Association, Washington, D.C.

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To balance the planning process, this technical analysis should be expanded to include financial and institutional issues such as:

- Does the city have legal authority to implement each requirement in an ordinance?

- How much will each cost, and who will pay for implementation of the control measures?

- Who will conduct compliance review, and who will pay for the reviews?

Numerous additional factors increase the need for financial and institutional analysis in all water quality management planning. Examples might include:

- Implementation of control programs occurs at the local level, and local budgets are being tightened as water quality expenditures compete with other local demands.

- Benefits from water quality projects are difficult to quantify and often accrue to people living downstream.

- It is becoming more difficult to obtain municipal funds through the bond market because of high interest rates.

- The cost of pollution controls is often sizable and difficult to allocate to specific polluters or beneficiaries.

These problems affect most areas of water quality management, but they are especially important in identifying and implementing solutions to urban runoff pollution.

Integrated Approach

An integrated planning approach helps water quality planners make the best control decisions in light of many complex issues. This approach takes the traditional planning process and adds to it financial and institutional elements at each step along the way. This integration is shown in Figure 4-3, with the traditional approach illustrated along the upper track and the financial and institutional elements added along the lower track.

During the early planning stages, financial and institutional issues are reviewed on a preliminary basis. This information becomes more detailed and refined as planning proceeds. Ultimately, the information forms the basis for a financial and institutional plan that supports the detailed design of a control alternative.

When very complex problems are being evaluated, it may be advisable to use a preliminary matrix early in the evaluation process for screening-out unacceptable alternatives. This approach permits a more detailed evaluation of issues surrounding the two or three best alternatives before a final selection is made. An example of a preliminary matrix is given in Figure 4-4.

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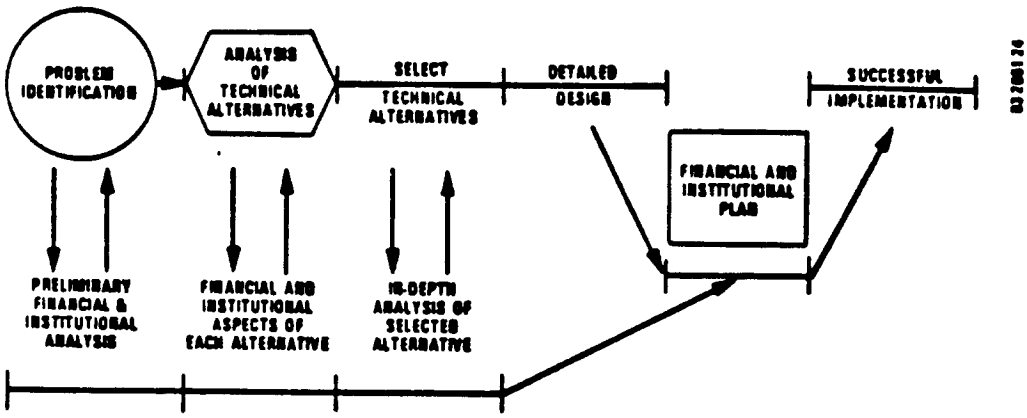

Figure 4-3. Integrated Water Quality Planning

CONTROL APPROACH	TECHNICAL DESCRIPTION	EFFECTIVENESS IN CONTROLLING POLLUTION	FINANCIAL ISSUES		INSTITUTIONAL ISSUES
			NET PRESENT VALUE	ABILITY TO PAY	
• SEPARATE SEWERS	CONSTRUCT NEW STORM SEWERS IN COMBINED AREAS	100% EFFECTIVE IN ELIMINATING CSOs	$1 BILLION	EXCEEDS CITY'S BONDING CAPACITY	EXISTING INSTITUTIONS COULD HANDLE THE PROJECT
• SELECTIVE EXPANSION OF UNDERSIZED TRUNK SEWERS	REMOVE BOTTLENECKS, REDUCE NUMBER OF OVERFLOW EVENTS	50% EFFECTIVE	$200 MILLION	IF STAGED OVER 10 YEARS, COULD BE FINANCED BUT WOULD RESTRICT OTHER PROGRAMS	EXISTING INSTITUTIONS COULD HANDLE THE PROJECT
• CONSTRUCTION OF DETENTION BASINS	CONSTRUCT 10 DETENTION BASINS SIZED TO HOLD THE FIRST FLUSH FROM A STORM	30% EFFECTIVE	$50 MILLION	IF STAGED OVER 5 YEARS, COULD BE FINANCED; COULD RESTRICT OTHER PROGRAMS	NEW ORGANIZATION MIGHT BE NEEDED TO MAINTAIN AND AND OPERATE BASINS

Figure 4-4. Preliminary Matrix for Selection of a Control Approach (Combined Sewer Overflows)

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Once a control approach is selected, a detailed design and a financial and institutional plan can be prepared. Figure 4-5 illustrates the major features of a financial and institutional plan. Key features of the detailed analysis required to prepare this plan are discussed in the following section.

INSTITUTIONAL SECTION

- RESPONSIBLE AGENCY
  - OPERATING PLAN
  - STAFFING NEEDS
  - ORGANIZATIONAL STRUCTURE
- LEGISLATIVE NEEDS
  - LEGAL ANALYSIS
  - DRAFT ORDINANCES
  - ASSISTANCE NEEDED

FINANCIAL SECTION

- PROGRAM COST
  - OPERATING BUDGET
  - CAPITAL REQUIREMENTS
- PROGRAM REVENUE
  - FUNDING SOURCES
  - FLOW OF FUNDS
  - PROGRAM CASH FLOW
  - COST ALLOCATION FORMULA
- OTHER FACTORS
  - FINANCIAL BURDEN ON PARTIES PAYING FOR THE PROGRAM
  - SENSITIVITY OF COST AND REVENUE ESTIMATES TO CHANGES IN FINANCIAL ASSUMPTIONS
  - INDIRECT IMPACTS

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Figure 4-5. Major Components of a Financial and Institutional Plan

Key Financial and Institutional Elements

There are six essential elements[3] of financial and institutional analysis which provide a structure for the integrated planning process;

- institutional assessment,
- cost analysis,
- revenue analysis,
- ability-to-pay analysis,
- sensitivity analysis, and
- indirect impact analysis.

[3] These elements were first defined in Planning for Clean Water Programs: The Role of Financial Analysis, U.S. EPA's Financial Management Assistance Program by the Government Finance Research Center of the Municipal Finance Officers Association, September 1981.

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Each of these elements threads through the planning process and becomes more definitive as the process proceeds. The following discussion defines each element and identifies its major features.

Institutional Assessment

The institutional assessment identifies the organizations or participating agencies that would be affected or involved in implementing a particular control program. The role of each entity in a program is evaluated with respect to its interest in solving the problem and its planning, management, operating, and regulatory capabilities. If the study team identifies an urban runoff problem, a preliminary institutional analysis can provide insight into capabilities of agencies that may be asked to play a role in the implementation and can, in some cases, aid in determining the types of technical alternatives that are analyzed.

The key factors to consider in evaluating an agency's capabilities are its statutory authority and organizational ability. In order to control urban runoff, an agency must have or be able to obtain the authority to implement a control measure. The authority of an agency can be assessed by thoroughly reviewing applicable federal, state, and local legislation. This review helps to determine which agency can best manage a given problem and highlights areas where additional legislation or local ordinances are needed.

Cost Analysis[4]

A cost analysis is performed to identify the additional capital, operational, maintenance, and administrative costs of each activity that is part of a control program. These costs are estimated for each agency responsible for an activity. Cost estimates are prepared in uninflated dollars (using today's cost for all projections into the future) and brought back to their present value (or present worth) for comparison among alternatives. The interest rate to be used in the present value analysis is the agency's current interest rate for borrowing funds minus the expected rate of inflation.[5]

Cost analysis of control alternatives is included in increasing detail in each step of the planning process. It begins with "ball park" estimates in early stages which are refined as the process progresses and finalized in the detailed financial plan.

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[4] A substantial part of this material is from a report, Collection of Economic Data from Nationwide Urban Runoff Program Projects, prepared for EPA by the Midwest Research Institute, 425 Volker Boulevard, Kansas City, MO 64110.

[5] For a further discussion of present value analysis, see pp 36 to 42 of Facilities Planning 1981, U.S. Environmental Protection Agency, FRD-20, 1981.

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Cost estimates cannot be static. They are prepared on a preliminary basis when an alternative is first considered and detail is added as an alternative becomes more feasible. As the planning process progresses, estimates are updated on a regular basis to account for changing costs.

To update and improve available data on the costs of specific urban runoff BMPs, EPA conducted a program to guide, assist, and coordinate the efforts of selected NURP projects in gathering cost data on the BMPs and BMP systems which they were evaluating as part of the NURP national workplan. A report[6] was prepared to summarize the preliminary economic data submitted by the NURP projects. Economic data were submitted for street sweeping, detention basins, catch basin cleaning, ocean discharge control systems, and a public education/information program by nine projects. The data must be considered preliminary and subject to change, particularly annual operating cost data. Most of the capital cost data are well documented and represent the actual cost of the BMP control and will not change. The annual operating cost data, however, range from detailed analyses to estimates, and some of the data reported are incomplete. Since most of the projects were still in progress, incomplete operating cost data were to be expected.

The capital costs of street sweepers varied from $21,988 (in 1975) to $40,000 in 1981. The annual operating costs of street sweeping programs varied from $53,445 to $1,138,097. The unit cost varied from $16.80 to $45.45 per hour of operation, and from $5.95 to $23.36 per curb-mile swept. This wide range indicates that many variables affect the actual cost of operating a street sweeper.

The installed capital costs of recharge basins in Fresno, California, ranged from $933,750 to $5,587,000. BMP modifications to three detention basins in Oakland County, Michigan, cost $2,345 to $8,442. The installed capital cost of the modifications to the wet pond in the Lansing, Michigan project was $50,149. Construction of the wet pond in the Salt Lake County, Utah project cost $41,138; modifications to the dry pond included placing aluminum plates in an existing underdrain and installing a redwood outlet skimmer at a nominal cost of $371.

The annual operating costs of the Fresno, California, basins range from $1,625 to $7,975. The annual cost for the basin in Lansing, Michigan is incomplete and includes only the interest cost on a 7 percent, $38,500 bond used to help finance the project. The annual operating costs for the ponds in the Salt Lake County, Utah project were estimated at $560 for the wet pond and $200 for the dry pond.

The costs of the structural control alternatives to control discharge to the ocean in Myrtle Beach, South Carolina, were presented in detail and are valid estimates of the costs that will be incurred if one of them is constructed.

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[6] Collection of Economic Data From Nationwide Urban Runoff Program Projects - Final Report, April 7, 1982, EPA Contract No. 68-01-5052. Detailed cost data provided by the projects are included in the appendices of this Report to show how the various projects prepared the data for submission.

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The 1980 construction cost estimates ranged from $32,849,200 to $50,973,500, and the annual operating cost estimates ranged from $3,735,400 to $5,301,900. The cost of the public education program at Salt Lake County, Utah, was estimated at $1,550. The project will report the actual cost of the program upon its completion.

Revenue Analysis

The revenue analysis identifies the funding sources needed to match the estimated cost for control activities by participating agencies. This analysis is important because it ensures adequate funding to implement the technical solution to an urban runoff problem.

There are three categories of funding that are typically used to pay for runoff control: Federal and State funds, local public funds, and private funds. These sources include a variety of different financing mechanisms, each with advantages and disadvantages. The use of any or a combination of these sources requires consideration regarding:

- Revenue adequacy - Will funds be available in the long- and short-term?
- Equity - Are the beneficiaries of the control program paying their full share?
- Economic efficiency - Is the charge that is assessed equal to the social cost of the program?
- Administrative simplicity - Can the funds be managed and directed to the control program without significant administrative problems?

Ability-to-Pay Analysis

The ability-to-pay analysis evaluates the implementing agencies' and the individual user's ability to pay for the proposed program by determining how reasonable a proposed revenue program is in terms of its overall impact on the community as a whole as well as on individual residents.

For a given revenue source, the additional burden of the program is expressed as a percentage of the base costs. For example, if the proposed program is to be financed by property taxes and it adds $.50 to a $1,000 tax bill, the additional tax burden is .05 percent. In this instance, it would appear that the homeowner's ability to pay is quite high.

An important factor to remember is that programs to control urban runoff are not the only programs that are placing a burden on the people or institutions who must support them. Hence, the cost of a control program may not be excessive but cannot be imposed because ability to pay has already been exceeded due to other projects.

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Sensitivity Analysis

The sensitivity analysis identifies the extent to which local ability to pay varies with changes in the assumptions used to estimate costs and revenues. Major assumptions that influence costs and revenues are: phasing of capital improvement, anticipated local funding requirements, rate of inflation, growth rate, and local fee policies.

The first step in this analysis is to determine a range of values for key cost and revenue assumptions that could occur during the program. (For example, inflation may vary between 5 percent and 15 percent.) The ability-to-pay analysis is then repeated using the high and low values for these assumptions. The final step is to evaluate the changes in burden with "best-" and "worst-" case situations in comparison with burden under the "most likely" assumption.

The purpose of this analysis is to identify control programs that are least vulnerable to changing conditions. It also helps to make the planner aware of best- and worst-case scenarios so that contingency plans can be developed to cope with such events.

Indirect Impact Analysis

The indirect impact analysis is an assessment of the costs and benefits that are not directly attributable to a proposed program. These costs and benefits can be economic, social, and/or environmental. Quantifying the indirect impacts of a program is usually quite difficult, so the planner generally resorts to qualitative measurement.

An Example: Planning an Educational Program

To illustrate further the process of identifying and resolving the financial and institutional issues connected with implementation of an urban runoff control program, the following spells out the steps involved in evaluating one control approach applicable in already developed areas. The example chosen is an educational program to inform citizens, industry, and public agencies of the problems caused by runoff-borne lawn and garden chemicals, oil and chemical residuals from industrial yards, and pesticides, herbicides, and fertilizer from parks and golf courses.

In this example, the activities would include: development of an informational brochure, including printing and distribution, and maintenance of an information center. In Figure 4-6, the institutional characteristics needed to accomplish these activities are compared with the capabilities of existing agencies. The matrix shows that the County Department of Pollution Control could provide the technical input to the Public Information Center to write the brochure. The Council of Governments might coordinate the effort and assume overall responsibilities for getting the job done.

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INSTITUTIONAL CHARACTERISTICS NEEDED	AGENCIES					
	STATE	COUNCIL OF GOVERNMENTS	DEPARTMENT OF POLLUTION CONTROL	DEPARTMENT OF PLANNING	PUBLIC INFORMATION CENTER	CHAMBER OF COMMERCE
• COMMITMENT TO PROGRAM GOALS	*	*	*	*	*	*
• WORKING KNOWLEDGE OF EACH WASTE CONTRIBUTION TO THE RUNOFF PROBLEM	*	*	*	*		
• ABILITY TO WRITE CLEAR AND CONCISE INFORMATION FOR THE PUBLIC					*	
• ABILITY TO PRINT AND AND DISTRIBUTE BROCHURE				*		
• STAFF TO RECEIVE FOLLOWUP CALLS		*				* DISTRIBUTE TO INDUSTRY
• ABILITY TO ACCEPT FUNDS FROM SEVERAL AGENCIES TO PAY FOR THE PROGRAM		*				

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Figure 4-6. Institutional Assessment for Educational Program to Control Chemical Substances

Cost Analysis. Cost analysis determines the additional funds needed to implement a control alternative, including capital improvements and operation and maintenance. Additional administrative costs are less significant because most of these projects are undertaken by a public agency that is already performing the function to some extent.

Capital cost estimates are best prepared by the water quality planner with the assistance of the municipal engineer and in some cases his/her outside engineering advisor. These estimates identify all costs related to the purchase of a new facility or piece of equipment for a project and may require some research into vendor prices and bids on similar projects around the country. For programs which require changes to existing practices (street sweeping, etc.), the cost attributable to the water quality program is the incremental cost of the program.

Ultimately, the cost analysis is used to identify the least-cost method(s) for reducing pollution problems. It is important to remember that all costs associated with a given program must be considered. It is incorrect to assume that educational efforts, for example, are provided at no additional cost.

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As an example of a cost analysis, a possible budget sheet for the educational program for the current year is presented in Figure 4-7.

ACTIVITIES	AGENCIES					
	STATE	COUNCIL OF GOVERNMENTS	DEPARTMENT OF POLLUTION CONTROL	DEPARTMENT OF PLANNING	PUBLIC INFORMATION CENTER	TOTAL
1. DEVELOP BROCHURE					$13,000	$13,000
2. PRINT BROCHURE				$1,500		$ 1,500
3. DISTRIBUTE BROCHURE				$ 800		$ 800
4. CONDUCT INFORMATIONAL MEETINGS	$2,000	$ 8,500	$2,000			$ 8,500
5. STAFF FOLLOWUP FOR PROGRAM		$24,000				$24,000
TOTAL	$2,000	$29,500	$2,000	$2,300	$13,000	$48,800

Figure 4-7. Cost Analysis for Educational Program to Control Chemical, Herbicide, Fertilizer and Pesticide Runoff

Revenue Analysis. After the program cost estimate is prepared, the potential sources of revenue are analyzed. There are several critical factors in analyzing revenue for urban runoff programs including:

- Cost/Revenue Balance - Will the revenues be sufficient to cover the costs on an annual basis?

- Equitable Allocation of Costs to Different Groups - Do those who contribute to the problem pay their fair share? Do those who benefit from the program pay their fair share?

- Revenue Agreement - Do groups understand their participation in a program and its revenue formula? Have written agreements which define the cost allocation procedure been prepared ?

Revenue analysis will vary with the type of control approach selected. The critical factor in the revenue analysis is the identification of each entity that will provide revenues and the development of an understanding by that entity of the problem, the control approach, and its share of the cost.

Ability-to-Pay Analysis. Most of the costs to control runoff from developed areas are imposed on the general public or the benefiting population as a new and additional governmental expense. The ability-to-pay analysis evaluates this increased burden on the local community as a percentage of property taxes, average income, property evaluation, or other appropriate measures.

Figure 4-8 illustrates an ability-to-pay analysis for the educational program example. The key parameters to determine homeowners' ability to pay in this case are the cost of the program per household, cost as a percentage of average annual household income, and cost as a percentage of property taxes.

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A. TOTAL PROGRAM COST (ONE-YEAR PROGRAM)	$48,000	
B. NUMBER OF HOUSEHOLDS AFFECTED	19,000	
C. COST PER HOUSEHOLD (A DIVIDED BY B)		$2.57
D. MEDIAN HOUSEHOLD INCOME	$14,700	
E. COST AS A % OF MEDIAN HOUSEHOLD INCOME (C DIVIDED BY D TIMES 100)		.02%
F. AVERAGE ANNUAL PROPERTY TAXES	$ 1,200	
G. COST AS A % OF PROPERTY TAXES (C DIVIDED BY F TIMES 100)		.21%

CONCLUSION: PROGRAM APPEARS TO NOT PLACE EXCESSIVE BURDEN ON LOCAL HOMEOWNERS

Figure 4-8. Ability to Pay Analysis for Educational Program to Control Chemical, Herbicide, Fertilizer and Pesticide Runoff

Sensitivity Analysis. The sensitivity analysis will vary depending upon the revenue mechanism and program selected for implementing a proposed program. The most common revenue mechanisms for programs controlling runoff from developed areas are general funds and fees. Analyzing the sensitivity of general revenues requires a review of past collections relative to key parameters--inflation, housing starts, collection rates, capital improvements, and so on. Collections are then projected for worst and best case scenarios.

An additional consideration in the sensitivity analysis is revenue requirements. This relates to phasing a program, either handling capital improvements or starting a program on a limited basis with expansion to come in later years. For any one program, numerous options exist for staggering cash flows, and different scenarios should be developed to assess their impact on the program as part of the sensitivity analysis.

Indirect Impact. The indirect impact of a runoff control program for developed areas are extremely difficult to quantify. Educational programs will raise community awareness regarding the impacts of local activities on water pollution. Other indirect impacts from control programs may relate to recreational benefits, local improvements in quality of life, and increased tourism.

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RELATIONSHIP BETWEEN NURP AND WQM PLANS

Of the locations selected for projects under the NURP effort, some 80 percent had state-approved (i.e., certified by the Governor) water quality management (WQM) plans with elements which addressed urban runoff. For 5 of these locations, the NURP project constituted the urban runoff element of the plan. For the other locations, however, the original 208 effort was unable to develop the necessary information on either water quality effects or performance of best management practices (BMPs) to justify structuring formal implementation plans for urban runoff control. Consequently, the typical WQM plan elements dealing with urban runoff identified the need for further study, usually specifying problem assessment and BMP performance evaluation. These elements became the focal points of the activities funded by NURP.

The WQM plans for the remaining 20 percent of the locations which participated in the NURP program did not contain a specific urban runoff element. Presumably this was due to time and resource constraints in relation to other issues which were assigned higher priorities in planning efforts. In these cases, the NURP projects provided the opportunity to address a water quality issue not adequately addressed in the original 208 planning studies.

Over two-thirds of the NURP project locations reported that NURP findings and recommendations have or will be incorporated in the next annual update of their formal WQM plans. The remainder generally indicate that they expect the planning issues to be addressed at the local level or that NURP results will support planning and implementation activities, even though they do not anticipate formal incorporation in WQM plans at this time.

Over half of the NURP project locations report either active or planned implementation efforts based on the results of NURP. Thirty percent indicated that no implementation is being planned because the need for or value of urban runoff control was not demonstrated. The balance (20 percent) of the NURP locations suggest that while implementation activities are not currently planned, they expect NURP results to influence future deliberations on this issue.

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CHAPTER 5
METHODS OF ANALYSIS

INTRODUCTION

This chapter identifies and briefly discusses the methods adopted to assemble and analyze the large data base developed by the NURP projects and also provides the methods employed to develop and interpret results. The chapter is structured according to the three prime areas of program emphasis; (1) characteristics of pollutants in urban runoff, (2) water quality effects of urban runoff discharges including water quality criteria/standards violations and impairment or denial of beneficial uses of receiving water bodies, and (3) the effectiveness of control measures to reduce pollutant loads.

The procedures employed in this assessment were designed to provide generalized results and findings about urban runoff issues of interest for nationwide use. This national perspective, and the need to consider the fundamental variability of urban runoff processes, has prompted some significant advancements in the application of statistical methods and models. The basic methods used were, however, largely developed under different EPA efforts, many under the sponsorship of the Office of Research and Development, or other programs. In some cases, similar or equivalent procedures were applied in individual NURP projects; in other cases, methods adopted by individual projects in response to local needs and interests were different. Where possible, comparisons have been made between either detailed results, or conclusions drawn from such results, as derived from both local and national perspectives.

The descriptions provided in this chapter are brief and intended to communicate the technical framework upon which the results and conclusions are based. More detailed information on the methods and techniques are contained in other documents developed by NURP. Pertinent NURP reports cover, in separate volumes, probabilistic methods for analyzing water quality effects, detention and recharge basins for control of urban stormwater quality, and street sweeping for control of urban stormwater quality. The Data Management Procedures Manual, another of the project documents, is an additional source of information on details of the analysis methods utilized.

Because field measurements and sampling formed one of the most important information sources, it was essential that the monitoring and analysis programs produce consistent and sound data. Accordingly, NURP required that all projects adopt Quality Assurance/Quality Control elements as integral parts of their work plans. Key components of these plans include the following:

- Program Coordination. Projects were required to designate a QA/QC coordinator, responsible for the entire QA/QC effort.

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- Field Quality Assurance. Guidance was provided to the projects for all key aspects of the data collection process.

- Laboratory Quality Assurance. A manual prepared by EPA's Environmental Monitoring and Support Laboratory was provided to all projects and contained analytical quality control information.

- Data Management. A manual entitled "Data Management Procedures" was provided to all projects and covered such topics as data formatting, data reduction, and some analysis.

- Data Analysis. To encourage innovative approaches and responsiveness to local conditions, uniform methods of data analysis were not stressed. Technical guidance and mandatory review of analytical procedures were provided.

URBAN RUNOFF POLLUTANT CHARACTERISTICS

General

A substantial component of the individual NURP projects was the acquisition (and subsequent analysis) of a data base for a number of storm events, consisting of precipitation and the resulting quantity and quality of runoff from a number of local urban catchments. One of the principal EPA objectives in the analysis of these data has been to develop a concise summary of the characteristics of urban runoff. There are a number of questions concerning urban runoff characteristics which need to be addressed for water quality planning purposes, including what are the appropriate measures of the statistical characteristics of urban runoff (e.g., population distribution, central tendency, variability, etc.)? Do distinct subpopulations exist and what are their characteristics? Are there significant differences in data sets grouped according to locations around the county (geographic zones), land use, season, rainfall amount, etc.? How may these variations be recognized? What is the most appropriate manner in which to extrapolate the existing data base to locations for which there are no or limited measurements? Though these questions cannot be fully answered given the current state of knowledge concerning urban runoff, these are the types of issues addressed by the methods described in this chapter and the results presented in Chapter 6.

The principal thrust of the individual NURP projects, and thus this nationwide assessment report, was the characterization of what has been adopted as "Standard Pollutants" of primary concern in urban runoff. These include solids, oxygen consuming constituents, nutrients, and a number of the more commonly encountered heavy metals. The methods used to characterize these standard pollutants are described under a separate heading below.

In approximately two-thirds of the NURP projects the occurrence of compounds on EPAs list of "Priority Pollutants" was investigated. This program element is also described under a separate heading below. A number of additional factors have also been addressed in the program. These are briefly discussed

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below because they relate closely to the general issue of pollutant characteristics. These include the following:

- Soluble vs Particulate Pollutant Forms. The distribution of soluble and particulate forms of a pollutant in urban runoff (particularly metals and nutrients) was examined in both the standard conventional pollutant and priority pollutant aspects of the study because certain beneficial use effects depend strongly on the form in which the contaminant is present. The priority pollutant program additionally determined "Total Recoverable" fractions, corresponding to contaminant forms used in EPA's published toxic criteria guidelines.

- Coliform Bacteria. Fecal coliform bacteria counts (and in some cases total coliform and fecal streptococcus as well) in urban runoff were monitored during a significant number of storms by seven of the NURP projects. Though the data base for bacteria is restricted, useful results are provided in Chapter 6.

- Wetfall/Dryfall. As part of program elements designed to examine sources of pollutants in urban runoff, a number of projects operated atmospheric monitoring stations for characterizing pollutant contributions from precipitation (wetfall) and from dry weather deposition (dryfall). Results of this work are reported in individual project reports and not included herein.

Standard Pollutants

The following constituents were adopted as standard pollutants characterizing urban runoff:

TSS - Total Suspended Solids
BOD - Biochemical Oxygen Demand
COD - Chemical Oxygen Demand
TP - Total Phosphorus (as P)
SP - Soluble Phosphorus (as P)
TKN - Total Kjeldahl Nitrogen (as N)
NO_{2+3}-N - Nitrite + Nitrate (as N)
Cu - Total Copper
Pb - Total Lead
Zn - Total Zinc

The list includes pollutants of general interest which are usually examined in both point and nonpoint source studies and includes representatives of important categories of pollutants--namely solids, oxygen consuming constituents, nutrients, and heavy metals.

The pollutant concentrations found in urban runoff vary considerably, both during a storm event, as well as from event to event at a given site and from site to site within a given city and across the country. This variability is the natural result of high variations in rainfall intensity and occurrence,

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geographic features that affect runoff quantity and quality, and so on. Considering this situation, a measure of the magnitude of the urban runoff pollution level and methods for characterizing its variability were needed. The event mean concentration (EMC), defined as the total constituent mass discharge divided by the total runoff volume, was chosen as the primary measure of the pollutant load. The rationale for adopting the EMC for characterizing urban runoff is discussed in the receiving water effects section of this chapter as well as in subsequent chapters. Event mean concentrations were calculated for each event at each site in the accessible data base. If a flow-weighted composite sample was taken, its concentration was used to represent the event mean concentration. Where sequential discrete samples were taken over the hydrograph, the event mean concentration was determined by calculating the area under the loadograph (the curve of concentration times discharge rate over time) and dividing it by the area under the hydrograph (the curve of runoff volume over time). Details of the calculation procedure have been described in the Data Management Procedures Manual. For the purpose of determining event mean concentrations, rainfall events were defined to be separate precipitation events when there was an intervening time period of at least six hours without rain.

A statistical approach was adopted for characterizing the properties of EMCs for standard pollutants. Standard statistical procedures were used to define the probability distribution, central tendency (a mean or median) and spread (standard deviation or coefficient of variation) of EMC data. EMC data for each pollutant from all storms and monitoring sites were complied in a central data base management system at the National Computer Center. The SAS computer statistical routines and other standard statistical methods were used to explore and characterize the data. The statistical methods used are, for the most part, not explained in this report since these are readily available in the literature. Nor are the operations of the SAS routines, which are available at most computer centers.

The underlying probability distribution of the EMC data was examined and tested by both visual and statistical methods. With relatively few isolated exceptions, the probability distribution of EMCs at individual sites can be characterized by lognormal distributions. Given this, concise characterization of the variable urban runoff characteristics at each of the sites is defined by only two values, the mean or median and the coefficient of variation (standard deviation divided by mean). Because the underlying distributions are lognormal, the appropriate statistic to employ for comparisons between individual sites or groups of sites is the median value, because it is less influenced by the small number of large values typical of lognormal distributions and, hence, is a more robust measure of central tendency. However, for comparisons with other published data which usually report average values and for certain computations and analyses (e.g., annual mass loads), the mean value is more appropriate.

Relationships among a number of statistical properties of interest are easily determined when distributions are lognormal. Figure 5-1 illustrates some relationships for lognormal distributions. In (a) the frequency distributions of two variable data sets which are log-normal and have the same median are shown. The log transforms of the data result in normal bell

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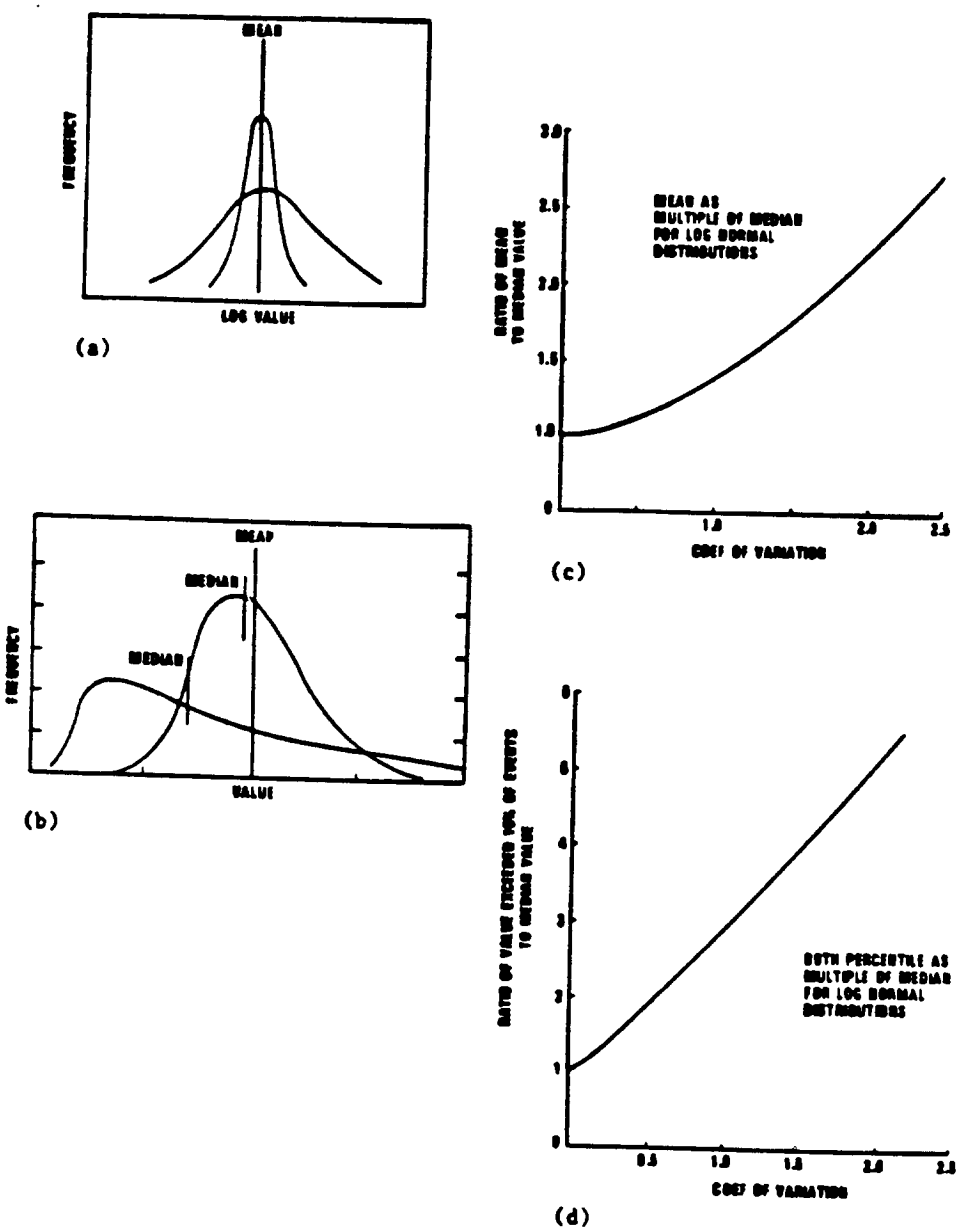

Figure 5-1. Lognormal Distribution Relationships

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shaped distributions; more variable data (higher coefficient of variation) result in a greater spread. Frequency histograms prepared using untransformed data values produce skewed distributions, as shown by (b) which illustrates two data sets which have the same arithmetic mean. The effect of coefficient of variation is shown as well as the relation between mean and median for lognormal distributions. An established relationship exists between median and mean, as shown by (c) and described by:

$$\frac{\text{Mean}}{\text{Median}} = \sqrt{1 + (\text{Coef Var})^2}$$

When a distribution is known to be lognormal the best estimate of the population mean is that derived from the lognormal relationships. For small samples it can be expected to be different than the result of a straight arithmetic averaging of sample data; the two estimates of the mean will give similar values when the number of samples is very large.

In addition, the expected value at any probability or frequency of occurrence (X_α) can be determined by:

$$X_\alpha = \sqrt{\exp\,(u_{\ln x} + Z_\alpha\, \sigma_{\ln x})}$$

where:

Z_α = the standard normal probability

$u_{\ln x}$ = mean of log-transformed data

$\sigma_{\ln x}$ = standard deviation of log-transformed data

X_α can be expressed as a ratio to the median value by the following equation which defines the ratio in terms of the coefficient of variation

$$\frac{X_\alpha}{\text{Median}} = \exp\,(Z_\alpha \sqrt{\ln\,(1 + (\text{Coef Var})^2)}).$$

This relationship is shown by (d) for 90th percentile values (10 percent exceedance, $Z_\alpha = 1.2817$).

The establishment of the fundamental distribution as lognormal, and the availability of a sufficiently large sample population of EMCs to provide reliable derived statistics, has a number of benefits:

- Concise summaries of highly variable data can be developed.
- Comparisons of results from different sites, events, etc., are convenient and are more easily understood.

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- Statements can be made concerning frequency of occurrence. One can express how often values will exceed various magnitudes of interest.

- A more useful method of reporting data than the use of ranges is provided; one which is less subject to misinterpretation.

- A framework is provided for examining "transferability" of data in a quantitative manner.

Priority Pollutants

In cooperation with EPA's Monitoring and Data Support Division (MDSD), a special study element was built into two-thirds of the NURP projects (20 of 28) to identify which of the compounds on EPA's list of "Priority Pollutants" are found in urban runoff, and the concentrations at which they occur. The base effort collected 121 samples of urban runoff which were analyzed for priority pollutants. A supplementary special metals study secured 147 samples. Methods utilized in this study element are described in the following report which covers this activity:

"NURP Priority Pollutant Monitoring Project: Summary of Findings", December 1983; EPA Monitoring and Data Support Division, Office of Water Regulations and Standards, Washington, D.C.

In addition to the above special study, as previously mentioned, most NURP projects monitored selected heavy metals (principally total copper, total lead, and total zinc) in their routine monitoring programs. Summaries of these data are presented in Chapter 6.

Hydrometerological Statistics

Consistent with the adoption of a storm "event" as the fundamental time scale used in the analysis of data and the interpretation of effects, rainfall data were analyzed to define "event" statistics for a significant number of locations throughout the country. The SYNOP program was employed for developing the statistical parameters of rainfall intensity, duration, volume, and interval between storm events. This program has been detailed in the NURP "Data Management Procedures Manual."

In addition to rainfall, rainfall-runoff relationships were characterized for monitored storm events. The runoff coefficient, defined as the ratio of runoff volume to rainfall volume, was computed, and effects of such catchment characteristics as land use and imperviousness were investigated. Long-term streamflow records for numerous stations across the country were also analyzed to characterize regional trends.

RECEIVING WATER QUALITY EFFECTS

General

A number of individual NURP projects examined the site-specific impacts of urban runoff on water quality for a variety of beneficial uses and receiving

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water types. These results provide important information on the extent to which urban runoff constitutes a "problem" as well as "ground truth" measurements against which more generalized techniques can be compared. Methodologies employed in these local studies vary and are described in the individual project reports. Relevant site-specific project results are cited in Chapter 9.

Receiving water impact analyses cannot be readily generalized because there is a high degree of site-specificity to the important factors. The type of beneficial use dictates the pollutants which are of principal concern; the type of water body (e.g., stream, lake, estuary) determines how receiving water quality responds to loads; and physical characteristics (e.g., size, geometry, flows) have a major influence on the magnitude of response to a particular load.

Despite the inherent limitations of a set of generalized receiving water impact analyses, a screening level analysis was considered a necessary element for a nationwide assessment of the general significance of urban runoff in terms of water quality problems, especially adverse effects on beneficial uses. Accordingly, a set of analysis methodologies were adopted and utilized as screening techniques for characterizing water quality effects of urban runoff loads on receiving water bodies. A key requirement was to delineate the severity of water quality problems by quantifying the magnitude, and in the case of intermittent loads, the frequency of occurrence of water quality impacts of significance. These procedures are identified and described briefly below. Significant technical aspects are detailed further in the supplementary NURP report which addresses the receiving water impact analysis methodology.

It was not possible to perform a "National Assessment" in the usual sense of the term. NURP has determined that it is not realistic (if the basis is effect on beneficial use of a water body) to estimate the total number of water quality problem situations in the nation which result from urban stormwater runoff or the cost of control which would ultimately result. The available analysis methods do permit an assessment of a different kind. NURP applied the analysis procedures as a screening type analysis to define the conditions under which problems of different types are likely or unlikely to occur. From the results of these screening analyses, NURP has drawn inferences and made general statements (Chapters 7 and 9) on the significance of urban runoff. Where it has been possible or practical to do so, these general screening analyses were applied to local situations which exist within certain of the individual NURP projects. Comparisons were made between specific water quality effects or broader conclusions relative to problems derived from both local analysis and general screening methods.

Time Scales of Water Quality Impacts

There are three types of water quality impacts associated with urban runoff. The first type is characterized by rapid, short-term changes in water quality during and shortly after storm events. Examples of this water quality impact include periodic dissolved oxygen depressions due to oxidation of contaminants, or short-term increases in the receiving water concentrations of one

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or more toxic contaminants. These short-term effects are believed to be an important concern and were the prime focus of the NURP analysis.

Long-term water quality impacts, on the other hand, may be caused by contaminants associated with suspended solids that settle in receiving waters and by nutrients which enter receiving water systems with long retention times. In both instances, long-term water quality impacts are caused by increased residence times of pollutants in receiving waters. Other examples of the long-term water quality impacts include depressed dissolved oxygen caused by the oxidation of organics in bottom sediments, biological accumulation of toxics as a result of up-take by organisms in the food chain, and increased lake entrophication as a result of the recycling of nutrients contributed by urban runoff discharges. The long-term water quality impacts of urban runoff are manifested during critical periods normally considered in point source pollution studies, such as summer, low stream flow conditions, and/or during sensitive life cycle stages of organisms. Since long-term water quality impacts occur during normal critical periods, it is necessary to distinguish between the relative contribution of urban runoff and the contribution from other sources, such as treatment plant discharges and other nonpoint sources. A site-specific analysis is required to determine the impact of various types of pollutants during critical periods, and this aspect of urban runoff effects was not addressed in detail in NURP.

A third type of receiving water impact is related to the quantity or physical aspects of flow and includes short-term water quality effects caused by scour and resuspension of pollutants previously deposited in the sediments. This category of impact was not addressed by NURP, in general, although one project provides some information.

As indicated previously, the first type of change in water quality associated with discharges from urban runoff is characterized by short-term degradation during and shortly after storm events. The rainfall process is highly variable in both time and space. The intensity of rainfall at a location can vary from minute to minute and from location to location. Phenomena which are driven by rainfall such as urban runoff and associated pollutant loadings are at least as variable. Short term measurements, on a time scale of minutes, to define rainfall, the runoff flow hydrograph, and concentrations of contaminants (pollutographs) feasibly can be taken at only a rather limited number of locations. These measurements have usually been employed in an attempt to refine or calibrate calculation procedures for estimating runoff flows and loads. Most urban areas contain a network of drainage systems which collect and discharge urban runoff into one or more receiving water bodies. Since the rainfall, runoff, and pollutant loads vary in both time and space, it is impossible to determine by calculation or measurement the very short time scale (minute-to-minute) changes in water quality of a receiving water and assign the changes to specific sources of runoff. Although very short duration exposures (on the order of minutes) to very high concentrations of toxics can produce environmental damage (mortality or sub-lethal effects) to aquatic organisms, it is likely that exposures on the order of hours have the highest possibility of causing adverse environmental impacts. This results, in part, from the smoothing obtained by mixing numerous sources which have high frequency (short-term) variability.

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In view of the above discussion, the time scale used by NURP for analysis of short-term receiving water impacts is the rainfall event time scale which is on the order of hours. To represent the average concentration of pollutants in urban runoff produced during such an event, NURP used the event mean concentration.

Criteria/Standards and Beneficial Use Effects

As discussed in previous chapters, three definitions have been adopted to assess receiving water problems associated with urban runoff; (1) impairment or denial of beneficial use, (2) violation of numerical criteria/standards, and (3) local perception of a problem. The procedures and methods employed in the NURP assessment focus on the first two problem definitions. A framework for identifying target receiving water concentrations associated with the criteria standards and beneficial use problems are provided below. The third problem type, local perception of a problem and degree of concern cannot be addressed by these quantitative procedures.

The analysis methods employed make it possible to project water quality effects caused by intermittent, short-term urban runoff discharges. Where appropriate, these effects are expressed in terms of the frequency at which a pollutant concentration in the water body is equalled or exceeded. However, if the basis for determining the significance of such water quality impacts (and hence the need for control) is taken to be the effect such receiving water concentrations have on the impairment or denial of a specific beneficial use, then it is necessary to go one step further. A basis is required for judging the degree to which a particular water quality impact constitutes an impairment of a beneficial use. With intermittent pollutant discharges, effects are variable and are best expressed in terms of a probability distribution from which estimates can be made of the frequency with which effects of various magnitude occur.

There is a rather broad consensus that existing water quality criteria, and water uses based on such criteria, are most relevant when considered in terms of continuous exposures (ambient conditions). Even where continuous discharges are involved, there has been discussion and debate as to whether a particular criterion should be interpreted as some appropriate "average" condition or a "never-to-exceed" limit. The basic issue is whether the more liberal interpretation will provide acceptable protection to the beneficial use for which the criterion in question has been developed. The only reason such distinctions become an issue is because the practical feasibility or relative economics, or both, are sufficiently different that one is encouraged to question whether the more restrictive interpretation is overly (or even excessively) conservative in terms of providing protection for the associated beneficial use.

The issue (i.e., whether traditional ambient criteria are excessively conservative measures of conditions which provide reasonable assurances of protection for a beneficial use when exceeded only intermittently) is particularly appropriate in the case of urban storm runoff. Analysis of rainfall records for a wide distribution of locations in the nation indicates that, even in the wetter parts of the country, urban runoff events occur only

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about 10 percent of the time. There are regional and seasonal differences, but typical values for annual average storm characteristics in the eastern half of the United States are:

	Average (Hours)	Median (Hours)	90th Percentile (Hours)
Storm Duration	6	4.5	15
Interval Between Storm Mid-Points	80	60	200

These estimates are based on results from an analysis of long-term rainfall records for 40 cities throughout the country. Median and 90th percentile values are derived from data mean and variance based on a gamma distribution, which has been shown to characterize the underlying distribution of storm event parameters quite well.

In the semi-arid regions of the western half of the country, average storm durations tend to be comparable to the above, but average intervals between successive storms increase substantially (two to four fold) and are highly seasonal. With urban storm runoff, therefore, one is dealing with pollutant discharges which occur over a period of a few hours every several days or more or after long dry periods. In advective rivers and streams, the water mass influenced by urban runoff tends to move downstream in relatively discrete pulses. Because of the variability in the magnitude of the pollutant loads from different storm events, only a small percentage of these pulses have high pollutant concentrations.

There are currently no formal "wet weather" criteria and, thus, no generally accepted way intermittent exposures having time scale characteristics typical of urban runoff can be related to use impairment. In the belief that it would be inappropriate to ignore such considerations in a general evaluation of urban runoff, NURP has developed estimates for concentration levels which result in adverse impacts on beneficial use when exposures occur intermittently at intervals/durations typical of urban runoff. These "effects levels" were used to interpret the significance of the variable, intermittent water quality impacts of urban runoff. It should be understood that these effects levels do not represent any formal position taken by EPA, but are simply the most reasonable yardsticks available to meet the immediate needs of the evaluation of urban runoff. As used in the screening analysis procedures, alternative values for "effects levels" may be readily substituted when either more accurate estimates can be made, or more (or less) conservative approaches are indicated in view of the importance of a particular water body or beneficial use.

Table 5-1 summarizes information on water quality criteria for a number of contaminants routinely found in urban storm runoff. The data presented include:

- Water quality criteria for substances on EPA's priority pollutant list (45 FR No. 79318, 11/28/80). These criteria provide

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TABLE 5-1. SUMMARY OF RECEIVING WATER TARGET CONCENTRATIONS USED IN SCREENING ANALYSIS - TOXIC SUBSTANCES
(ALL CONCENTRATIONS IN MICROGRAMS/LITER, μg/ℓ)

Contaminant	Water Hardness mg/l (as Ca CO_3)	Freshwater Aquatic Life		Saltwater Aquatic Life		Human Ingestion	Estimated Effect Level for Intermittent Exposure	
		24 Hour	Max	24 Hour	Max	(1)	Threshhold	Significant Mortality
Copper	50	5.6	12	4.0	23	NP	20	50 - 90
	100	5.6	22	4.0	23		35	90 - 150
	200	5.6	42	4.0	23		80	170 - 350
	300	5.6	62	4.0	23		115	265 - 500
Zinc	50	47	100	58	170	NP	300	870 - 3,200
	100	47	321	58	170		600	1,550 - 4,500
	200	47	520	58	170		1,200	2,750 - 8,000
	300	47	800	58	170		1,700	3,850 - 11,000
Lead	50	0.75	74				150	250 - 3,200
	100	3.8	172	(25)	(670)	50.0	360	870 - 7,500
	200	12.5	400				850	1,950 - 17,850
	300	50.0	660	(C)	(A)		1,400	3,100 - 29,000
Chrome (+3)	50		2,200					
	100	(44)	4,700	N.P.	(10,300)	170.00	8,650	
	300	(C)	15,000		(A)			
Chrome (+6)	-	0.29	21.0	18	1260	50.0		
Cadmium	50	0.01	1.5				3	7 - 160
	100	0.02	3.0	4.5	59.0	10	6.6	15 - 350
	300	0.08	9.6				20	45 - 1,070
Nickel	50	56	1,090					
	100	96	1,800	7.1	140.6	13.4		
	300	220	4,250					

NOTES:

- NP - No criteria proposed.
- Some toxic criteria are related to total hardness of receiving water. Where this applies, several values are shown. Other values may be calculated from equations presented in EPA's Criteria Document (Federal Register, 45,231, November 28, 1980). Where a single value is shown, water hardness does not influence toxic criteria.
- Concentration values shown within parentheses ( ) are not formal criteria values. They reflect either chronic (C) or acute (A) toxicity concentrations which the EPA toxic criteria document indicated have been observed. Values of this type were reported where the data base was insufficient (according to the formally adopted guidelines which were used in developing the criteria) for EPA to develop 24 hour and Max values.
- Note (1): The "Human Ingestion" criteria developed by the EPA Toxic Criteria documents are indicated to relate to ambient receiving water quality. The Drinking Water Criteria relate to finished water quality at the point of delivery for consumption.
- Estimated Effects levels reflect estimates of the concentration levels which would impair beneficial uses under the kind of exposure conditions which would be produced by Urban Runoff. They are an estimate of the relationship between continuous exposure and intermittent, short duration exposures (several hours once every several days). Threshold concentrations are those estimated to cause mortality of the most sensitive individual of the most sensitive species.

  Significant Mortality concentrations are shown as a range which reflects 50 percent of the most sensitive species and mortality of the most sensitive individual of the 25th percentile species sensitivity.

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an extensive set of numerical values derived from bioassay studies.

- Estimates of "effects levels" which are suggested by NURP analysis to be relevant for the intermittent exposures characteristic of urban runoff.

By incorporating the numerical values for EPA's ambient water quality criteria and the concentration levels suggested by NURP for intermittent effects in the same table (or on the same graph in Chapter 7), a convenient, concise comparison is provided of the practical implications of applying one or the other as the yardstick for judging the protection or impairment of water use. The two sets of numerical values thus provide measures for two of the three options for defining a problem: violation of criteria or actual impairment of a beneficial use.

Comparison of the pollutant concentrations in urban runoff showing the frequency and magnitude of exceedance of ambient criteria and intermittent effects levels provides a qualitative sense of the control requirements (and implications regarding costs) attendant on the adoption of either problem definition as the operative one.

Rivers and Streams

The approach adopted to quantify the water quality effects of urban runoff for rivers and streams focuses on the inherent variability of the runoff process. What occurs during an individual storm event is considered secondary to the overall effect of a continuous spectrum of storms from very small to very large. Of basic concern is the probability of occurrence of water quality effects of some relevant magnitude.

To consider the intermittent and variable nature of urban runoff, a stochastic approach was adopted. The method involves a direct calculation of receiving water quality statistics using the statistical properties of the urban runoff quality and other relevant variables. The approach uses a relatively simple model of the physical behavior of the stream or river (as compared to many of the deterministic simulation models). The results are therefore an approximation, but appropriate as a screening tool.

The theoretical basis of the technique is quite powerful as it permits the stochastic nature of runoff process to be explicitly considered. Application is relatively straightforward, and the procedure is relevant to a wide variety of cases. These attributes are particularly advantageous given the national scope of the NURP assessment. The details of the stochastic method are summarized and presented below.

Figure 5-2 contains an idealized representation of urban runoff discharges entering a stream. The discharges usually enter the stream at several locations but are considered here to be adequately represented by an equivalent discharge flow which enters the system at a single point.

Receiving water concentration (CO) is the resulting concentration after complete mixing of the runoff and stream flows and is interpreted as the mean

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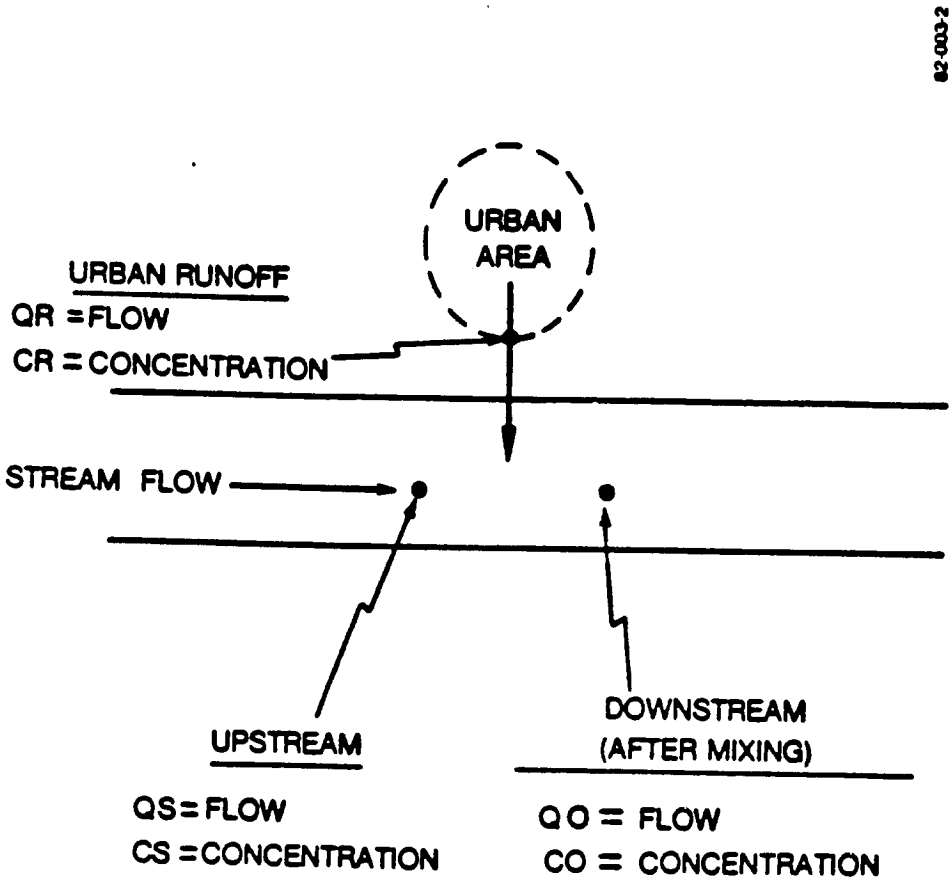

Figure 5-2. Idealized Representation of Urban Runoff Discharges Entering a Stream

stream concentration just downstream of all of the discharges as shown in Figure 5-2. The four input variables considered are:

- Urban runoff flow (QR)
- Urban runoff concentration (CR)
- Stream flow (QS)
- Stream concentration (CS)

Each is considered to be a stochastic random variable, which together combine to determine downstream flow and concentration. In addition, all variables are assumed to be independent, except urban runoff flow and streamflow where correlation effects can be incorporated as warranted.

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An essential condition of the current computational structure is that each of the four variables which contribute to downstream receiving water quality can be adequately represented by a lognormal probability distribution; from analysis of data or other estimating procedures, the statistical properties of each of the input parameter distributions are defined. Examination of a reasonably broad cross-section of data indicates that lognormal probability distributions can adequately represent discharges from the rainfall/runoff process, the concentration of contaminants in the discharge, and the daily flow record of many rivers and streams, particularly for a national scale screening approach. It should be noted, however, that modifications of the computation techniques could be made to accommodate the use of other distributions (e.g., gamma, exponential) for some or all of the parameters.

The analysis procedure is described in more detail in the supplementary NURP report cited earlier. It essentially operates as follows:

- Downstream Concentrations. Stream concentrations of a pollutant are considered to result from the combination of upstream flow at background concentration and runoff flow at its concentration. Variations in stream concentrations below the urban runoff discharge result from variations in each of these inputs; the most significant source of variation being whether or not an event is occurring (i.e., whether runoff flows and loads are present). Stream flows must be considered because of the major effect of dilution on the resulting concentrations. Upstream concentrations can, however, be set at zero for the calculations; in which case, the result obtained is the exclusive effect of urban runoff discharges, and not the overall expected stream concentration. Effects of urban runoff can be evaluated by considering only the periods during which runoff occurs.

- Parameter Estimates. Estimates for runoff flows and concentrations are developed from information derived from the NURP monitoring programs. Information on stream flow can be obtained from analysis of local stream gage records. Upstream concentrations tend to be very site-specific; for this reason, the screening analysis calculated only the effect of urban runoff discharges.

- Statistical Calculations. From the statistical properties (specifically, the means and standard deviations) of the flows and concentrations, properties of the dilution ratio can be defined, and the statistical properties of the resulting in-stream concentrations are calculated directly. The frequency with which any particular target concentration is exceeded during wet weather can be calculated from the statistical properties of stream concentration, using formulas or scaled directly from a standard plot of cumulative (lognormal) probability distributions.

  The frequency with which the target concentration is exceeded during all periods -- wet and dry -- is simply the product of

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the wet weather frequency and the probability (frequency) that it is raining. The probability that it is raining at any time is defined by the ratio of mean storm duration to mean inter-storm period, derived from the rainfall statistics.

$$\frac{D = \text{mean duration of storms}}{\Delta = \text{mean interval between storm midpoints}} = \text{fraction of time it is wet}$$

- Mean Recurrence Interval. In the presentation of results in Chapter 7, the probability distribution of event mean stream concentrations of an urban runoff pollutant during runoff periods is converted to a Mean Recurrence Interval (MRI) as a device to assist in the interpretation of results. The recurrence interval is defined as the reciprocal of probability. Because the basic calculation is based on storm events, this definition yields the overall average number of storms between specific event occurrences. Event recurrence is converted to what is believed to be a more meaningful time recurrence by dividing by the average number of storms per year, which is developed from analysis of rainfall records and defined as

$$\frac{\text{Hours/year} = 8760}{\text{Average interval between storm midpoints}} = \text{average \# storms per year}$$

As an example of the MRI calculations consider a stream concentration which has an exceedance probability of 1.0 percent (Pr = 0.01)

$$\text{Recurrence Interval} = 1/Pr = 1/0.01 = 100$$

The analysis is in terms of storm events, not time. Therefore this result is interpreted as one storm in every 100 events on average, will produce concentrations greater than the selected value. For an area where rainfall patterns produce an average of 100 storms per year, the average recurrence interval expressed in time units rather than events, is:

$$\text{Recurrence Interval (time)} = \frac{\text{event recurrence}}{\text{\# events/year}} = \frac{100 \text{ events}}{100 \text{ events/year}} = 1 \text{ year}$$

Currently, the primary use of the above procedure is as a screening tool in which approximate results and relative values are of interest. In this regard, NURP believes the Mean Recurrence Interval is a very useful definition. It should be interpreted as the long-term average interval between occurrences.

When results of this nature are interpreted, the following factors should be noted. The recurrence intervals of most interest relate to very low probabilities of occurrence. The tails of distributions may have appreciable uncertainty, and in the natural water systems, distributions may be lognormal

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over the bulk of the range but may deviate from the assigned distribution at the extremes. Computed stream concentrations at long recurrence intervals are likely to be conservative, that is, overstated because there are likely to be practical upper limits for runoff concentrations and lower limits to stream flow.

It also should be noted that serial correlations of streamflows or the tendency of wet and dry years to occur in clusters, though not a general behavior, may be significant in some cases. This situation would cause the average one year condition, for example, not to repeat itself every year but rather to occur several times per year, at intervals greater than one year.

Other Receiving Waters

Other receiving waters of general interest in assessing urban runoff effects include lakes, estuaries, embayments, and coastal zones. The methods adopted for lakes are briefly described below. The other receiving waters generally require site-specific and often complex analysis techniques (numerical methods, multi-dimensional modeling, etc.). Given this, a generalized screening-level assessment was not believed to be appropriate for this report. A number of the individual NURP projects consider these coastal water bodies and report on the specific methods adopted and results obtained.

For lake eutrophication problems, the time scale for analysis is considerably longer than the short (event scale) periods necessary for estuaries and rivers. For this case, annual average loads were used in a steady-state analysis performed using the type of empirical model advanced by Vollenweider and others. The EMC data developed from NURP monitoring programs can be readily converted to annual loads directly from annual flows or indirectly based on annual rainfall.

For total phosphorus, typically the limiting nutrient of concern, average concentrations are calculated using the following formula:

$$P = \frac{W'}{H/\tau \cdot \upsilon_s} \cdot 1000$$

The input values include pollutant mass loading (W'), lake physical characteristics of depth (H) and residence time (τ) and reaction rate coefficients (υ_s). The relative contribution of all load sources to lake total P concentrations can be defined by solving this equation for each of the sources. By comparing results in terms of lake concentrations for initial conditions (no control), and then modifying loads to reflect various levels of control, alternative control operations can be compared directly to effect on lake water quality.

Some judgement is involved in defining acceptable lake water quality concentrations, which depend in part on water use and on regional norms and expectations.

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EVALUATION OF CONTROLS

General

The evaluation of controls has two elements: (a) characterizing the controls' performance capabilities and (b) defining costs. For this report, only the characterization of performance is emphasized; cost relationships are addressed to a more limited extent. EPA's Economic Analyses Staff, Office of Analysis and Evaluation, has prepared the following report under contract:

> "Collection of Economic Data from Nationwide Urban Runoff Program Projects," EPA Office of Water Regulations and Standards, April 7, 1982.

This report, issued at an early stage in the NURP program, assembled and analyzed cost information on potential control measures. Useful cost information for detention basins was developed by the Washington, D.C. area NURP project and is discussed further in Chapter 8.

Detention Basins

There are a number of procedures which can be adopted for evaluation of detention basin control devices. Procedures adopted by individual NURP projects are described in project reports. The procedure adopted by NURP to generalize the analysis of detention basins, and provide a planning level basis for estimating capabilities and requirements, is detailed in a detention basin handbook being issued by NURP as a supplementary report.

Results presented in Chapter 8 provide a summary of observed performance characteristics of the detention devices monitored under the NURP program and a projection of long-term performance expected on the basis of basin size and regional rainfall characteristics. The latter result is based on the probabalistic analysis methodology described in the supplementary report. Planning level cost estimates for control of urban runoff using this technique are also presented.

Street Sweeping

A number of the individual NURP projects adopted street sweeping as a principal subject of investigation. Procedures and results are described in individual project reports and are consolidated and summarized in Chapter 8. The adopted procedure and detailed results are presented in the supplementary NURP report, which was cited earlier.

Recharge Devices

Recharge devices include impoundments or other structures such as pits, trenches, retention basins, percolating catch basins, in-line percolation chambers or perforated pipes, which function by intercepting some portion of storm runoff and allowing it to percolate into the ground.

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One of the basic questions which arises when controls of this type are considered is whether the percolation encouraged will produce undesirable degradation of groundwater quality. This aspect was examined by two NURP projects, and is discussed in Chapter 7 of this report.

Evaluation of percolating basins of any size is readily accomplished using the standard storage/treatment routines of stormwater models such as STORM or SWMM. In such cases the local soil permeability (the percolation rate) is applied as the treatment rate. In addition, statistical analysis procedures described in "A Statistical Method for the Assessment of Urban Stormwater" (EPA 440/3-79-023, May 1979) have been developed. A probabalistic analysis methodology adapted from the latter approach has been used by NURP to provide estimates of performance capabilities of recharge devices, which are presented in Chapter 8. A detailed discussion of the methodology is provided in the supplementary NURP report on detention/recharge devices cited earlier.

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CHAPTER 6
CHARACTERISTICS OF URBAN RUNOFF

INTRODUCTION

This chapter presents a condensed summary of data developed by the individual NURP projects together with analysis results and interpretations based on the aggregated data from all projects.

Both the format for the summaries and the evaluations performed were selected to best serve the NURP objective of developing a national perspective. The results presented do not exhaust the useful information and insights which can be derived from the extensive data base that has been assembled. Individual project reports and a substantial number of articles published in a variety of technical journals independently examine specific aspects of urban runoff, often from the perspective of local issues.

Comprehensive tabulations of NURP data have been assembled and will be made available to interested parties for use in local planning or continuing research or engineering activities. As noted below, only a portion of the entire data base generated by the 28 NURP projects has been made generally accessible at this time. Under an ongoing effort, the entire data base is being subjected to final quality assurance checks and placed into a separate file, copies of which will be made available to interested parties upon request. In addition, a summary of the event averaged data, used for the analyses presented in this chapter, is reproduced in a Data Appendix issued with this report.

Field monitoring was conducted to characterize urban runoff flows and pollutant concentrations and mass loadings. This was done for a variety of pollutants at a substantial number of sites distributed throughout the country. The resultant data represent a cross-section of regional climatology, land use types, slopes, and soil conditions and thereby provide a basis for identifying patterns of similarities or differences and testing for their significance. To meet the objective of maximizing the degree of transferability of urban runoff data, the NURP approach involved covering a spectrum of regional and land use characteristics, requiring consistent quality assurance programs among all projects, and encouraging each of the projects to obtain data for a statistically significant number of storm events at a site.

The portion of the NURP data base used in the characterization of urban runoff presented in this section excludes monitoring sites which are downstream of devices which modify runoff (e.g., detention basins). The data base of acceptable "loading sites" consists of 81 sites in 22 different cities, and includes more than 2300 separate storm events. The actual number of events

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for specific pollutants varies, and is somewhat smaller than the total number of storms monitored because all pollutants were not measured for all storms at all sites.

Data summaries and analyses were performed using storm event average values; within-event fluctuations are not considered. An event mean concentration (EMC) for pollutants of interest has been determined for each monitored storm. Preliminary results presented in an earlier NURP report were based on analysis of "pooled" EMCs which were available at the time regardless of site. This provided a useful start, a reference for individual NURP project activities, and established the order of magnitude of concentrations of various pollutants in urban runoff. With the substantially larger data set now available, a more useful approach is possible. For the analyses and comparisons presented in this chapter, the storm event average data were aggregated by site to describe site characteristics. Site mean values were then aggregated or compared.

Summaries, comparisons, and evaluations were restricted to concentrations and runoff-rainfall ratios. Although loading data (Kg/Ha) are also available for all monitored storms, they have not been used in comparisons for the following reason. Mass load is very strongly influenced by the size (volume) of the monitored storm event. Monitored events usually represent a very small sample of all storms for an area, are generally biased toward larger events, and are different from site to site. Therefore comparisons between sites or locations using loading data derived from monitored storms are quite likely to present a distorted picture.

Event mean concentrations, on the other hand, have been determined to be essentially uncorrelated with runoff volume, as discussed further later in this chapter. Site comparisons can be made with high confidence levels using concentration data, and the most meaningful load comparisons would be those developed by using concentrations, area rainfall volumes, and runoff-rainfall relationships.

Separate summaries of results are provided below for standard pollutants, coliform bacteria, pollutant loads, and priority pollutants.

LOGNORMALITY

As was pointed out in Chapter 5, the key to the mathematical tractability of the NURP methodologies is that the data can be well represented by a known probability density function (pdf). There are actually two issues involved; (1) the adequacy of the assumed pdf in terms of representing the essential characteristics of the data set in question, and (2) the estimation of the parameters of the population pdf that the observed data set is presumed to represent. These will be discussed in turn.

Adequacy of Representation

One can fit a polynomial of order (n-1) exactly to any data set of n numerical items, but its utility in predicting the probability of realizing a given value on a subsequent trial (either within or outside the original data set,

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i.e., the interpolation or extrapolation problem) is likely to be very limited. The number of parameters involved and the need to investigate its properties on an individual basis are further deterrents to such a practice. There is no dearth of pdf's that have been the subject of intensive investigation. However, the selection of a pdf is an objective choice that is best made based on professional knowledge of the processes deemed important to the desired probability model and the use to be made of it. For example, if the data are known to result from the product of many small effects, their logs will be the sum of the logs of these effects. By appeal to the central limit theorem, it is known that this sum is asymptotically normal and, therefore, that the data will be lognormally distributed. Based upon such natural expectations and prior experience (of a growing body of other workers in the field as well), the lognormal pdf was chosen. The fact that the variables of interest can assume only positive values with a finite mean and a finite nonzero lower bound (even in a standardized form) leads to the rejection of any pdf defined over the entire real domain, such as the normal distribution for instance.

There are a number of statistical procedures for evaluating the normality of a complete sample; at least nine can be found in the current literature. Some are origin and scale invariant (e.g., the Shapiro-Wilk, standard third moment, standard fourth moment, and studentized range) and thus are appropriate for testing the composite hypothesis of normality. Others require the complete specification of the null distribution (e.g., Kolmogorov-Smirnoff, Cramer-Von Mises, weighted Cramer-Von Mises, modified Kolmogorov-Smirnoff-D, and chi-squared), and typically, the mean and variance of the specified normal hypothesis are taken to be the known mean and variance of the complete sample. Some procedures (e.g., chi-squared) utilize the specified theoretical pdf, while others (e.g., the modified Kolmogorov-Smirnoff D-test) utilize the cumulative frequency distribution.

In testing for normality (in the logorithmic domain in our case), one specifies the level of significance (α), i.e., the probability of rejecting the null hypothesis when it is in fact true (Type I error). The choice of α requires tempered judgement, however. The power of a test (β) is the probability of rejecting the null hypothesis when it is in fact false. The probability of accepting the null hypothesis when it is in fact false (Type II error) is $1-\beta$. For a given sample size and test, fixing a value for α also determines a value for β (i.e., they are not independent). The smaller the α level, the less powerful the test. Thus one is forced to make a trade-off between the consequences of a Type I or II error when selecting an α value.

The median EMC values for each constituent at each site were calculated, and these sample sets were examined for lognormality using the Kolmogorov-Smirnoff D test. The α levels for TSS, Total P, TKN, Total Pb, and Total Zn were all greater than 0.15, indicating a high power level. In other words, these sample sets are extremely well represented by a lognormal distribution. For COD and nitrate + nitrite the α levels were 0.059 and 0.057 respectively, indicating a lower power level but suggesting that even for these constituents the lognormal distribution quite well describes the data. Because BOD, Soluble P, and Total Cu were measured at fewer than half of the project

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sites, the D-test could not meaningfully be used (i.e., n is too small). Stated another way, at the $\alpha = 0.05$ level, the hypothesis that the samples were drawn from a population with a lognormal distribution cannot be rejected for any of the constituents examined.

Turning to the individual sites, there were very few instances where n was large enough to support the meaningful use of the D-test, and so a different approach for examining the appropriateness of the lognormal distribution was used. Essentially it consisted of examining the cumulative frequency distributions (in log space) and third and fourth moment based statistics for adequacy of representation. Taking into account detection limit phenomenon, uncertainties associated with sampling and analytical determination errors (especially at low concentration levels), and an occasional outlier, well over 90 percent of the constituent distribution at all NURP sites were quite well represented by the lognormal distribution. For the few remaining data sets, the lognormal distribution, although not perfect, was adequate for our purposes.

Estimation of Parameters

As noted in Chapter 5, the lognormal distribution is completely specified by two parameters, the mean and the coefficient of variation. The values of these two parameters as calculated from the sample data set are the best estimates of the parameters of the underlying population in the maximum likelihood sense. For this reason, they were used in the NURP analysis. However, due to the existence of detection limit problems and sampling/analytical determination errors, the reasonableness of this decision was examined in general for all constituents and in great detail for Total Cu, the results of which will be described below.

For each of the 49 NURP sites where at least five Total Cu determinations were made, data were plotted (in logarithmic form) on probability paper. A line of best fit was drawn in, using professional judgement where detection limit or outlier problems existed, and the values of the median and standard deviation were read from the plot and converted into arithmetic space. These were then compared with those values calculated from the data themselves. One example is given in Figure 6-1 (the 116th and Claude Street site in Denver). Here the median and coefficient of variation from the plot (20 µg/l and 0.75) compare very well with those calculated directly from the data (22 µg/l and 0.74).

An example of an outlier plot is given in Figure 6-2 (the strip commercial site in Knoxville, TN). The one very low value (1 µg/l) is one-twentieth the typical detection limit (20 µg/l) and clearly does not belong to the same distribution that the other values do. Ignoring it, a very good fit exists and the parameters of the plot are 30 µg/l and 0.37 for the median and coefficient of variation as compared with the 25 µg/l and 1.35 values calculated from the data. The difference in medians is not too great, but the difference in coefficients of variation is quite large (over a factor of 3.5). This means that the upper end of the tail of the pdf is quite overestimated by the parameters estimated from the data and, consequently, that

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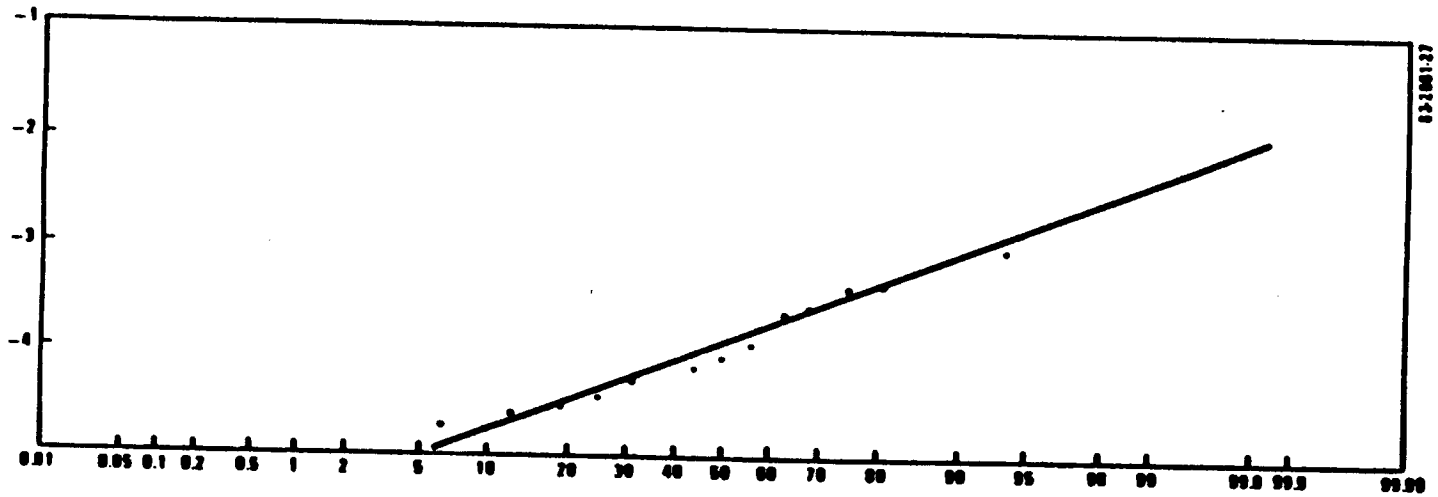

Figure 6-1. Cumulative Probability Distribution of Total Cu at CO1 116 and Claude Site

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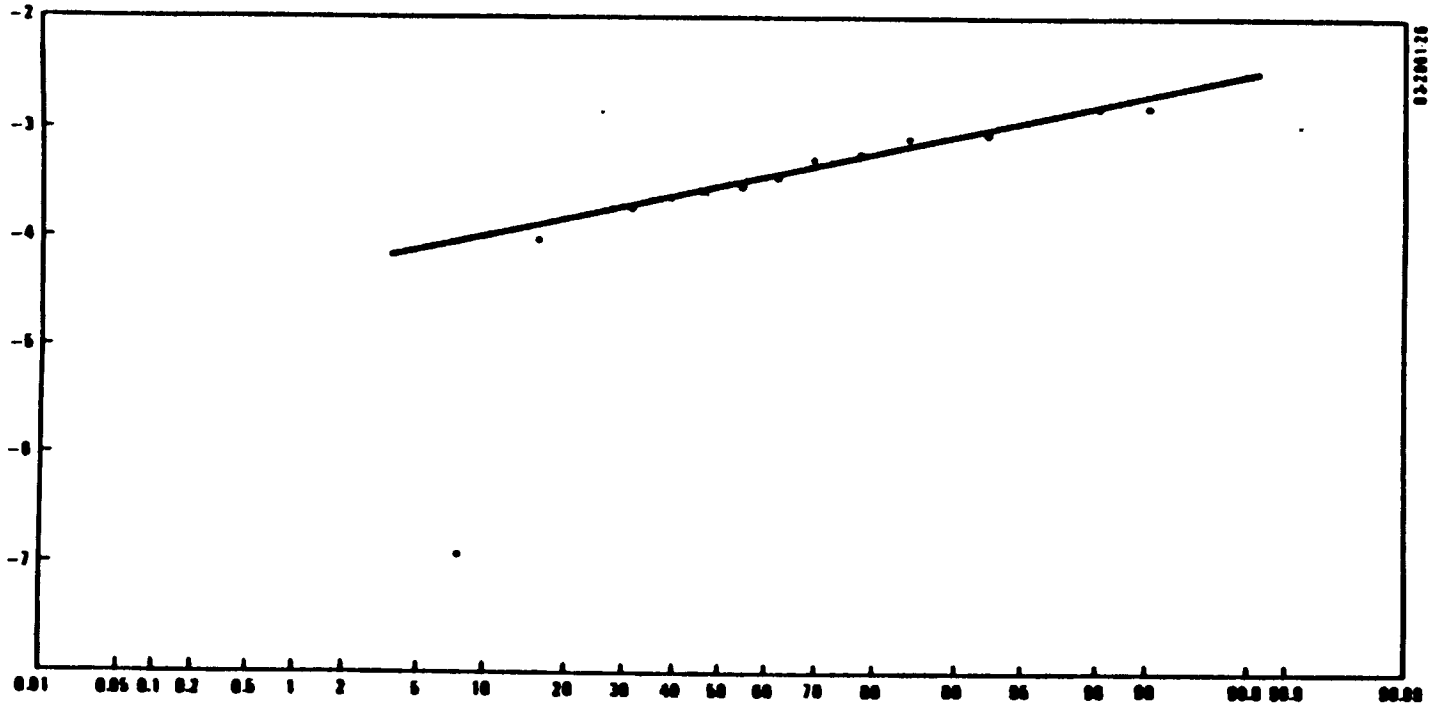

Figure 6-2. Cumulative Probability Distribution of Total Cu at TN1 SC Site

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subsequent analyses will be extremely conservation, i.e., higher values of copper concentrations will occur less often than predicted. In general, the effect of an outlier is to increase or decrease the estimate of the median, depending upon whether the outlier is high or low, and to increase the estimate of the coefficient of variation as compared to those obtained from the remainder of the data.

An example of a detection limit problem is given in Figure 6-3, the plot of copper data of the Durham, NH parking lot site. Although only four points appear on the plot, actually n = 31, meaning that 27 points are represented by the first plotting position (90.6 percent). These values (all reported at 100 µg/l) are presumably the detection limit of the analytical laboratory. Of course in reality not all 27 values are 100 µg/l; they are simply equal to or less than this value. Fitting a line to the remaining four data points merely assigns appropriate plotting positions to these "less than" values. The estimates of the median and coefficient of variation from the plot are 63 µg/l and 0.36 respectively, as compared to the estimates from the data of 103 µg/l and 0.13. In this case, the latter significantly overestimates the median and significantly underestimates the coefficient of variation, and this is the general effect when a detection limit problem is present. In terms of the effect on prediction of rare occurrences of high copper levels (the upper tail of the pdf) these effects are somewhat counterbalancing. To the extent that the increase in the coefficient of variation dominates, the results of subsequent analyses will not be conservative, since larger concentrations will occur somewhat more frequently than would be predicted.

When the results of this exercise are compared for all 49 sites, the median as estimated from the plot was found to be higher than that estimated from all the data at only six sites, was equal at five sites, and was less at 38 sites. However, at only three sites was the change greater than 10 µg/l. Considering the population of all copper sites, the average median is 47 µg/l and the coefficient of variation is 0.84 when the estimates are based on all the data. If the estimates are based upon the plots, the respective values are 42 µg/l and 0.24 respectively. The significant reduction in the coefficient of variation in this latter case deserves comment, because it suggests that much of the apparent variability from site to site is due to data artifacts such as detection limit phenomena, outliers, and/or sampling/analytical errors. Similar comparisons of the coefficients of variation for each site showed increases at 21 sites, 6 unchanged, and decreases at 22 sites. Considering all sites, the average coefficient of variation is essentially unchanged (0.61 vs 0.63) as is its variability (0.47 vs 0.49).

Based on the results of the analyses which have been performed, the NURP findings are as follows:

- Lognormal distributions adequately represent both the storm-to-storm variations in pollutant EMC's at an urban site, and site-to-site variations in the median EMC's which characterize individual sites.

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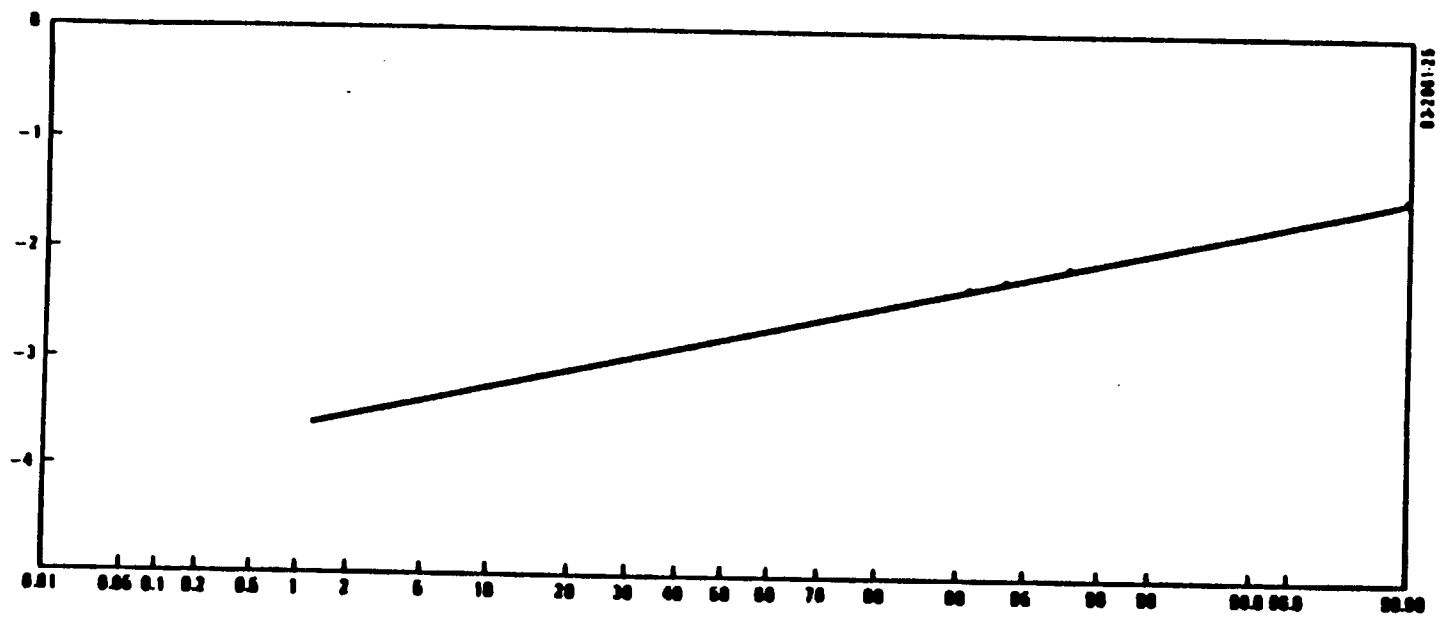

Figure 6-3. Cumulative Probability Distribution of Total Cu at NHI Pkg. Site

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- More detailed analysis to compensate for sampling errors (e.g., outliers and detection limit problems) would result in some adjustments in the statistical parameters tabulated later on in this chapter. The data summaries presented are based on statistics computed directly from the log transforms of the data.

- Such adjustments would not have any significant effect on overall results nor on the general conclusions reached. However, at a small percentage of sites, the parameter estimates for some pollutants would change significantly.

- In general, estimates of the site median EMC would be least affected; estimates of variability more so. It is likely that the very high or very low values for coefficient of variation (storm-to-storm variability) would be adjusted to more central values.

STANDARD POLLUTANTS

This grouping includes the following pollutants:

TSS - Total Suspended Solids
BOD - Biochemical Oxygen Demand
COD - Chemical Oxygen Demand
TP - Total Phosphorus (as P)
SP - Soluble Phosphorus (as P)
TKN - Total Kjeldahl Nitrogen (as N)
NO_{2+3}-N - Nitrite + Nitrate (as N)
Cu - Total Copper
Pb - Total Lead
Zn - Total Zinc

It includes pollutants of general interest which are usually examined in other studies (both point and nonpoint sources) and includes representatives of important categories of pollutants, namely solids, oxygen consuming constituents, nutrients, and heavy metals.

Condensed Data Summary

Tables 6-1 through 6-10 summarize the NURP results for these pollutants. Monitoring sites are grouped in each of the tables according to dominant land use. Broad categories have been used; residential, commercial, industrial, urban open/nonurban (other), and mixed, this latter category being used for sites which had no predominant land use. It should be noted that the industrial category does not include heavy industry sites, but more typically reflects an industrial park type of use. As a result, most of these sites are more closely related to a commercial use than to the typical image called up by the term industrial site. For subsequent comparisons, the data shown in Tables 6-1 through 6-10 for the commercial and industrial sites, are combined and designated as commercial land use.

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TABLE 6-1. SITE MEAN TSS EMCs (mg/ℓ)

Residential

	Site	Land Use %	Area (A)	Pop. Den (#/A)	% IMP	No. of EMCs	TSS Mean	TSS CDV	TSS Median	TSS 90% Confidence Limits
1	CO1 Big Dry Cr	100	33	19	41	16	303	1.04	245	182-305
2	CO1 Cherry	100	57	24	30	14	180	.90	179	87-190
3	CO1 110/Lincoln	100	162	14	24	16	266	1.17	237	154-300
4	OC1 Dutch	100	12	-	-	8	96	1.02	30	51-74
5	OC1 Lakeridge	100	60	21	27	49	175	1.47	98	76-127
6	OC1 Stratton	100	8	-	-	33	54	1.04	30	30-40
7	SL1 John D	100	54	10	19	51	206	1.36	122	96-150
8	SS1 Overton	100	50	8	30	15	2216	1.47	1247	706-2032
9	MN2 Hamlet	100	50	5	16	5	70	2.00	20	8-111
10	MD1 Bolton Hill	100	16	30	51	10	74	1.37	46	30-60
11	MD1 Homeland	100	23	9	20	13	50	1.06	26	15-45
12	MD1 Mt Wash	100	17	12	20	20	96	1.12	63	64-80
13	MD1 Rec Hill	100	10	96	36	13	127	1.06	80	57-135
14	MD1 Cecil's B.	100	73	13	20	23	42	.86	32	25-42
15	MD1 Unque	100	-	-	-	8	66	.53	57	41-80
16	MD3 Cromston	100	146	5	22	10	134	1.15	80	52-150
17	MD3 E. Rock.	100	345	10	30	7	294	1.12	186	104-300
18	TN1 Hollingsworth	100	60	3	26	9	227	1.13	190	85-263
19	MD1 Surrey	100	95	9	20	113	113	.51	101	90-140
20	MD1 Durham	100	63	15	10	45	206	.44	203	210-270
21	MD1 Hastings	100	33	17	51	33	170	.68	141	117-180
22	FL1 Young Apts	100	9	-	6	17	53	1.23	34	21-50
23	FL1 Hart	99	370	9	40	15	150	1.61	82	40-130
24	WI1 Lincoln	97	36	10	57	23	251	.69	206	166-250
25	TN1 DJ	96	40	4	13	11	63	1.13	42	25-60
26	OC1 Westbrgh	93	41	3	21	41	75	1.45	43	33-57
27	OS1 SC - Blad	52	63	-	37	13	156	.84	139	83-171
28	SL1 John S.	91	30	10	10	40	240	1.50	120	100-170
29	SD1 DJ	91	69	11	33	11	611	.73	492	395-700
30	WI1 Lake Hills	91	102	12	37	126	127	.80	100	90-110
31	SL1 Hattie S.	90	20	22	37	50	311	1.00	211	174-256
32	FL1 Charter Bdg	89	42	-	16	12	33	1.70	16	9-28
33	OC1 Fairidge	80	19	-	34	47	25	1.96	14	10-16
34	CO1 Asbury	86	177	9	22	9	993	.82	888	294-903
35	SL2 Comb Tablets	86	529	8	17	27	250	.75	200	161-200
36	MN1 Locust	86	154	11	16	6	257	1.75	120	60-130
37	OC1 #1072	84	129	6	27	46	291	1.92	136	104-170
38	MN1 Jordan	79	110	10	21	9	70	1.74	30	19-81
39	OC1 Seabrick	70	27	15	34	47	50	1.02	30	31-67

Urban Open and Suburban

	Site	Land Use % Open	Area (A)	Pop. Den (#/A)	% IMP	No. of EMCs	TSS Mean	TSS CDV	TSS Median	TSS 90% Confidence Limits
1	CO1 Stanton	100	633	-	-	13	710	.83	551	386-700
2	CO1 Rooney Gulch	100	605	0	1	7	683	.63	301	273-521
3	OH3 Thornell	100	20,400	-	0	11	154	.92	113	70-173
4	OH2 English Br	98	5,240	-	1	20	17	2.05	6	4-10
5	OH2 West Br	97	5,180	-	1	20	64	2.77	27	14-36
6	OH3 Shaker Cr	91	17,770	1	11	9	64	.74	54	30-77
7	OH3 Tower Cr	90	2,303	-	6	5	13	.77	26	14-50
8	OH2 Shorette Bank	80	547	-	7	37	370	2.33	149	90-224

Mixed

	Site	Land Use %	Area (A)	Pop. Den (#/A)	% IMP	No. of EMCs	TSS Mean	TSS CDV	TSS Median	TSS 90% Confidence Limits
1	SS1 Roland	-	36	3	48	16	200	.91	200	140-200
2	MD1 Hampden	-	17	40	22	20	82	1.62	43	20-67
3	SL1 Hattie B	-	17	3	50	16	202	1.01	190	106-230
4	MD1 Beverly	-	30	11	60	35	86	1.20	52	30-80
5	MN1 SC	-	107	3	43	13	71	1.07	60	34-70
6	MN1 Wood Cir	-	45	12	81	47	303	.70	302	206-302
7	MN1 St D	-	120	7	23	7	351	2.06	154	60-305
8	MN1 Concord	-	100	1	33	8	54	1.53	30	14-63
9	MN1 Grand D Br	-	453	5	30	23	150	1.76	90	80-130
10	MN2 Pitt AB-S	-	2001	2	21	6	40	.37	43	37-50
11	MN2 Cedar	-	76	-	5	27	791	1.92	134	80-202
12	MD1 Anne	-	604	9	12	6	150	2.05	60	34-106
13	MN3 Pitt AB-U	-	2071	2	06	6	40	.47	61	42-80
14	MN1 Grace D	-	164	5	20	23	172	.86	131	104-171
15	MN3 Swift Run	-	1207	2	6	5	80	.91	50	30-170
16	SD1 Meade	-	2030	-	-	15	3003	1.30	1004	1120-7007
17	CA1 Anne	-	1042	12	-	19	203	1.32	171	115-256
18	PA1 D. Jarrett	-	30	-	13	15	87	3.50	23	11-40
19	FL1 Wilder	-	194	-	57	16	33	.71	27	20-37
20	CO1 North Ave	-	60	9	50	32	490	.96	304	270-651

Commercial

	Site	Land Use % Comm	Area (A)	Pop. Den (#/A)	% IMP	No. of EMCs	TSS Mean	TSS CDV	TSS Median	TSS 90% Confidence Limits
1	CO1 Mile Hiaite	100	74	0	81	27	200	1.00	177	81-183
2	OC1 MD1 (CBD)	100	23	0	60	60	163	1.15	107	80-130
3	OH3 Southgate	100	179	2	23	12	141	.76	112	70-150
4	MN1 Post Office	100	12	0	100	50	212	.86	164	133-197
5	MN1 Pkg Lot	100	1	0	90	32	74	1.66	30	27-50
6	MN1 CBD	100	76	0	90	15	123	.73	90	74-133
7	MN1 Rustler	100	12	0	100	42	202	.60	167	142-196
8	OS1 SC Metcalf	85	50	-	57	27	80	2.12	30	21-96
9	FL1 Bayou Pk	94	67	-	65	12	22	1.13	14	9-27
10	WI1 State Fair	74	70	50	77	20	412	.97	296	270-382

Industrial

	Site	Land Use %	Area (A)	Pop. Den (#/A)	% IMP	No. of EMCs	TSS Mean	TSS CDV	TSS Median	TSS 90% Confidence Limits
1	OH2 Addison	100	10	0	60	5	60	.34	57	40-71
2	MN1 Indus Drive	100	63	0	64	10	97	.87	71	53-96
3	SS1 Lenore	96	72	-	66	16	107	1.33	64	40-97
4	MN1 Grace S.	57	75	5	30	20	100	.90	130	104-105

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TABLE 6-2. SITE MEAN BOD EMCs (mg/ℓ)

Residential

	Site	Land Use %	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMPS	BOD Mean	BOD CDV	BOD Median	BOD 90% Confidence Limits
1	CO1 Big Dry Cr	100	33	19	01	0	-	-	-	-
2	CO1 Cherry	100	57	24	30	0	-	-	-	-
3	CO1 110/Cloudc	100	167	14	24	0	-	-	-	-
4	OK1 Butler	100	12	-	-	0	-	-	-	-
5	OK1 Lakeridge	100	80	21	32	0	-	-	-	-
6	OK1 Stratton	100	0	-	-	0	-	-	-	-
7	TX1 John D	100	54	10	19	0	-	-	-	-
8	MS1 Overton	100	50	0	30	5	12	.99	11	6-18
9	NM2 Hanlock	100	50	5	16	0	-	-	-	-
10	MD1 Dalton Mill	100	14	30	51	0	-	-	-	-
11	MD1 Homeland	100	73	9	29	0	-	-	-	-
12	MD1 Mt Wash	100	17	12	19	0	-	-	-	-
13	MD1 Rev Hill	100	10	55	36	0	-	-	-	-
14	MV1 Cerit's B.	100	73	13	20	0	-	-	-	-
15	MV1 Omaha	100	-	-	-	0	-	-	-	-
16	MV1 Cranston	100	100	5	22	0	-	-	-	-
17	MV1 E. Hach.	100	100	10	30	0	-	-	-	-
18	TX1 Hallingwood	100	80	3	21	0	-	-	-	-
19	MN1 Surrey	100	95	9	29	0	-	-	-	-
20	MV1 Burbank	100	63	15	50	20	7	.60	6	5-7
21	MV1 Hastings	100	33	17	51	20	9	.62	8	6-10
22	FL1 Young Apts	100	9	-	6	17	16	1.30	11	7-17
23	TX1 Hart	40	170	9	60	0	-	-	-	-
24	MV1 Lincoln	97	30	10	57	11	10	1.25	12	7-20
25	TX1 07	95	80	4	13	10	9	.80	7	5-10
26	OK1 Westleigh	93	41	3	20	3	-	-	-	-
27	KS1 KC - Ohad	97	63	-	37	5	20	.65	21	13-31
28	FL1 John S.	91	30	10	10	0	-	-	-	-
29	TX1 D1	91	99	11	33	9	10	.87	11	7-18
30	MV1 Lake Hills	91	100	17	37	0	-	-	-	-
31	FL1 Hatts S.	80	70	27	37	0	-	-	-	-
32	FL1 Charter Hdg	80	40	-	10	17	13	1.24	8	5-13
33	OK1 Fairidge	80	19	-	24	5	5	.64	4	2-7
34	CO1 Asbury	86	177	9	27	0	-	-	-	-
35	TX1 Comb Estate	85	529	8	17	0	-	-	-	-
36	MN1 Larvet	80	550	11	10	0	-	-	-	-
37	OK1 PMPS	86	374	8	27	7	11	.83	10	6-15
38	MN1 Jordan	79	130	10	21	0	-	-	-	-
39	OK1 Stadelet	70	27	15	30	3	-	-	-	-

Urban Open and Recreation

	Site	Land Use % Open	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMPS	BOD Mean	BOD CDV	BOD Median	BOD 90% Confidence Limits
1	CO1 Sooslee	100	633	-	-	0	-	-	-	-
2	CO1 Rumey Ranch	100	405	0	1	0	-	-	-	-
3	OK1 Thornell	100	20,410	-	0	0	-	-	-	-
4	OK2 English Dr	80	5,700	-	1	0	-	-	-	-
5	OK2 West Dr	97	5,330	-	1	0	-	-	-	-
6	OK1 Thomas Cr	91	17,770	1	11	0	-	-	-	-
7	OK1 Tracer Cr	80	7,307	-	6	5	7	.01	7	-
8	OK2 Sheriff Park	80	967	-	7	0	-	-	-	-

Mixed

	Site	Land Use %	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMPS	BOD Mean	BOD CDV	BOD Median	BOD 90% Confidence Limits
1	MS1 Roland	-	36	3	00	1	-	-	-	-
2	MD1 Hampden	-	17	40	72	0	-	-	-	-
3	ILS Mattis D	-	17	3	50	0	-	-	-	-
4	OK1 Shearly	-	30	11	00	21	9	.04	7	6-9
5	TX1 SX	-	107	3	43	17	14	.07	11	7-16
6	MS1 Wood Ctr	-	40	17	01	11	14	.54	13	11-15
7	MN1 Mt 9	-	330	7	23	0	-	-	-	-
8	MN1 Concord	-	100	1	13	0	-	-	-	-
9	MN1 Grand O Dr	-	453	5	30	17	8	.67	7	5-9
10	MN3 Pitt AB-5	-	7001	7	21	6	5	.49	5	3-7
11	MV2 Cedar	-	36	-	5	0	-	-	-	-
12	MN1 Anna	-	604	9	12	0	-	-	-	-
13	MN3 Pitt AB-8	-	2071	7	26	6	8	.38	5	3-9
14	MN1 Grace O	-	304	5	20	11	8	.70	7	5-10
15	MN3 Twin Run	-	1707	7	4	5	3	.41	3	2-4
16	SD1 Meade	-	2030	-	-	16	19	.75	15	11-21
17	CO1 Dean	-	1542	12	-	0	-	-	-	-
18	FL1 D. Jewett	-	30	-	13	15	16	.95	12	8-17
19	FL1 Wilder	-	194	-	97	15	16	1.10	10	7-15
20	CO1 North Ave	-	60	9	50	32	-	-	-	-

Commercial

	Site	Land Use % Comm	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMPS	BOD Mean	BOD CDV	BOD Median	BOD 90% Confidence Limits
1	CO1 Mile Hollo	100	36	0	90	0	-	-	-	-
2	OK1 NW3 (CBD)	100	73	0	60	23	10	.08	13	10-17
3	OK3 Southgate	100	179	2	23	0	-	-	-	-
4	MN1 Post Office	100	17	0	100	35	9	.50	8	7-9
5	MN1 Mpg Int	100	1	0	80	33	11	.05	13	10-16
6	TX1 CBD	100	26	0	90	13	13	.40	12	10-15
7	MN1 Rochter	100	12	0	-	27	13	.29	10	8-13
8	KS1 KC Metcalf	95	50	-	97	13	8	.40	7	5-9
9	FL1 Mamo Pk	91	67	-	85	12	12	.60	9	6-13
10	MN1 Stone Falr	74	29	80	72	15	19	.72	15	11-20

Industrial

	Site	Land Use %	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMPS	BOD Mean	BOD CDV	BOD Median	BOD 90% Confidence Limits
1	OK2 Addison	100	30	0	00	0	-	-	-	-
2	MN1 Indus Drive	100	63	0	64	0	10	.50	9	6-13
3	MS1 Lenore	95	72	-	66	0	14	.77	11	7-17
4	MN1 Grace S.	92	79	5	30	9	5	.30	5	4-6

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TABLE 6-3. SITE MEAN COD EMCs (mg/l)

	Site	Land Use %	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMCs	COD Mean	COD CDV	COD Median	90% Confidence Limits
Residential										
1	CO1 Big Dry Cr	100	32	19	01	16	119	.72	105	70-130
2	CO1 Cherry	100	57	24	30	14	127	.66	102	77-135
3	CA1 110/Elmdale	100	167	54	24	16	137	.74	103	70-130
4	DC1 Buffalf	100	12	-	-	7	64	.30	62	54-74
5	DC1 Lakeridge	100	60	71	32	44	60	.56	50	43-50
6	DC1 Stratton	100	0	-	-	31	51	.55	46	35-63
7	IL1 John D	100	54	10	19	31	126	.80	90	70-177
8	IS1 Overton	100	50	0	30	14	162	.67	135	100-180
9	MA7 Hemlock	100	50	5	16	0	-	-	-	-
10	MD1 Bottom Drill	100	14	30	51	19	230	1.30	180	80-303
11	MD1 Homeland	100	23	9	29	13	172	.73	130	101-190
12	MD1 Mt Wash	100	17	12	29	20	160	.80	120	80-170
13	MD1 Red Hill	100	10	56	26	13	177	.80	130	90-190
14	MI1 Carll's H	100	73	13	20	0	-	-	-	-
15	MI1 Hague	100	-	-	-	0	-	-	-	-
16	MN3 Cranston	100	106	5	22	0	33	.63	34	24-41
17	NY1 E. Rock.	100	346	30	30	7	66	.31	62	46-100
18	TX1 Bellingwood	100	50	3	71	0	70	.45	64	49-84
19	WA1 Surrey	100	86	9	29	110	48	.54	42	30-46
20	WI1 Burbank	100	63	15	50	27	30	.70	30	24-30
21	WI1 Hastings	100	33	12	51	23	61	.56	55	30-66
22	FL1 Young Apts	100	9	-	6	12	73	.95	52	34-79
23	TX1 Hart	99	370	9	40	11	82	.83	63	62-94
24	WI1 Lincoln	87	36	10	57	30	91	.96	66	66-94
25	IN1 B2	98	60	4	13	11	45	.30	42	34-52
26	DC1 Westleigh	93	41	3	21	30	51	.46	46	41-52
27	WS1 DC - Bend	87	63	-	32	11	176	.80	126	80-197
28	IL1 John S.	81	30	10	10	29	111	.86	87	60-100
29	MN1 B1	91	60	11	32	11	170	.98	62	56-130
30	WA1 Lake Hills	91	102	12	37	127	44	.54	38	36-41
31	IL1 Hollis S.	80	26	22	37	30	180	.72	146	119-170
32	FL1 Charter Hdg	80	42	-	46	12	56	.54	47	36-64
33	DC1 Fairidge	80	19	-	30	40	51	.46	47	42-52
34	CO1 Asbury	80	177	9	22	9	230	1.12	156	80-273
35	IL2 Camb Inlets	66	524	0	17	29	130	.90	102	70-136
36	MN1 Locust	65	154	11	36	6	104	.45	96	67-126
37	DC1 #1073	64	329	6	27	34	80	.07	64	51-82
38	MN1 Jordan	79	140	10	21	9	70	.53	30	51-95
39	DC1 Stoddard	70	77	15	36	45	45	.60	30	30-45
Mixed										
1	CS1 Roland	-	36	3	60	17	140	.46	80	66-172
2	MD1 Hampden	-	17	60	72	20	111	.73	80	60-115
3	IL1 Hollis Q	-	17	3	50	35	150	.60	104	130-136
4	MN1 Waverly	-	30	11	60	27	64	.80	50	40-63
5	TN1 SC	-	107	3	43	13	80	.70	40	36-67
6	WI1 Wood Cir	-	95	12	81	30	92	.57	80	60-90
7	MA1 Dr 9	-	130	7	73	6	107	.60	80	53-140
8	MA1 Concord	-	100	1	33	0	72	.67	61	47-80
9	MA1 Grand O Dr	-	453	5	30	10	71	.47	66	54-70
10	MN3 Pitt AA-5	-	2001	2	21	4	-	-	-	-
11	NY2 Cedar	-	36	-	5	0	-	-	-	-
12	MA1 Anna	-	441	9	17	6	80	.51	70	53-116
13	MN3 Pitt AA-6	-	2071	2	26	3	-	-	-	-
14	MA1 Grace O	-	104	5	30	17	72	.43	66	56-79
15	MN3 Smith Run	-	1707	2	4	5	79	.17	79	76-33
16	SD1 Reede	-	2010	-	-	16	170	.30	167	100-700
17	CA1 Dana	-	1042	12	-	21	93	.60	80	80-90
18	FL1 D. Jewell	-	30	-	13	15	50	1.10	33	22-50
19	FL1 Wilder	-	104	-	57	15	51	.30	40	41-57
20	CO1 North Ave	-	60	0	50	32	200	.74	275	106-275
Commercial										
1	CO1 Villa Italia	100	74	0	91	27	104	.07	130	100-170
2	DC1 WB13 (CBD)	100	73	0	60	40	170	.79	90	70-113
3	MN1 Southgate	100	179	2	21	9	40	.30	30	31-47
4	WI1 Post Office	100	12	0	100	40	57	.67	40	41-56
5	MN1 Pkg Lot	100	1	0	90	33	80	.72	70	66-96
6	MN1 CBD	100	26	0	60	16	73	.58	66	57-81
7	WI1 Butler	100	17	0	-	70	50	.76	47	37-50
8	CS1 DC Metcalf	98	50	-	97	20	56	.05	41	31-56
9	FL1 Burns Pk	91	47	-	46	12	41	.47	37	29-47
10	WI1 State Fair	74	70	10	77	21	113	.80	84	64-112
Industrial										
1	MN2 Adamson	100	10	0	60	0	-	-	-	-
2	WI1 Indus Drain	100	63	0	64	17	67	.46	64	60-77
3	CS1 Lenexa	96	72	-	60	16	50	.60	50	30-64
4	MN1 Grace S.	57	75	5	30	11	60	.79	47	37-60
Urban Open and Suburban										
1	CA1 Newton	100	613	-	-	14	111	.47	102	80-173
2	CO1 Rooney Gulch	100	405	0	1	7	73	.33	60	54-67
3	MN3 Thorwall	100	20,036	-	4	0	26	.36	23	20-28
4	MN2 English Dr	90	6,240	-	1	0	-	-	-	-
5	MN2 West Dr	87	6,330	-	1	0	-	-	-	-
6	MN3 Thomas Cr	81	17,720	1	11	6	26	.26	26	21-32
7	MN3 Trower Cr	80	7,303	-	6	5	25	.19	25	21-30
8	MN2 Sheriff Run	80	562	-	3	0	-	-	-	-

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TABLE 6-4. SITE MEAN TOTAL P EMCs (μg/ℓ)

Residential

	Site	Land Use % Res	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	Total P Mean	Total P CDF	Total P Median	Total P 90% Confidence Limits
1	CO1 Big Dry Cr	100	33	19	01	16	693	.38	505	396-716
2	CO1 Cherry	100	57	24	30	10	479	.54	377	297-479
3	CO1 110/Claude	100	107	14	24	15	630	.05	513	392-677
4	DC1 Buffet	100	17	-	-	5	499	.32	475	353-600
5	DC1 Lakeridge	100	68	71	33	48	375	.70	256	217-307
6	DC1 Stratton	100	0	-	-	20	340	.50	300	295-353
7	FL1 John D	100	56	10	19	33	750	.62	630	530-753
8	FS1 Overton	100	50	0	30	8	1436	.01	1307	717-2031
9	MN2 Hanlock	100	50	5	36	5	330	1.05	240	95-601
10	MD1 Dalton Mill	100	10	30	51	10	930	1.15	613	425-883
11	MD1 Homeland	100	73	9	29	13	671	.70	505	353-671
12	MD1 Mt Wash	100	37	12	29	20	956	.03	470	320-566
13	MD1 Rex Mill	100	50	95	70	13	4040	1.05	2025	1045-4175
14	MD1 Carill's B.	100	73	13	30	20	773	.50	595	503-733
15	MD1 Unque	100	-	-	-	0	770	.61	190	130-705
16	MD3 Cranston	100	100	5	22	13	300	.54	204	200-340
17	MD3 E. Rock.	100	345	10	30	0	640	.07	605	300-540
18	TX1 Bellingwood	100	60	3	21	9	700	.55	733	500-377
19	UT1 Surrey	100	95	9	20	130	230	.03	300	104-305
20	UT1 Garbank	100	63	15	50	45	270	.05	200	100-733
21	UT1 Hastings	100	33	17	51	30	700	.51	730	201-700
22	FL1 Young Apts	100	0	-	6	10	193	.05	270	205-300
23	TX1 Hart	99	370	0	60	30	333	.00	700	170-340
24	UT1 Lincoln	97	30	30	57	23	653	.00	373	200-406
25	TX1 DZ	95	05	6	33	11	790	.41	777	303-707
26	DC1 Westleigh	93	41	3	21	41	307	.75	320	200-300
27	FS1 DC - Stud	92	63	-	37	30	1797	1.31	707	441-1405
28	FL1 John S.	91	39	30	30	32	730	.05	600	507-727
29	TX1 D1	91	09	11	33	11	705	.35	605	557-804
30	UT1 Lake Hills	91	100	12	37	177	304	.03	300	300-777
31	FL1 Hollis S.	90	30	27	37	32	507	.00	403	401-507
32	FL1 Charter Hdg	89	42	-	36	17	395	1.01	300	195-370
33	DC1 Fairidge	89	19	-	34	47	751	.73	750	202-330
34	CO1 Asbury	86	177	9	27	9	1005	.71	834	561-1739
35	FL2 Cobb Inlets	85	520	0	17	25	500	.70	397	310-501
36	MD1 Forest	85	154	11	30	6	1770	.70	600	545-1713
37	DC1 FTDF3	80	320	6	27	63	520	.00	375	317-600
38	MD1 Jordan	79	170	10	71	8	640	.95	304	140-995
39	DC1 Stoddert	70	27	15	36	60	300	.05	375	201-370

Mixed

	Site	Land Use %	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	Total P Mean	Total P CDF	Total P Median	Total P 90% Confidence Limits
1	FS1 Roland	-	36	3	60	7	555	.37	570	413-671
2	MD1 Hampden	-	17	40	77	20	754	1.01	630	701-843
3	FL1 Hollis B	-	17	3	50	35	490	.50	431	370-501
4	MD1 Beverly	-	30	11	60	35	190	.64	167	101-197
5	TX1 SE	-	107	3	43	13	352	.64	290	271-300
6	MN1 Wood City	-	45	17	31	47	300	.50	244	210-304
7	MD1 DC 9	-	330	7	73	5	1170	.63	905	573-1770
8	MD1 Concord	-	300	1	33	0	490	1.00	300	00-601
9	MN1 Grand & Qk	-	453	5	30	77	450	.05	304	300-477
10	MN3 Pike Ad-5	-	7001	2	71	6	103	.50	93	61-131
11	MN2 Cedar	-	76	-	4	17	103	1.24	233	170-300
12	MN3 Anna	-	001	9	17	6	534	.00	407	216-700
13	MN3 Pike Ad-8	-	2071	7	76	6	700	.07	741	300-751
14	MN3 Grace D	-	304	5	20	23	300	.54	307	205-430
15	MN3 Smith Run	-	1707	2	4	5	134	.56	117	71-193
16	SD1 Rhode	-	2030	-	-	15	1005	1.70	1363	703-1650
17	CO1 Omaha	-	1547	17	-	19	430	.50	370	310-453
18	FL1 D. Jewell	-	30	-	03	15	190	.71	300	170-710
19	FL1 Orlando	-	190	-	07	15	279	.52	204	163-255
20	CO1 North Ave	-	69	9	50	32	700	.00	673	470-705

Commercial

	Site	Land Use % Com	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	Total P Mean	Total P CDF	Total P Median	Total P 90% Confidence Limits
1	CO1 Villa Italia	100	30	0	95	27	700	1.70	630	310-605
2	DC1 5013 (CBD)	100	73	0	00	61	395	.50	347	300-303
3	MN3 Southgate	100	170	2	71	17	730	.35	700	303-730
4	MN1 Post Office	100	17	0	100	00	100	.55	94	00-105
5	MN1 Mag Lot	100	1	0	50	27	273	1.71	174	127-730
6	TX1 CBD	100	30	0	90	15	712	.03	195	102-275
7	MN1 Boston	100	17	0	-	44	105	.70	67	00-00
8	MN1 DC Rockville	99	50	-	07	30	240	.00	170	120-242
9	FL1 Korea Pk	99	07	-	05	17	151	.50	130	100-177
10	UT1 State Fair	70	70	10	77	70	511	1.19	330	205-403

Urban Open and Recreation

	Site	Land Use % Open	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	Total P Mean	Total P CDF	Total P Median	Total P 90% Confidence Limits
1	CO1 Sheridan	100	033	-	-	13	500	.02	495	319-600
2	CO1 Ramey Gulch	100	005	0	1	7	670	.07	300	270-570
3	MN3 Thornell	100	20,030	-	0	13	193	.05	179	101-217
4	MN2 English Dr	90	5,700	-	1	30	27	1.70	17	13-21
5	MN2 West Dr	97	5,330	-	1	31	57	1.77	37	24-61
6	MN3 Phoenix Cr	91	17,770	1	11	12	195	.07	177	140-273
7	MN3 Fraser Cr	90	7,307	-	0	5	91	.30	85	60-171
8	MN2 Sheriff Dock	80	957	-	7	75	204	1.04	100	145-730

Industrial

	Site	Land Use % Ind	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	Total P Mean	Total P CDF	Total P Median	Total P 90% Confidence Limits
1	MN2 Addison	100	30	0	00	5	134	00	95	41-170
2	MN1 Indian Drain	100	63	0	64	30	540	.50	477	370-600
3	MN1 Lenora	95	77	-	44	35	409	.07	457	375-630
4	MN1 Grace S.	57	75	5	30	17	475	.71	395	271-604

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TABLE 6-5. SITE MEAN SOLUBLE P EMCs (µg/ℓ)

Residential										
	Site	Land Use % Res	Area (A)	Pop. Den. (#/A)	% IMP.	No. of EMC's	SOL P Mean	CDV	Median	90% Confidence Limits
1	CO1 Big Dry Cr	100	33	10	41	15	193	.64	163	175-213
2	CO1 Cherry	100	57	24	30	14	232	.47	197	155-232
3	CO1 116/Claude	100	167	14	24	16	196	.35	179	156-200
4	DE1 Buffet	100	12	-	-	6	666	.95	397	257-500
5	DE1 Lakeridge	100	66	21	33	47	69	.62	50	51-60
6	DE1 Stratton	100	8	-	-	27	251	.66	230	173-250
7	ILI John D	100	54	10	19	0	-	-	-	-
8	ES1 Overton	100	10	8	30	0	313	.61	290	273-300
9	MA7 Hancock	100	50	5	16	5	100	.09	120	90-200
10	MD1 Dalton Mill	100	10	30	51	0	-	-	-	-
11	MD1 Homeland	100	23	9	20	0	-	-	-	-
12	MD1 Mt Hush	100	17	12	20	0	-	-	-	-
13	MD1 Des Mill	100	10	15	26	0	-	-	-	-
14	MT1 Cartl's D.	100	23	13	20	0	-	-	-	-
15	MT1 Unque	100	-	-	-	0	-	-	-	-
16	MT1 Cranston	100	106	5	22	0	-	-	-	-
17	NY1 E. Rock.	100	346	10	30	0	-	-	-	-
18	TX1 Gallimmond	100	66	3	23	0	-	-	-	-
19	VA1 Surrey	100	95	9	20	0	-	-	-	-
20	WI1 Burbank	100	63	15	50	0	-	-	-	-
21	WI1 Hastings	100	33	17	51	0	-	-	-	-
22	FL1 Young Apts	100	9	-	6	0	-	-	-	-
23	IN1 Hart	99	370	9	40	0	-	-	-	-
24	WI1 Lincoln	97	36	10	57	0	-	-	-	-
25	MN1 B2	96	89	4	13	11	137	.63	117	87-192
26	DE1 Westleigh	93	41	3	25	41	273	.71	187	150-215
27	ES1 SC - 52nd	92	63	-	37	10	241	.62	205	142-280
28	IL1 John S.	91	30	10	10	0	-	-	-	-
29	MN1 B1	91	69	11	33	11	136	.94	90	66-153
30	MN1 Lake Hills	91	102	12	37	0	-	-	-	-
31	IL1 Mattis S.	89	29	22	32	0	-	-	-	-
32	FL1 Charter Hdg	89	42	-	16	0	-	-	-	-
33	DE1 Fairiage	88	19	-	30	46	297	.87	229	185-370
34	CO1 Asbury	86	127	9	22	9	212	.22	207	181-237
35	IL7 Cook Inlets	85	529	8	17	26	90	1.21	63	46-88
36	MN1 Forest	85	154	11	16	6	304	.42	300	171-235
37	DE1 #1023	84	329	6	27	0	-	-	-	-
38	MN1 Jordan	79	110	10	21	7	202	1.11	136	70-262
39	DE1 Stoddard	70	27	15	30	41	251	.70	206	176-243

Mixed										
	Site	Land Use %	Area (A)	Pop. Den. (#/A)	% IMP.	No. of EMC's	SOL P Mean	CDV	Median	90% Confidence Limits
1	ES1 Roland	-	36	3	60	0	166	.57	140	100-200
2	MD1 Hampden	-	37	40	72	0	-	-	-	-
3	IL1 Mattis N	-	37	3	50	0	-	-	-	-
4	MI1 Beverly	-	30	11	60	32	43	.76	30	20-47
5	MO1 SC	-	107	3	43	13	197	1.17	120	81-200
6	NY1 Wood Ctr	-	46	12	61	0	-	-	-	-
7	OH1 Dt 9	-	330	7	23	5	160	.30	150	105-213
8	OR1 Convent	-	100	1	33	0	105	1.03	53	90-130
9	PA1 Grand & Dt	-	452	5	30	20	60	.66	50	44-71
10	PA1 Pitt AA-5	-	2001	2	21	6	13	.32	13	10-17
11	WV1 Cedar	-	20	-	5	25	49	1.06	32	23-66
12	WA1 Anna	-	601	0	12	4	-	-	-	-
13	WV1 Pitt AA-8	-	2971	2	26	6	50	.80	44	30-87
14	WV1 Grace 8	-	164	5	20	21	67	.67	62	35-90
15	WV1 Tuft Run	-	1207	2	4	5	39	.46	35	23-53
16	SD1 Meade	-	2030	-	-	14	87	.61	70	57-97
17	CA1 Anna	-	1542	12	-	30	160	.99	130	80-180
18	FL1 B. Jewett	-	30	-	13	0	-	-	-	-
19	FL1 Wilder	-	100	-	97	0	-	-	-	-
20	CO1 North Ave	-	80	0	90	30	270	.95	300	170-217

Commercial										
	Site	Land Use % Coml	Area (A)	Pop. Den. (#/A)	% IMP.	No. of EMC's	SOL P Mean	CDV	Median	90% Confidence Limits
1	CO1 Villa Italia	100	74	0	91	26	293	1.09	190	147-300
2	DE1 1013 (CBD)	100	23	0	60	0	-	-	-	-
3	MT1 Southgate	100	170	2	21	0	-	-	-	-
4	NY1 Post Office	100	12	0	100	0	-	-	-	-
5	OH1 Pkg Lot	100	1	0	50	0	-	-	-	-
6	OR1 CBD	100	30	0	90	15	66	.72	37	20-50
7	WI1 Bustler	100	12	0	-	0	-	-	-	-
8	ES1 W Metcalf	95	50	-	97	21	136	1.06	80	50-111
9	FL1 Dunns Pk	94	42	-	45	0	-	-	-	-
10	WI1 State Fair	74	29	10	77	0	-	-	-	-

Industrial										
	Site	Land Use % Ind	Area (A)	Pop. Den. (#/A)	% IMP.	No. of EMC's	SOL P Mean	CDV	Median	90% Confidence Limits
1	MA7 Addison	100	30	0	60	5	75	.97	55	20-110
2	MI1 Indus Drive	100	63	0	64	10	127	.72	101	70-140
3	ES1 Lenexa	96	22	-	64	25	146	1.46	170	100-270
4	WI1 Grace S.	52	25	5	30	36	50	1.20	31	20-50

Urban Open and Nonurban										
	Site	Land Use % Open	Area (A)	Pop. Den. (#/A)	% IMP.	No. of EMC's	SOL P Mean	CDV	Median	90% Confidence Limits
1	CA1 Newton	100	633	-	-	17	105	1.20	91	66-150
2	CO1 Rooney Gulch	100	605	0	1	7	137	.46	129	90-171
3	NY1 Thornapple	100	70,016	-	4	0	-	-	-	-
4	OH7 English Br	90	5,740	-	1	10	5	.35	5	4-6
5	OH7 West Br	97	5,130	-	1	25	8	.54	7	6-8
6	OH7 Thomas Cr	91	17,770	1	11	0	-	-	-	-
7	WI1 Fraser Cr	90	7,303	-	6	5	11	.55	20	10-47
8	WA7 Sherrill Beach	80	552	-	7	17	30	1.11	20	20-30

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TABLE 6-6. SITE MEAN TKN EMCs (μg/ℓ)

	Site	Land Use % Open	Area (A)	Pop. Den (P/A)	% IMP.	No. of EMC	TKN Mean	TKN COV	TKN Median	TKN 90% Confidence Limits
Residential										
1	CO1 Big Dry Cr	100	33	19	41	16	2,300	.30	2001	1612-2506
2	CO1 Cherry	100	57	24	30	14	2,000	.39	2030	2030-2500
3	CO1 Ind/Lincoln	100	107	14	24	15	2,003	.51	2501	2000-3112
4	OK1 Bethel	100	17	-	-	6	2,006	.13	2060	1001-2770
5	OK1 Lakeridge	100	60	21	33	40	1,770	.04	1490	1790-1670
6	OK1 Stratton	100	0	-	-	20	1,011	.39	1000	1000-1500
7	PA1 John G	100	54	18	10	13	3,000	.01	3107	2570-3011
8	PA1 Overton	100	50	0	10	5	-	-	-	-
9	NJ2 Hooters	100	50	5	16	5	3,079	.95	3017	1971-5797
10	MD1 Dalton Mill	100	14	30	51	10	6,007	.77	4015	3640-6370
11	MD1 Homeland	100	73	9	20	13	6,505	.40	6000	4900-7317
12	MD1 Mt Wash	100	17	12	20	20	6,975	.61	6400	5507-7403
13	MD1 Rps Mill	100	10	95	20	13	10,000	.63	9915	8009-12150
14	MD1 Cortt's D.	100	73	13	20	20	1,407	.73	1701	955-1509
15	MD1 Unoo	100	-	-	-	0	1,400	.70	1303	1140-1610
16	MD1 Cranston	100	100	5	22	13	1,907	.05	1390	1090-1679
17	MD1 E. Rock.	100	340	10	30	7	3,246	.50	2431	1359-4705
18	TN1 Gallingwood	100	80	3	21	9	5,004	.37	1042	670-4954
19	OH1 Surrey	100	95	9	20	100	1,007	.02	957	705-930
20	WV1 Orchard	100	63	15	50		1,700	.50	1175	900-1505
21	WV1 Hastings	100	33	17	51	15	1,307	.54	909	801-1173
22	FL1 Young Apts	100	9	-	0	17	1,370	.70	1097	791-1527
23	TX1 Mart	90	370	9	40	11	3,046	.75	2417	1670-3470
24	WV1 Lincoln	97	35	10	57	1	-	-	-	-
25	TX1 02	90	00	6	13	11	470	.23	450	370-530
26	OK1 Westleigh	75	41	3	25	45	1,501	.50	1000	1007-1000
27	OK1 SE - Wood	90	63	-	37	0	4,307	.00	3051	1700-5500
28	OK1 John S.	95	39	10	50	30	3,577	.00	2401	1000-3955
29	TX1 01	95	00	11	33	11	1,131	.34	1071	800-1703
30	WV1 Lake Hills	91	302	12	37	177	1,050	.73	850	770-930
31	OK1 Hills S.	90	20	27	37	30	3,440	.00	2575	2301-3400
32	FL1 Charter Bdg	80	42	-	30	12	1,700	.03	1100	600-1001
33	OK1 Fairidge	40	10	-	30	46	2,717	.53	1950	1731-2715
34	CO1 Asbury	85	127	9	22	7	3,775	.50	3703	2770-4700
35	NJ2 Comb Inlets	85	520	8	17	0	-	-	-	-
36	MD1 Locust	85	154	11	16	0	2,000	.30	2507	1004-3012
37	OK1 #1073	60	324	6	27	07	1,400	.94	1000	973-2277
38	MD1 Jordan	70	136	10	21	9	1,391	.00	1190	805-1001
39	OK1 Stadwick	30	27	15	30	43	1,095	.57	1003	1695-1001
Urban Open and Recreation										
1	CA1 Sprague	100	633	-	-	13	3670	.90	1190	2411-4130
2	CO1 Rooney Gulch	100	005	0	0	7	7090	.53	7015	1015-3700
3	OH1 Thornell	100	70,036	-	4	13	1000	.90	607	770-1700
4	OH2 Smith Dr	00	5,740	-	0	15	300	.90	305	705-370
5	OH2 West Dr	97	5,330	-	1	20	307	.57	307	707-407
6	OH1 Thomas Cr	94	17,770	1	13	90	1111	.30	1095	804-1270
7	OH1 Trevor Cr	90	7,303	-	6	9	600	.11	603	700-901
8	OH2 Shorliff Gulch	80	957	-	7	99	953	.76	705	630-907
Mixed										
1	CT1 Upland	-	30	3	00	0	-	-	-	-
2	MD1 Hampden	-	17	40	72	19	6000	.95	6100	5000-7933
3	PA1 Mills D	-	17	3	30	35	7077	.04	7177	7000-7000
4	OH1 Beverly	-	30	11	00	35	1490	.53	1310	1107-1510
5	MD1 SC	-	007	3	43	13	673	.30	910	607-705
6	CO1 Wood Cir	-	05	17	30	16	1047	.35	1309	1000-1500
7	MD1 Dt 9	-	330	7	73	5	2400	.50	2100	1304-3437
8	MD1 Concord	-	000	1	30	0	1000	.04	910	615-1307
9	OH1 Grand D Dt	-	013	5	30	23	1031	.07	1300	1304-1700
10	MD1 Pitt RD-5	-	2001	2	73	6	005	.70	011	607-1405
11	OH2 Cedar	-	70	-	5	21	1717	.03	951	770-1700
12	MD1 Anne	-	001	9	12	6	1000	.70	1547	000-2001
13	MD1 Pitt RD-8	-	2071	7	70	6	1056	.73	1011	007-1731
14	OH1 Grace D	-	300	5	30	23	1000	.07	1002	1530-2315
15	MD1 Saint Ann	-	1707	7	4	5	1110	.15	1100	950-1773
16	TX1 Meade	-	2030	-	-	13	4243	.90	3002	3010-4007
17	CA1 Dean	-	1547	07	-	20	7770	.75	1775	1371-7700
18	FL1 N. Jewett	-	30	-	13	15	1300	.00	1200	1011-1507
19	FL1 Ortiber	-	100	-	07	15	1007	.31	1056	000-1717
20	CO1 North Dam	-	00	0	10	23	4105	.05	3572	2047-4750
Commercial										
1	CO1 Little Dublin	100	70	0	41	27	3057	.05	2705	2100-3540
2	OK1 1043 (CBD)	100	73	0	00	61	1013	.70	1310	1157-1500
3	OH1 Southgate	100	170	2	71	13	1700	.05	1140	975-1410
4	OH1 Post Office	100	17	0	100	27	1073	.00	930	815-1075
5	OH1 Pkg Lot	100	1	0	97	10	2117	.05	1701	1370-2750
6	TX1 CBD	100	30	0	99	15	040	.01	907	600-710
7	OH1 Quetler	100	17	0	-	75	1073	.01	910	795-1110
8	FL1 N Metcalf	40	50	-	97	17	1175	.73	040	770-1757
9	FL1 Bunny Pk	95	07	-	05	17	070	.00	073	070-075
10	FL1 State Fair	70	75	10	77	0	1056	.05	1300	070-2000
Industrial										
1	NJ2 Addison	100	10	0	00	5	3002	.09	3070	1707-2000
2	OH1 Indian Drain	100	63	0	04	10	1774	.51	1307	001-1375
3	OH1 Lenore	90	72	-	04	17	1305	.73	1117	700-1500
4	OH1 Grace S.	17	75	5	10	10	1713	.10	1003	1705-1050

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TABLE 6-7. SITE MEAN NITRITE PLUS NITRATE EMCs (μg/ℓ)

Residential

	Site	Land Use & Area	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	NO_{2+3}^{-N} Mean	CDV	Median	90% Confidence Limits
1	CO1 Big Dry Cr	100	33	10	41	15	527	.34	490	420-600
2	CO1 Cherry	100	67	20	30	14	700	.40	667	567-700
3	CO1 110/Claude	100	167	10	20	16	630	.51	570	450-710
4	OK1 Relief	100	12	-	-	0	640	.35	600	350-900
5	OK1 Lakeridge	100	60	21	30	40	745	.62	630	567-735
6	OK1 Stratton	100	0	-	-	35	610	.65	317	350-305
7	FL1 John D	100	54	10	10	-	-	-	-	-
8	CA1 Overton	100	10	0	35	-	-	-	-	-
9	MA2 Hanlock	100	60	5	16	4	-	-	-	-
10	MD1 Dalton Mill	100	14	30	51	10	9535	1.50	5070	3240-7030
11	MD1 Mansfield	100	33	5	20	13	6343	0.56	1360	530-3230
12	MD1 Mt Rush	100	17	12	20	20	7072	1.16	6270	2753-6007
13	MD1 Rec Mill	100	10	56	76	13	6410	1.00	4700	3040-7300
14	MD1 Carll's H.	100	73	33	20	24	720	1.30	642	311-627
15	MD1 Indian	100	-	-	-	0	1033	-	-	1000-1037
16	MD1 Cranston	100	166	5	22	0	-	-	-	-
17	MD1 E. Rock.	100	340	50	30	0	-	-	-	-
18	FL1 Hollingsmead	100	60	9	21	9	870	.61	700	501-1000
19	MA1 Surrey	100	96	0	20	0	-	-	-	-
20	MA1 Burbank	100	63	16	50	16	775	.40	690	600-840
21	MA1 Hastings	100	33	17	51	24	670	.50	502	510-600
22	FL1 Young Apts	100	5	-	6	12	311	.04	302	103-304
23	TX1 Hart	00	170	0	00	30	1635	.54	1430	1007-1967
24	MA1 Lincoln	97	33	10	57	3	-	-	-	-
25	TX1 02	00	00	6	13	11	307	1.36	237	130-412
26	OK1 Westleigh	03	61	3	71	41	702	.50	600	575-700
27	CA1 SC - Ofnd	97	63	-	37	0	-	-	-	-
28	FL1 John S.	91	30	10	36	0	-	-	-	-
29	TX1 01	91	69	11	33	11	670	.77	460	315-600
30	MA1 Lake Hills	91	102	12	37	0	-	-	-	-
31	FL1 Hollis S.	30	70	22	32	0	-	-	-	-
32	FL1 Shorter Hdg	00	42	-	16	17	616	.77	953	330-600
33	OK1 Fairidge	00	10	-	34	40	577	.56	777	667-093
34	CO1 Asbury	06	177	0	77	9	601	.21	667	750-600
35	MA2 Comb Inlets	96	520	0	17	21	756	.55	699	575-040
36	MA1 Locust	96	156	11	36	5	1706	.60	1406	770-7540
37	OK1 01023	04	320	6	27	67	730	.60	501	521-670
38	MA1 Jordan	70	130	10	21	9	1267	.55	1004	795-1105
39	OK1 Stonewick	70	27	15	34	42	837	.70	605	500-600

Mixed

	Site	Land Use & Area	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	NO_{2+3}^{-N} Mean	CDV	Median	90% Confidence Limits
1	KS1 Roland	-	36	3	60	0	-	-	-	-
2	MA1 Hampden	-	17	40	72	20	11,520	4.00	2700	3457-6200
3	IA1 Hotels N	-	17	3	50	0	-	-	-	-
4	MA1 Beverly	-	30	11	60	16	775	.40	600	600-700
5	TX1 SC	-	107	3	43	13	567	1.00	327	302-900
6	MA1 Wood Cir	-	65	12	34	17	751	.40	630	670-805
7	MA1 Oc 9	-	100	7	23	5	1,700	.40	1613	1000-2000
8	MA1 Convent	-	100	1	31	6	906	.30	890	600-1710
9	MA1 Grand O Ok	-	40	5	30	23	803	.46	607	600-930
10	MA3 Pitt AS-6	-	2004	2	71	6	304	.40	706	170-372
11	MA2 Cedar	-	76	-	5	32	240	.22	700	-
12	MA1 Anna	-	604	0	12	6	1,300	.40	1000	600-1714
13	MA3 Pitt AS-8	-	2071	2	35	5	604	.24	450	354-571
14	MA1 Grace B	-	160	5	30	23	675	.43	600	503-931
15	MA3 Butte Run	-	1707	2	4	5	1,030	.76	671	631-1503
16	MA1 Shade	-	2030	-	-	16	630	.40	571	470-600
17	CA1 Anna	-	1642	12	-	37	1,111	.35	1004	301-1710
18	FL1 H. Jenkin	-	30	-	13	14	376	.54	332	301-472
19	FL1 Wilmer	-	100	-	57	15	456	.47	412	330-500
20	CO1 North Ave	-	60	0	50	32	1,704	.92	1206	1017-1675

Commercial

	Site	Land Use & Area	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	NO_{2+3}^{-N} Mean	CDV	Median	90% Confidence Limits
1	CO1 Villa Italia	100	34	0	91	27	1300	.05	895	701-1143
2	OK1 1013 (CBD)	100	23	0	90	61	1130	.56	900	870-1004
3	MA3 Southgate	100	170	2	21	0	-	-	-	-
4	MA1 Post Office	100	12	0	100	20	700	.60	500	670-712
5	MA1 Peg Lot	100	1	0	90	30	604	.04	615	406-770
6	IA1 CBD	100	30	0	90	15	642	.62	642	630-720
7	MA1 Shelter	100	12	0	-	70	701	.00	642	530-701
8	KS1 SC Metcalf	90	50	-	57	0	-	-	-	-
9	FL1 Ronda Pk	04	42	-	45	12	306	.45	323	257-400
10	MA1 State Fair	76	20	30	77	12	703	.50	702	540-007

Urban Open and Recreation

	Site	Land Use & Open	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	NO_{2+3}^{-N} Mean	CDV	Median	90% Confidence Limits
1	CA1 Sawtoo	100	633	-	-	17	1347	.40	1303	1007-1750
2	CO1 Bonny Golfc	100	406	0	1	7	501	1.03	406	217-706
3	OH3 Thornell	100	20,416	-	4	0	-	-	-	-
4	OH2 English Dr	90	5,700	-	1	30	240	.60	206	173-295
5	OH2 West Dr	97	5,330	-	1	31	047	.53	763	646-000
6	OH3 Thomas Cr	91	17,770	1	11	0	-	-	-	-
7	OH3 Grover Cr	00	2,303	-	6	5	1400	.17	1047	930-1303
8	OH2 Sheriff Dach	00	647	-	7	31	303	1.02	260	200-303

Industrial

	Site	Land Use & Area	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	NO_{2+3}^{-N} Mean	CDV	Median	90% Confidence Limits
1	MA2 Addison	100	50	0	60	5	1306	.79	1300	902-1705
2	MA1 Indus Drain	100	63	0	64	10	606	.40	637	540-706
3	CA1 Lenoxo	96	72	-	64	0	-	-	-	-
4	MA1 Grace S.	52	75	5	30	17	742	.62	667	530-000

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TABLE 6-8. SITE MEAN TOTAL COPPER EMCs (µg/ℓ)

	Residential							Total Copper			
	Site	Land Use % Res	Area (A)	Pop. Den. (#/A)	% IMP.	Dp. of BMPs		Mean	CDV	Median	90% Confidence Limits
1	CO1 Big Dry Cr	100	33	19	41	14	30	.07	25		30-30
2	CO1 Cherry	100	57	24	30	14	35	1.40	20		12-33
3	CO1 110/Lincoln	100	107	14	24	16	20	.74	22		16-29
4	OC1 Quiver	100	12	-	-	21	-	-	-		-
5	OC1 Lakeridge	100	60	21	22	24	30	.95	33		20-40
6	OC1 Stratton	100	0	-	-	10	20	.30	27		23-30
7	PL1 John D	100	64	10	19	36	63	.05	63		51-70
8	OS1 Overton	100	50	0	30	17	91	.50	91		93-103
9	OR7 Hawlark	100	50	5	16	0	-	-	-		-
10	MD1 Dalton Mill	100	14	30	51	19	107	.70	80		80-117
11	MD1 Homeland	100	21	9	20	13	317	.30	290		292-349
12	MD1 Mt Rush	100	17	12	29	20	26	.70	20		19-30
13	MD1 Bra Mill	100	30	95	70	13	42	.09	34		29-40
14	OR1 Cartlt's B.	100	73	11	20	0	-	-	-		-
15	OR1 Shaps	100	-	-	-	0	-	-	-		-
16	OR1 Crawford	100	105	5	27	0	-	-	-		-
17	OR1 E. Rock.	100	245	10	30	0	-	-	-		-
18	TX1 Gallingwood	100	60	7	21	0	-	-	-		-
19	MD1 Surrey	100	45	9	29	0	-	-	-		-
20	WI1 Burbank	100	63	16	50	0	-	-	-		-
21	WI1 Hastings	100	33	17	51	0	-	-	-		-
22	PL1 Young Rate	100	0	-	6	12	0	.30	0		5-7
23	TX1 Hart	90	370	0	40	0	-	-	-		-
24	WI1 Lincoln	87	16	10	57	0	-	-	-		-
25	TX1 DF	90	60	4	13	11	30	1.94	15		0-77
26	OC1 Westridge	93	41	3	25	0	37	.43	34		24-40
27	CS1 TC - 99nd	92	63	-	37	0	-	-	-		-
28	PL1 John S.	91	30	10	10	20	41	.04	33		26-40
29	TX1 D1	91	69	11	23	11	61	.60	57		10-70
30	WI1 Lake Mills	91	107	12	37	5	27	.35	21		19-29
31	PL1 Mills S.	90	30	27	37	35	45	.26	30		30-40
32	PL1 Charter Oak	89	42	-	10	12	10	.04	7		5-11
33	OC1 Fairidge	88	19	-	34	0	26	.30	25		19-31
34	CO1 Asbury	86	127	0	27	0	50	.04	45		29-71
35	PL2 Cash Lakes	85	524	0	17	26	49	.53	43		30-51
36	WI1 Locust	85	154	11	30	0	107	.73	100		86-125
37	OC1 PORT	84	109	6	27	49	30	.60	23		29-37
38	WI1 Jordan	79	150	30	25	0	34	.24	27		-
39	OC1 Stadwell	70	27	19	34	0	30	.35	20		23-30

	Mixed							Total Copper			
	Site	Land Use %	Area (A)	Pop. Den. (#/A)	% IMP.	Dp. of BMPs		Mean	CDV	Median	90% Confidence Limits
1	OS1 Noland	-	30	3	60	9	40	.30	45		30-57
2	MD1 Hampden	-	17	60	72	20	61	.06	61		46-80
3	OC1 Mills D	-	17	3	50	37	40	.05	37		31-45
4	OR1 Beverly	-	30	11	60	10	15	.54	13		10-16
5	TX1 SC	-	107	3	43	13	47	1.36	25		15-81
6	OS1 Wood Cov	-	45	12	61	0	-	-	-		-
7	MD1 Dr 9	-	330	7	23	7	117	.45	100		71-101
8	OR1 Cornwall	-	140	1	33	7	105	.43	90		71-130
9	OR1 Grand O Qt	-	953	5	30	13	30	.67	20		20-35
10	OR3 Pitt 88-5	-	2006	2	71	0	-	-	-		-
11	OR7 Cedar	-	20	-	5	0	-	-	-		-
12	OR1 Dana	-	801	9	12	5	54	.51	40		30-95
13	OR3 Pitt 88-8	-	2071	2	20	0	-	-	-		-
14	OR1 Grace 8	-	160	5	20	9	14	.31	13		11-20
15	OR3 Tuff Run	-	1707	2	4	0	-	-	-		-
16	SD1 Rhode	-	2030	-	-	0	-	-	-		-
17	CA1 Dean	-	1542	12	-	17	40	1.10	45		44-46
18	PL1 W. Jacobs	-	30	-	13	15	7	.03	6		5-8
19	PL1 Bridge	-	300	-	57	15	6	.04	5		4-7
20	CO1 North Ave	-	69	9	50	32	77	.03	50		69-70

	Commercial							Total Copper			
	Site	Land Use % Comm	Area (A)	Pop. Den. (#/A)	% IMP.	Dp. of BMPs		Mean	CDV	Median	90% Confidence Limits
1	CO1 Villa Italia	100	34	0	91	27	33	.07	25		30-37
2	OC1 DOIS (CDOT)	100	23	0	80	51	70	.54	61		55-80
3	OR3 Southgate	100	170	0	21	0	-	-	-		-
4	OR1 Post Office	100	17	7	100	0	-	-	-		-
5	OR1 Pkg Lot	100	1	0	90	31	100	.13	100		-
6	TX1 CBD	100	20	0	80	15	42	.60	30		30-45
7	WI1 Rustler	100	12	0	-	0	-	-	-		-
8	OS1 DC Metcalf	95	30	-	90	6	41	.33	30		30-61
9	PL1 Grove Pk	91	47	-	45	12	11	.07	10		8-13
10	WI1 Stone Fate	90	20	10	77	0	-	-	-		-

	Urban Open and Recreation							Total Copper			
	Site	Land Use % Open	Area (A)	Pop. Den. (#/A)	% IMP.	Dp. of BMPs		Mean	CDV	Median	90% Confidence Limits
1	CO1 Sportsm	100	631	-	-	12	50	.33	55		48-65
2	CO1 Rooney Gulch	100	605	0	1	7	37	1.09	25		13-48
3	OR3 Thornell	100	20,000	-	4	0	-	-	-		-
4	OR7 English Br	90	5,700	-	1	0	-	-	-		-
5	OR7 West Br	97	5,330	-	1	0	-	-	-		-
6	OR3 Thomas Cr	95	17,720	1	11	0	-	-	-		-
7	OR3 Tripper Cr	90	7,300	-	0	0	-	-	-		-
8	OR7 Sheriff Gulch	80	950	-	7	0	-	-	-		-

	Industrial							Total Copper			
	Site	Land Use % Ind	Area (A)	Pop. Den. (#/A)	% IMP.	Dp. of BMPs		Mean	CDV	Median	90% Confidence Limits
1	OR7 Addison	100	30	0	80	0	-	-	-		-
2	WI1 Indus Drive	100	63	0	64	6	38	.53	37		31-49
3	OS1 Lenexa	95	77	-	40	5	35	.74	35		30-40
4	WI1 Grove S.	57	35	5	30	7	35	.05	31		34-37

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TABLE 6-9. SITE MEAN TOTAL LEAD EMCs (μg/ℓ)

Residential

	Site	Land Use % Res	Area (A)	Pop. Dens (P/A)	% IMP	No. of EMPS	Total Lead Mean	CDV	Median	90% Confidence Limits
1	CO1 Big Dry Cr	100	33	10	41	16	303	.88	137	88-196
2	CO1 Cherry	100	57	29	30	14	196	.97	143	80-207
3	CO1 110/Claude	100	167	14	29	10	292	.87	230	151-392
4	DE1 Relief	100	12	-	-	1	-	-	-	-
5	DE1 Lakeridge	100	60	21	33	10	227	.50	200	160-265
6	DE1 Stratton	100	8	-	-	0	-	-	-	-
7	FL1 John D	100	54	10	19	36	237	.73	199	150-234
8	KS1 Overton	100	50	8	30	11	130	.30	120	100-167
9	MN2 Hamlet	100	50	5	30	0	-	-	-	-
10	MD1 Bolton Hill	100	14	30	51	19	2705	4.13	597	195-1100
11	MD1 Homeland	100	73	9	29	13	70	.46	69	50-85
12	MD1 Mt Wash	100	17	12	25	20	85	.40	77	65-92
13	MD1 Roj Hill	100	30	56	26	13	461	1.06	230	110-900
14	MN1 Carll's O.	100	73	13	20	0	-	-	-	-
15	MN1 Wayne	100	-	-	-	0	60	1.36	52	30-103
16	MN3 Cranston	100	146	5	22	13	34	.77	27	19-30
17	MN3 E. Hosh.	100	146	10	30	0	103	.60	144	85-240
18	MN3 Bellingwood	100	60	3	21	0	-	-	-	-
19	MN3 Surrey	100	96	0	29	150	152	.51	135	120-145
20	MN1 Durham	100	63	15	50	44	96	.72	77	65-91
21	MN1 Hastings	100	33	17	51	36	100	.67	80	75-107
22	FL1 Young Apts	100	9	-	6	12	76	1.03	63	30-82
23	TX1 Hart	80	370	9	40	0	-	-	-	-
24	MN1 Lincoln	87	30	10	57	22	303	1.10	200	143-300
25	TN1 B2	96	80	6	13	11	133	.41	123	80-153
26	DE1 Wrelleigh	93	41	3	23	9	185	.37	180	157-230
27	KS1 DC - Ohio	92	63	-	32	3	-	-	-	-
28	KS1 John S.	91	30	30	19	33	217	.80	160	135-300
29	TN1 B1	91	84	11	33	15	408	.61	370	277-511
30	MN1 Lake Hills	91	102	12	37	126	152	.67	150	140-170
31	KS1 Hotts S.	80	20	22	37	37	595	1.12	300	300-500
32	KS1 Charter Oak	80	62	-	16	12	80	1.60	26	14-47
33	DE1 Fairidge	80	19	-	34	3	-	-	-	-
34	CO1 Asbury	80	127	9	22	9	433	.72	351	253-520
35	FL1 Comm Inlets	65	526	0	17	24	327	1.04	277	160-200
36	MN1 Locust	65	154	11	16	6	271	.67	275	130-371
37	DE1 #0673	64	176	6	27	66	254	.88	162	157-215
38	MN1 Jordan	75	110	10	21	0	160	.37	160	132-190
39	DE1 Stoddick	70	27	15	34	11	141	.41	120	100-161

Urban Open and Suburban

	Site	Land Use % Open	Area (A)	Pop Dens (P/A)	% IMP	No. of EMPS	Total Lead Mean	CDV	Median	90% Confidence Limits
1	CA1 Newton	100	63	-	-	7	210	.80	190	90-270
2	CO1 Bonney Gulch	100	605	0	1	7	52	.91	30	27-60
3	MN3 Thornell	100	70,000	-	0	10	12	.67	11	9-14
4	MN2 English Br	96	5,240	-	1	21	9	.60	8	6-10
5	MN2 Mud Cr	97	5,330	-	1	25	30	1.40	27	30-31
6	MN3 Thomas Cr	91	17,270	1	11	12	35	1.06	30	30-33
7	MN3 Grover Cr	80	7,303	-	6	0	-	-	-	-
8	MN2 Sheriff Bush	80	562	-	7	33	137	1.05	91	71-117

Mixed

	Site	Land Use %	Area (A)	Pop. Dens (P/A)	% IMP.	No. of EMPS	Total Lead Mean	CDV	Median	90% Confidence Limits
1	KS1 Roland	-	36	3	60	9	164	.90	147	130-195
2	MN1 Hampden	-	17	40	72	20	227	.87	175	133-232
3	KS1 Hotts B	-	17	3	50	41	564	1.06	300	300-470
4	MN1 Beverly	-	30	11	40	20	111	1.00	75	55-102
5	TN1 SC	-	107	3	43	13	237	.31	277	205-260
6	MN1 Wood Cir	-	45	12	81	45	502	.80	420	300-517
7	MN1 Pk 9	-	330	7	73	7	430	1.07	307	306-571
8	MN1 Concord	-	100	1	13	7	106	.04	103	80-257
9	MN1 Grand & Ok	-	453	6	30	10	122	.90	91	60-175
10	MN3 Pitt AB-5	-	2001	2	71	6	71	1.63	11	6-70
11	MN2 Cedar	-	70	-	5	20	75	1.25	67	30-84
12	MN1 Anna	-	604	0	12	4	-	-	-	-
13	MN3 Pitt AB-8	-	2071	2	35	5	61	.71	50	27-92
14	MN1 Grace B	-	160	5	30	10	170	1.30	80	65-191
15	MN3 Twin Dam	-	1707	2	4	4	-	-	-	-
16	MN1 Maple	-	2030	-	-	24	303	1.13	254	104-300
17	CA1 Dana	-	1542	12	-	22	496	.90	361	250-675
18	FL1 D. Jewett	-	30	-	13	15	56	1.22	35	23-54
19	FL1 Wilder	-	190	-	57	15	85	.85	65	40-91
20	CO1 North Ave	-	60	9	50	33	350	.81	270	270-303

Commercial

	Site	Land Use % Comm	Area (A)	Pop. Dens (P/A)	% IMP.	No. of EMPS	Total Lead Mean	CDV	Median	90% Confidence Limits
1	CO1 Villa Italia	100	34	0	91	27	267	1.21	167	127-270
2	DE1 I013 (CBD)	100	23	0	60	61	302	.81	270	254-305
3	MN3 Southgate	100	170	0	21	13	47	.50	42	33-53
4	MN1 Post Office	100	12	2	100	50	193	.83	140	130-173
5	MN1 Pkg Lot	100	1	0	90	33	200	.93	152	171-192
6	TN1 CBD	100	36	0	90	15	150	.52	140	112-175
7	MN1 Hustler	100	12	0	-	40	121	.73	90	83-135
8	KS1 DC Metcalf	96	50	-	92	7	-	-	-	-
9	FL1 Ramon Pk	95	67	-	45	12	86	1.04	32	21-40
10	MN1 State Fair	70	29	10	77	27	400	.86	340	243-306

Industrial

	Site	Land Use % Ind	Area (A)	Pop. Dens (P/A)	% IMP.	No. of EMPS	Total Lead Mean	CDV	Median	90% Confidence Limits
1	MN2 Addison	100	30	0	60	0	-	-	-	-
2	MN1 Indus Drive	100	63	0	84	13	116	.77	92	80-170
3	KS1 Emporia	96	32	-	46	6	-	-	-	-
4	MN1 Grace S	52	75	5	30	13	116	.26	92	80-120

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TABLE 6-10. SITE MEAN TOTAL ZINC EMCs (μg/ℓ)

Residential

	Site	Land Use % Res	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	Total Zinc Mean	CDV	Median	90% Confidence Limits
1	CO1 Big Dry Cr	100	33	19	41	15	194	.60	151	170-200
2	CO1 Cherry	100	57	24	30	10	195	.63	165	175-217
3	CO1 Ft/Cloude	100	167	14	24	16	195	.66	150	171-205
4	DE1 Belief	100	12	-	-	0	156	.76	151	127-179
5	DE1 Lobridge	100	40	21	33	10	129	.70	100	91-173
6	DE1 Stratton	100	8	-	-	20	84	.67	76	60-80
7	FL1 John D	100	54	10	15	0	-	-	-	-
8	GA1 Overton	100	90	6	30	13	831	.99	900	500-804
9	MD2 Rentors	100	50	5	16	0	-	-	-	-
10	MD1 Dalton Hill	100	34	30	51	15	1100	2.21	573	320-972
11	MD1 Homeland	100	23	9	29	13	170	.35	111	90-130
12	MD1 NE Wash	100	17	32	29	20	97	.50	81	67-90
13	MD1 Rec Hill	100	30	95	35	13	531	1.20	340	213-542
14	MD1 Forit's D.	100	23	13	20	0	-	-	-	-
15	MD1 Shape	100	-	-	-	0	-	-	-	-
16	MD3 Cranston	100	100	5	27	9	410	.80	317	290-490
17	MD3 E Rock.	100	340	30	30	0	400	1.70	307	300-500
18	TN1 Nottingwood	100	80	3	21	0	-	-	-	-
19	VA1 Surrey	100	95	0	29	130	124	.42	114	107-171
20	VA1 Burbank	100	63	10	30	10	100	1.30	63	67-95
21	VA1 Hastings	100	33	17	51	21	100	1.70	69	65-90
22	FL1 Young Apts	100	9	-	6	12	80	.65	56	64-89
23	TX1 Hart	90	370	9	40	0	-	-	-	-
24	VA1 Lincoln	97	30	10	57	0	-	-	-	-
25	TN1 R2	96	80	0	33	11	93	.57	81	81-100
26	DE1 Westleigh	93	41	3	21	30	67	.90	40	30-61
27	GA1 IC - 92nd	92	63	-	37	3	-	-	-	-
28	FL1 John S.	91	30	10	10	1	-	-	-	-
29	MD1 R1	91	60	11	35	11	612	.80	504	503-677
30	VA1 Lake Hills	91	107	12	37	170	170	.53	107	99-119
31	FL1 Hatts S.	80	20	22	37	0	-	-	-	-
32	FL1 Charter Bdg	89	42	-	36	17	54	1.02	30	25-80
33	DE1 Fairidge	80	15	-	30	44	88	.52	76	67-80
34	CO1 Asbury	86	177	9	22	9	349	.63	295	300-472
35	FL2 Comb Inlets	80	524	0	17	27	230	.80	309	154-232
36	MD1 Locust	85	154	11	36	6	247	.31	230	309-303
37	DE1 ESPS	84	124	6	27	40	170	.81	130	110-100
38	MD1 Jordan	79	140	30	23	9	230	.20	230	177-290
39	DE1 Stoddard	70	27	15	30	45	91	.70	75	60-80

Urban Open and Recreation

	Site	Land Use % Open	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	Total Zinc Mean	CDV	Median	90% Confidence Limits
1	CA1 Sawtow	100	633	-	-	17	190	.60	160	175-200
2	CO1 Mummy Gulch	100	605	0	1	7	105	.50	91	81-115
3	DE1 Thornell	100	70,010	-	0	0	202	2.30	300	130-270
4	DE1 English Br	90	5,700	-	1	0	-	-	-	-
5	DE1 West Br	87	5,330	-	1	0	-	-	-	-
6	DE1 Thomas Cr	91	17,770	1	11	9	1003	3.14	327	124-830
7	DE1 Trower Cr	90	7,303	-	0	2	-	-	-	-
8	DE1 Sheriff Ditch	80	552	-	7	0	-	-	-	-

Mixed

	Site	Land Use %	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	Total Zinc Mean	CDV	Median	90% Confidence Limits
1	FL1 Roland	-	30	3	80	9	814	1.19	575	741-980
2	MD1 Pumpkin	-	17	40	72	13	310	.35	117	275-340
3	FL1 Hatts D	-	17	3	50	0	-	-	-	-
4	MD1 Beverly	-	30	11	60	17	171	.65	130	147-137
5	TN1 SE	-	107	3	43	13	140	.40	130	114-167
6	VA1 Wood Cir	-	40	17	61	27	470	1.21	101	277-614
7	MD1 Dr 9	-	330	7	21	7	300	.43	274	305-350
8	MD1 Concord	-	100	1	33	7	707	.99	170	130-260
9	MD1 Grand D Dr	-	43	5	30	14	245	.71	200	160-271
10	MD1 Pill DR-5	-	2401	7	21	4	-	-	-	-
11	MD7 Cedar	-	15	-	5	0	-	-	-	-
12	MD1 Anne	-	600	0	17	5	170	1.40	90	35-270
13	MD3 Pill DR-8	-	2021	7	26	4	-	-	-	-
14	MD1 Grace D	-	160	5	20	5	140	.35	140	111-171
15	MD1 Turfs Run	-	1207	7	4	7	-	-	-	-
16	VA1 Brade	-	2030	-	-	0	-	-	-	-
17	CA1 Snow	-	1547	17	-	71	103	.24	110	175-195
18	FL1 D Jewett	-	30	-	13	19	60	.60	70	50-103
19	FL1 Wilder	-	106	-	07	15	51	.35	37	30-51
20	CO1 North Ave	-	60	0	50	31	543	.62	421	301-570

Commercial

	Site	Land Use % Coml	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	Total Zinc Mean	CDV	Median	90% Confidence Limits
1	CO1 Villa Italia	100	20	0	91	27	320	.07	247	295-313
2	DE1 9013 (CDD)	100	25	0	89	80	533	.51	430	470-576
3	DE1 Southgate	100	170	2	71	9	1036	2.95	517	710-1307
4	DE1 Post Office	100	17	0	100	32	105	1.16	90	71-120
5	DE1 Pkg Lot	100	1	0	90	31	513	.05	430	501-517
6	TN1 CDD	100	26	0	90	15	315	.03	300	300-309
7	VA1 Hunter	100	17	0	-	19	196	.35	175	90-163
8	GA1 DC Metcalf	95	50	-	97	7	664	.70	300	277-611
9	FL1 Ramos Pk	91	67	-	45	17	37	.00	70	10-41
10	VA1 State Farm	70	70	10	77	7	200	.06	230	190-303

Industrial

	Site	Land Use % Ind	Area (A)	Pop. Den (#/A)	% IMP.	No. of EMC	Total Zinc Mean	CDV	Median	90% Confidence Limits
1	MD7 Addison	100	30	0	60	0	-	-	-	-
2	VA1 Indus Drive	100	63	0	90	7	260	.42	275	167-303
3	FL1 Lennox	95	72	-	64	6	2771	3.70	701	217-2007
4	GA1 Grove S.	57	75	5	30	7	271	.50	195	175-300

* All observations below detection limit.

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These tables (one for each pollutant) list each of the appropriate sites in the data base, grouped according to general land use category. Some pertinent site characteristics are identified: drainage area, population density, and the percentage of the total area covered by impervious surfaces. The number of monitored storms at each site is tabulated. Urban runoff quality is summarized by the mean and median EMC for all storms monitored at the site, the storm-to-storm variability of EMC's (defined by the coefficient of variation), and the 90 percent confidence limits for the site median EMC.

Transferability of Data

The urban runoff loading site EMC data were carefully examined in an effort to determine whether specific groupings of results would suggest the presence of consistent patterns of similarities and/or differences that could be used to support estimates of urban runoff characteristics at unmonitored locations and sites.

Variability of EMCs at a Site. Inspection and analysis of the individual site coefficient of variation entries in Tables 6-1 through 6-10 shows that with very few exceptions (usually associated with constituents that were monitored in fewer than 10 storm events) the coefficients of variation fall in the range of 0.5 to 1.0. This applies to all constituents except TSS, for which the range in coefficients of variation is more like 1 to 2.

The frequency of occurrence of any EMC of interest can be estimated readily from the coefficient of variation by using the procedures outlined in Chapter 5. Thus, for TSS, 90 percent of the individual storm events at a given site will have EMCs that do not exceed a value of roughly 3 to 5 times the median EMC value for that site. For the other constituents, 90 percent of the individual storm events at a site will have EMCs less than about 2 to 3 times the median EMC value for that site. More refined estimates and values for other exceedance probabilities can be readily computed using the relationships presented in Chapter 5.

Effect of Geographic Location. Figures 6-4 through 6-13 indicate the range of median EMC's at individual sites, grouped by project. The land use category of the site is indicated by the letter R for residential, M for mixed, and C for commercial/industrial, and the plotting position is the median value as given by the data in Tables 6-1 through 6-10. The ends of the bars for each project are the highest and lowest 90 percent confidence limits for site median EMCs at the project for the constituent in question. Inspection of Figures 6-4 through 6-13 indicates that, for any given constituent, each project can be put into one of three rather general categories: (1) low EMCs and tightly grouped; (2) average characteristics; and (3) wide range and high EMCs. Using the numbers 1, 2, and 3 as shorthand, project categories for each constituent are summarized in Table 6-11. Although no site is category consistent for all constituents, WASHCOG (DC1), Tampa (FL1), Lansing (MI1), and Ann Arbor (MI3) tend to have lower and more tightly grouped EMCs than the others while Kansas City (KS1), Lake Quinsigamond (MA1), and Baltimore (MD1) tend to have a wider range and higher EMCs than the others. Thus we can conclude that some projects represented in the database appear, from the monitoring sites selected, to tend towards somewhat higher or lower EMC median values and ranges than the bulk of the projects. However, there are no distinct geographical patterns revealed.

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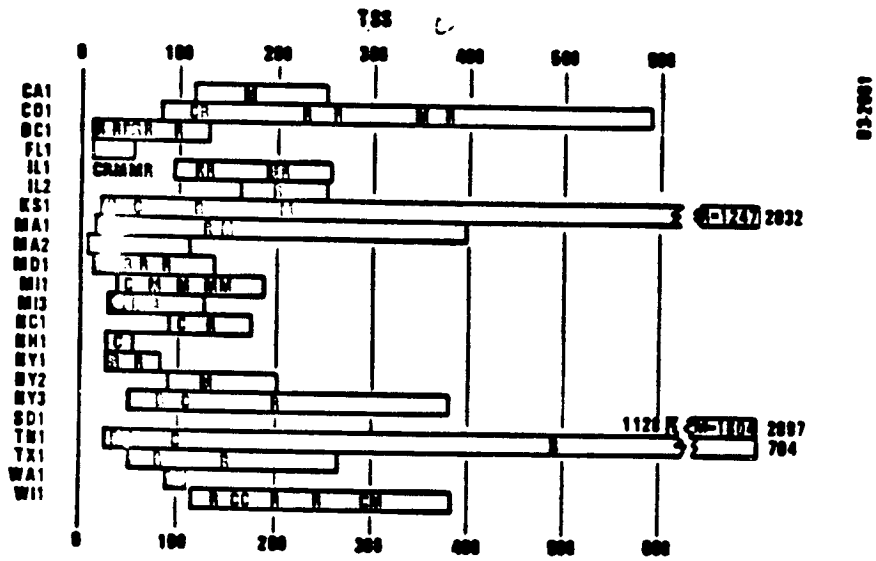

Figure 6-4. Range of TSS EMC Medians (mg/l) by Project

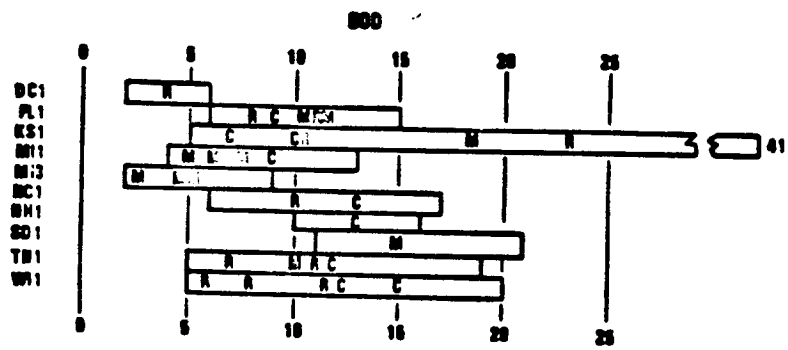

Figure 6-5. Range of BOD EMC Medians (mg/l) by Project

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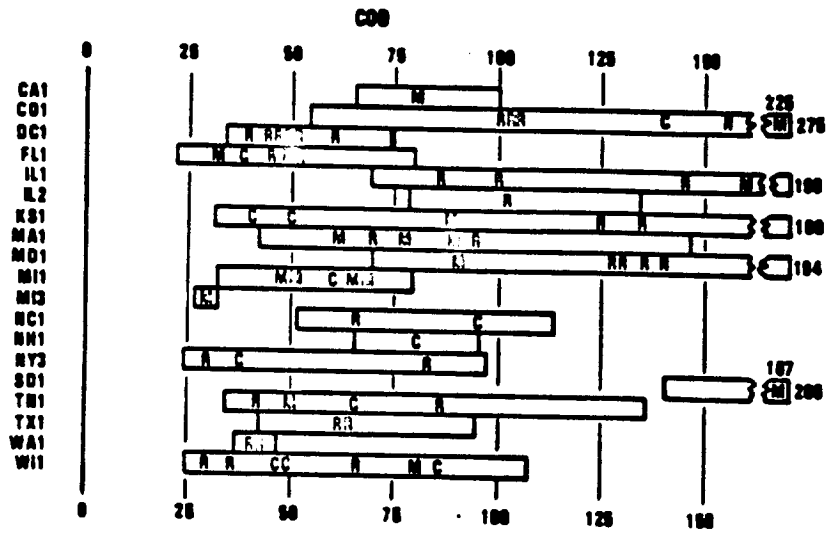

Figure 6-6. Range of COD EMC Medians (mg/l) by Project

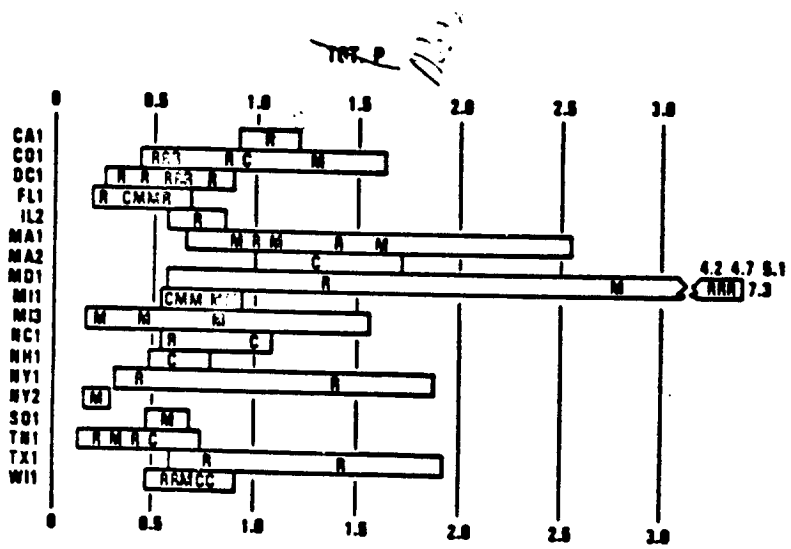

Figure 6-7. Range of Total P EMC Medians (mg/l) by Project

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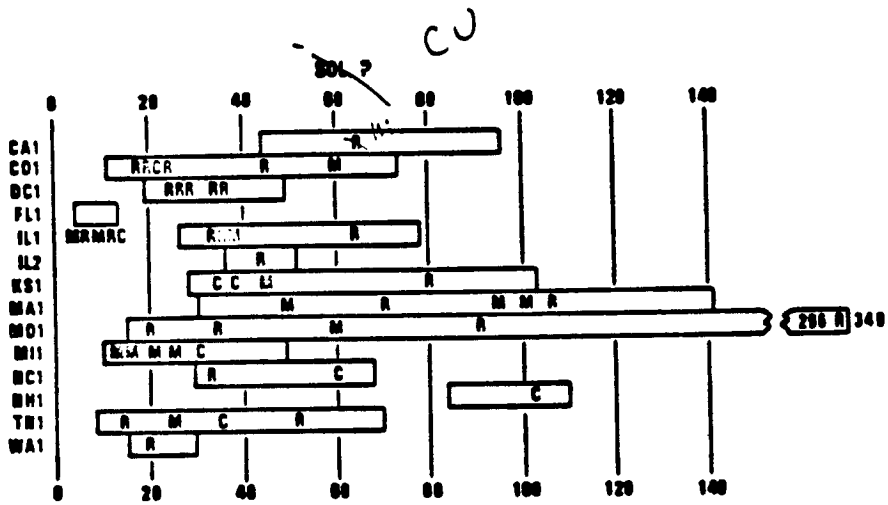

Total CU

Figure 6-8. Range of ~~Soluble P~~ EMC Medians (mg/l) by Project

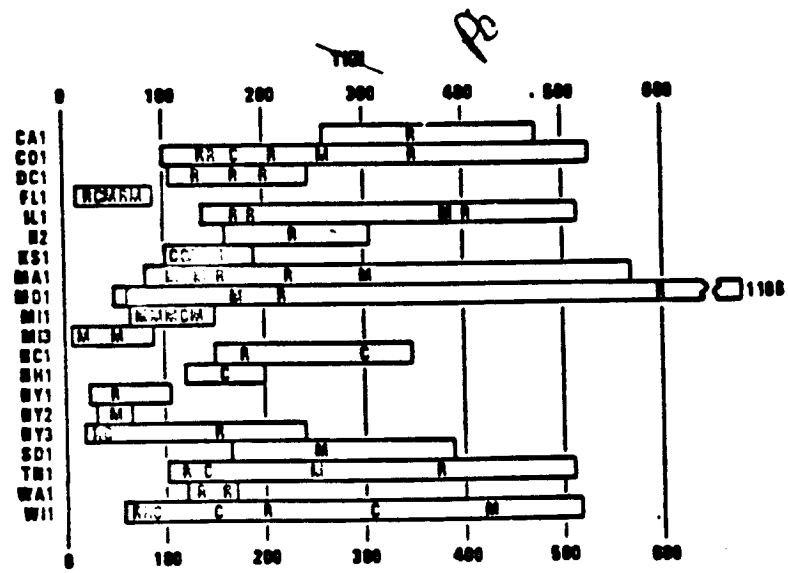

Figure 6-9. Range of TKN EMC Medians (mg/l) by Project

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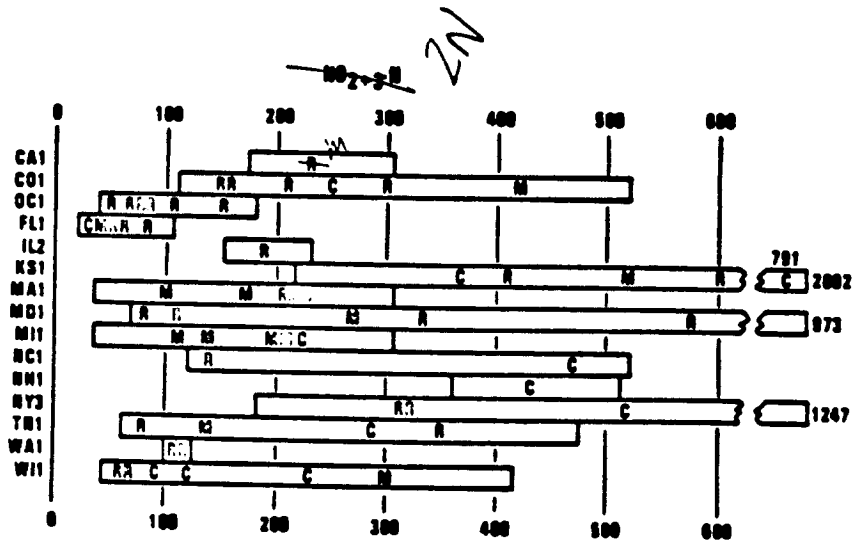

Figure 6-10. Range of NO_{2+3}-N EMC Medians (mg/l) by Project

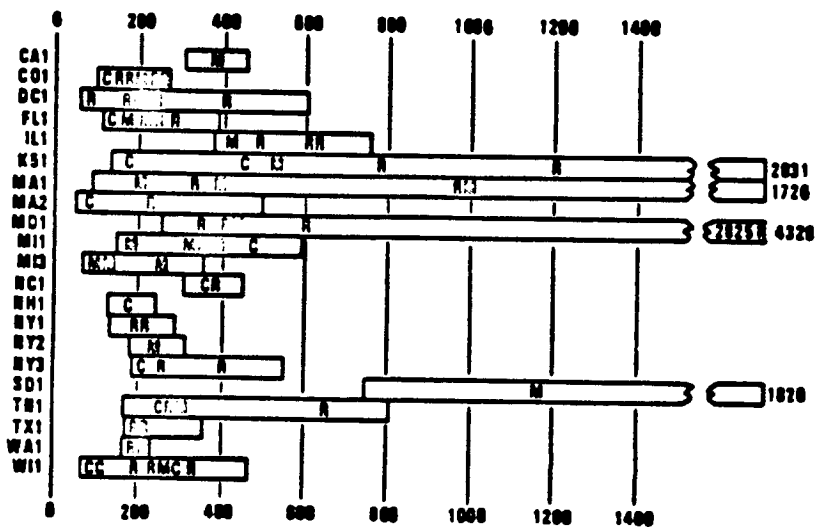

Figure 6-11. Range of Total Cu EMC Medians (µg/l) by Project

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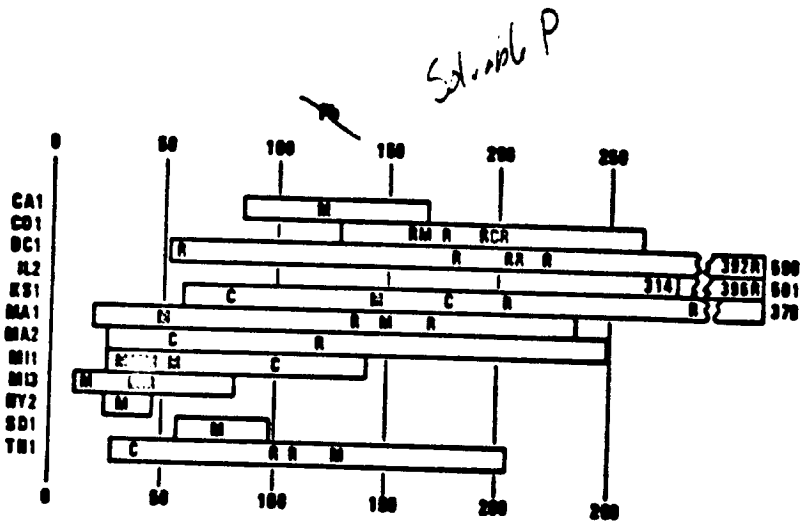

Figure 6-12. Range of Total Pb EMC Medians (µg/l) by Project

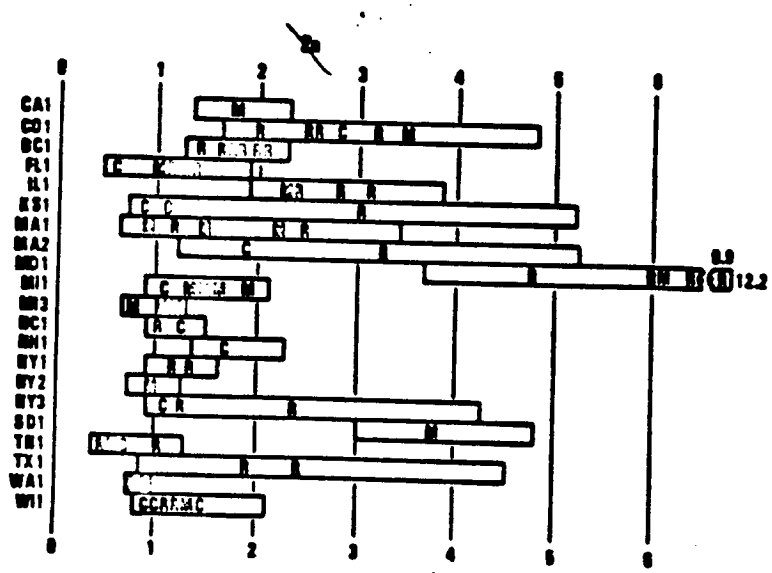

Figure 6-13. Range of Total Zn EMC Medians (µg/l) by Project

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TABLE 6-11. PROJECT CATEGORY SUMMARIZED BY CONSTITUENT

	CO1	DC1	FL1	IL1	KS1	MA1	MD1	MI1	MI3	NY3	TN1	WI1
TSS	3	1	1	2	3	3	1	1	1	2	3	2
BOD	-	-	2	-	3	-	-	2	1	-	2	2
COD	3	1	1	3	3	2	3	1	-	1	2	2
Tot. P.	1	2	1	2	3	3	3	2	1	2	2	2
Sol. P.	2	3	-	-	3	2	-	2	1	-	2	-
TKN	2	1	1	2	2	2	3	1	1	2	1	1
NO_{2+3}-N	2	1	1	-	-	3	3	1	2	-	1	1
Tot. Cu	2	1	1	2	2	3	3	1	-	-	2	-
Tot. b	2	1	1	2	1	2	3	1	-	1	2	2
Tot. Zn	2	1	1	-	3	2	3	2	-	3	2	2

It must also be realized that had any particular project monitored other local sites (or additional sites) its categorization could well change. This can be seen qualitatively by perusing Figures 6-4 through 6-13 and mentally dropping the highest or lowest site from each grouping. Although some locations, such as Tampa, will undoubtably and appropriately be influenced by the relatively low EMCs and tight groupings found there in estimating probable values for other urban sites in the area, there is little to warrant attributing similar characteristics to other locations in the same geographical region. For the other locations it would appear that individual site differences eclipse any possible geographic ones.

Effect of Land Use Category. The data in Tables 6-1 through 6-10 were presented by land use category; residential, mixed, commercial, industrial, and open/non-urban. The question to be addressed here is the extent to which such site categorization can be used to assist in predicting EMC parameters for unmonitored sites. Two approaches were used. In the first, the site data for each project with more than three sites were normalized by dividing the site median and its upper and lower 90 percent confidence limits by the average project median value for the constituent in question. This procedure simply allows all constituents to be viewed on a common scale that is centered at unity. An example of the result is given in Figure 6-14. A legend is provided in Figure 6-14(a) showing the lower 90 percent confidence limit, the upper 90 percent confidence limit, and the location of the point estimate of the median within this confidence interval for a hypothetical constituent. Sites that fall to the right of the unity line have higher EMCs than average for this location, while sites that fall to the left of the unity line have lower EMCs than average. Thus, the interpretation is that for this location, Site #1 is the "dirtiest" (has the highest EMC value), Site #3 is the "cleanest", and Site #2 is in between, being somewhat "dirtier" than average. Since the 90 percent confidence limits for these three sites no not overlap, we know that this difference is statistically significant.

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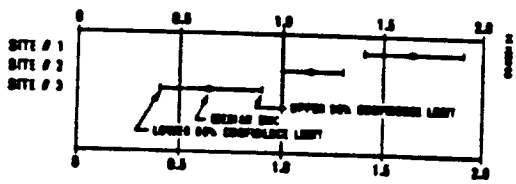
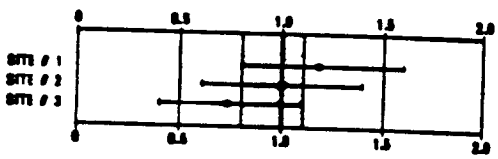
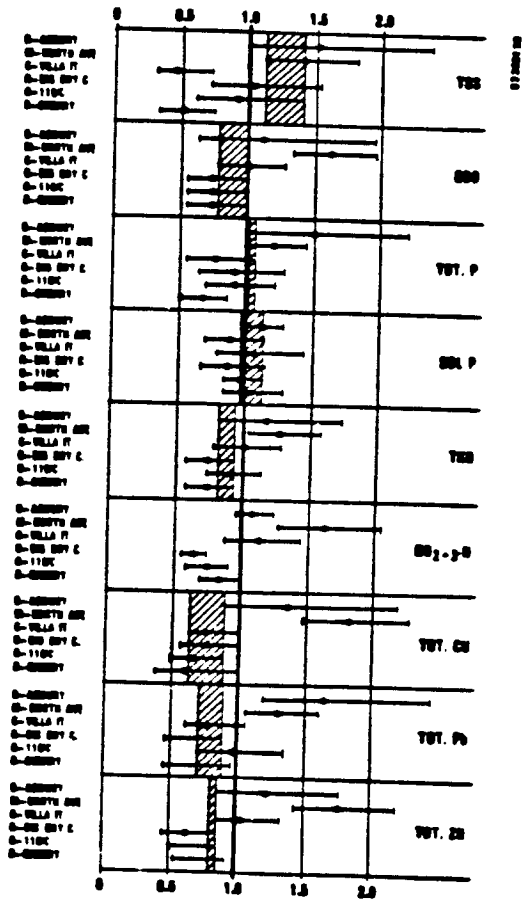


(a) Significantly Different Sites



(b) Sites with No Significant Difference



(c) EMC Data from Denver (CO1)

Figure 6-14. Range of Normalized EMC Medians at Denver (CO1)

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The actual data for the Denver (CO1) project are presented in Figure 6-14(c). With the exception of nitrate + nitrite, there is little to no statistically significant difference among the majority of the sites for each constituent examined. The lack of consistency among the sites over the various constituents is apparent. One can observe that the Cherry site (residential) tends to plot at the lowest position for all constituents, suggesting that it is the "cleanest," the Asbury site (also residential) tends to plot at the highest position, suggesting that it is the "dirtiest." The Big Dry Cottonwood site, which is also residential, tends to fall between these two. Careful examination of other site data does not provide any evidence to explain this difference in response for sites in the same land use category at the same location. Thus, based on the information presented in Figure 6-14(c), one is forced to conclude that land use category does not provide a useful basis for predicting differences in site EMC values, at least for this project.

When the foregoing type of analysis was applied to the other applicable NURP projects, the results were the same. As another example, the range of normalized EMC medians at Tampa (FL1) and WASHCOG (DC1) are shown in Figure 6-15. These are essentially similar to the Denver results just discussed.

The WASHCOG data presented in Figure 6-15(b) suggest that there is little consistent difference among residential land use sites at that project. The data from Champaign/Urbana (IL1) presented in Figure 6-16 suggest just the opposite. As a part of this project's experimental design, two site pairs were selected. The sites of each pair were expected to respond in a similar fashion. That they do and that the responses of the two pairs are different from each other for most constituents is apparent in Figure 6-16. However, there is no consistency in the pair responses. For example, the Mattis pair has significantly higher EMC values for TSS, COD, and Total Pb, while the John Pair is higher in Total P. The residential land use category for these sites provides no explanation of these differences in response.

Based upon the foregoing approach, we can conclude that, while there can be differences in the responses of different sites at a given location, significant differences do not appear to be widespread, and where they occur, the site land use category is virtually useless in trying to understand or predict them.

The second approach to examining the effect of land use category on the EMC parameters of a site makes use of the observation, discussed earlier, that geographic location has no discernible effect on site response. Since site to site variability was shown to be very well represented by the lognormal distribution, analysis procedures similar to those described previously for characterizing an individual site were applied. Table 6-12 lists the median EMCs for all sites within each land use category. The coefficient of variation quantifies the variability of site characteristics within the land use category. To the extent that the sites included in this database provide a "representative" sample of the land use classifications, then the information summarized by Table 6-12 indicates the effect of land use on urban storm runoff pollutant discharges.

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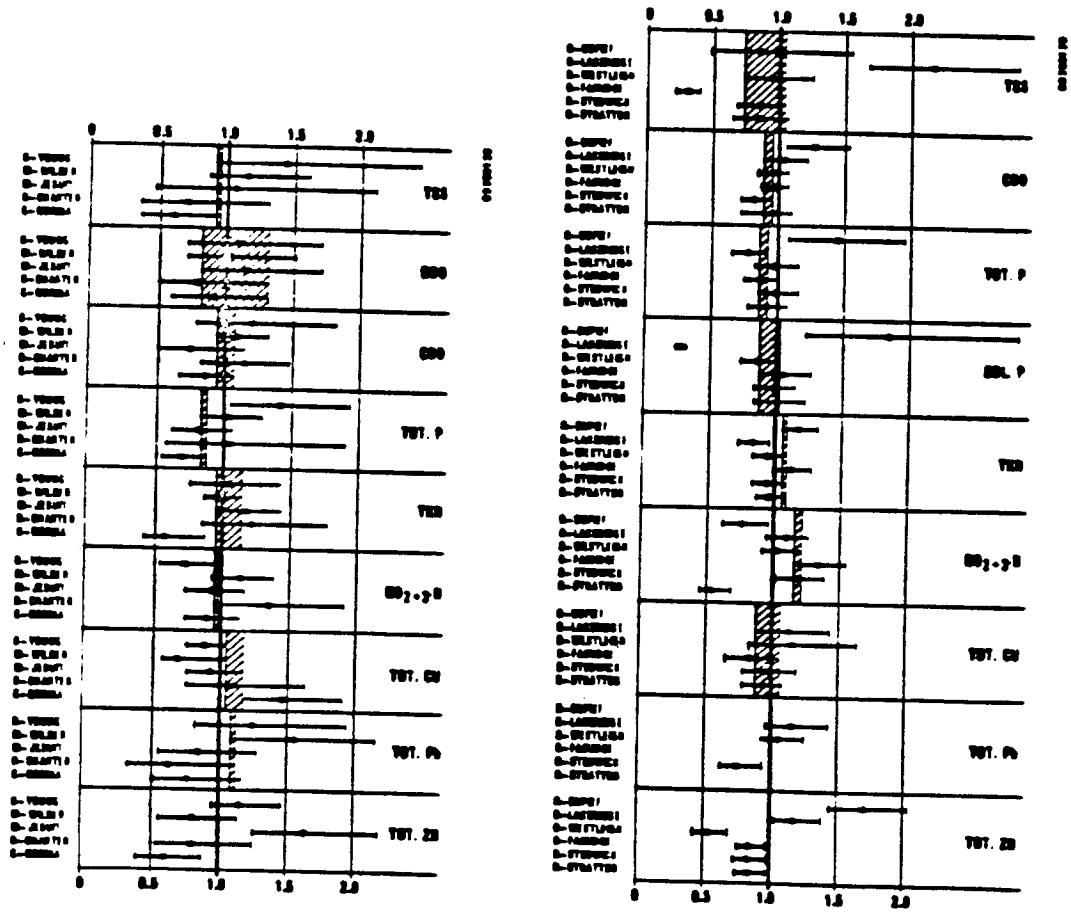

(a) Tampa Sites

(b) WASHCOG Sites

Figure 6-15. Range of Normalized EMC Medians at FL1 and DC1

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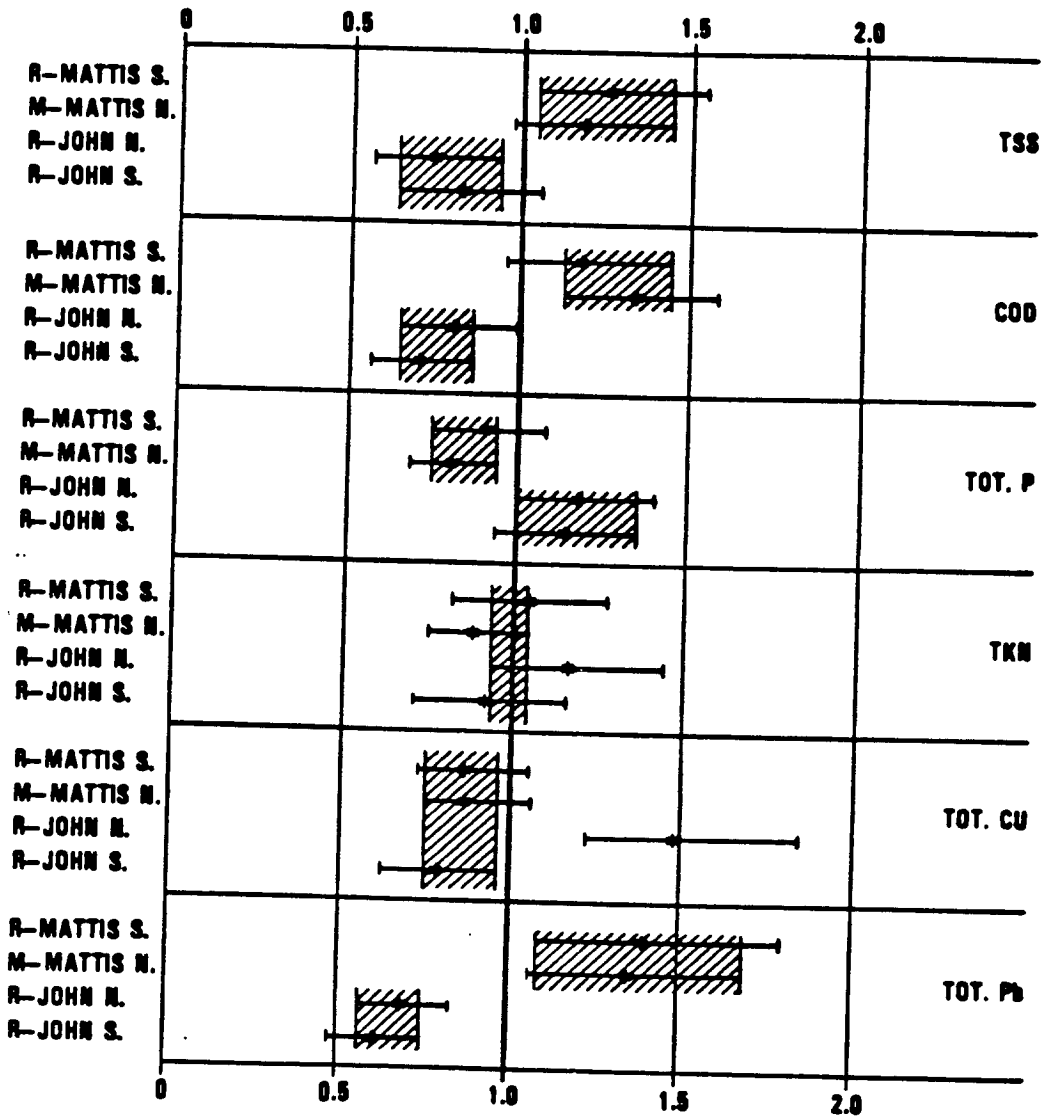

Figure 6-16. Range of Normalized EMC Medians at IL1

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TABLE 6-12. MEDIAN EMCs FOR ALL SITES BY LAND USE CATEGORY

Pollutant		Residential		Mixed		Commercial		Open/Nonurban	
		Median	CV	Median	CV	Median	CV	Median	CV
BOD	mg/ℓ	10.0	0.41	7.8	0.52	9.3	0.31	-	-
COD	mg/ℓ	73	0.55	65	0.58	57	0.39	40	0.78
TSS	mg/ℓ	101	0.96	67	1.14	69	0.85	70	2.92
Total Lead	µg/ℓ	144	0.75	114	1.35	104	0.68	30	1.52
Total Copper	µg/ℓ	33	0.99	27	1.32	29	0.81	-	-
Total Zinc	µg/ℓ	135	0.84	154	0.78	226	1.07	195	0.66
Total Kjeldahl Nitrogen	µg/ℓ	1900	0.73	1288	0.50	1179	0.43	965	1.00
NO_2 -N + NO_3 -N	µg/ℓ	736	0.83	558	0.67	572	0.48	543	0.91
Total P	µg/ℓ	383	0.69	263	0.75	201	0.67	121	1.66
Soluble P	µg/ℓ	143	0.46	56	0.75	80	0.71	26	2.11

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Some caution in the interpretation of the information presented in Table 6-12 is in order since statistical confidence limits are not given. These are indicated in Figure 6-17 (a through k), which illustrates land use differences graphically, with additional statistical detail derived from the basic parameters listed in Table 6-11, to assist in interpretation and comparisons. The box plots which compare characteristics of all sites within a land use category identify the land use, median EMC, its 90 percent confidence limits, and the 10, 25, 75 and 90 percent quantities for the sites. Careful perusal of these box plots leads one to the conclusion that only the open/non-urban land use category appears to be significantly different overall. Responses of the other land use categories are varied and inconsistent among constituents. This may be seen in a somewhat different way by observing the plotting positions of the land use categories presented in Figures 6-4 through 6-13. Here also, there are no consistent tendencies. There are undeniably some trends. For example, in Figure 6-7 commercial sites occupy the lowest plotting position at each project for total phosphorus (MI1 and one WI1 site are exceptions), which certainly suggests that there might be a land use category difference for this constituent.

Review of Figure 6-17(j), however, suggests that while a trend to lower total phosphorus EMC values is apparent as one goes from residential, to mixed, to commercial land uses, the statistical significance may not be great. The actual site median total phosphorus EMC probability density functions for each land use are presented in Figure 6-18. Here it can be seen that although three different pdfs can be drawn for residential, mixed, and commercial land use categories, their degree of overlap is so great that there is little statistical significance to the apparent difference. Since this was the strongest tendency towards land use effect, we must conclude that using this approach there is again no truly discernible and consistent effect of land use on the quality of urban runoff.

The one exception is the open/non-urban category which, as its name suggests, includes atypical sites. The data in Table 6-12 and the box plots of Figure 6-12 suggest that the pdfs for this land use category are quite different from those of the other land use categories, and this is in fact the case. Figure 6-18 shows it dramatically for total phosphorus.

Thus, regardless of the analytical approach taken, we are forced to conclude that, if land use category effects are present, they are eclipsed by the storm to storm variabilities and that, therefore, land use category is of little general use to aid in predicting urban runoff quality at unmonitored sites or in explaining site to site differences where monitoring data exist.

Correlation Between EMCs and Runoff Volume. To examine the possible relationship between the event mean concentration of a particular constituent and the runoff volume, linear correlation coefficients (r) were calculated. The null hypothesis that the two variables are linearly unrelated was tested at both the 90 and 95 percent confidence levels. Since it is possible for correlation to be either positive or negative, the two-tailed test was used. Failure to reject the null hypothesis is interpreted as meaning that linear dependency between the two variables in the population has not been shown.

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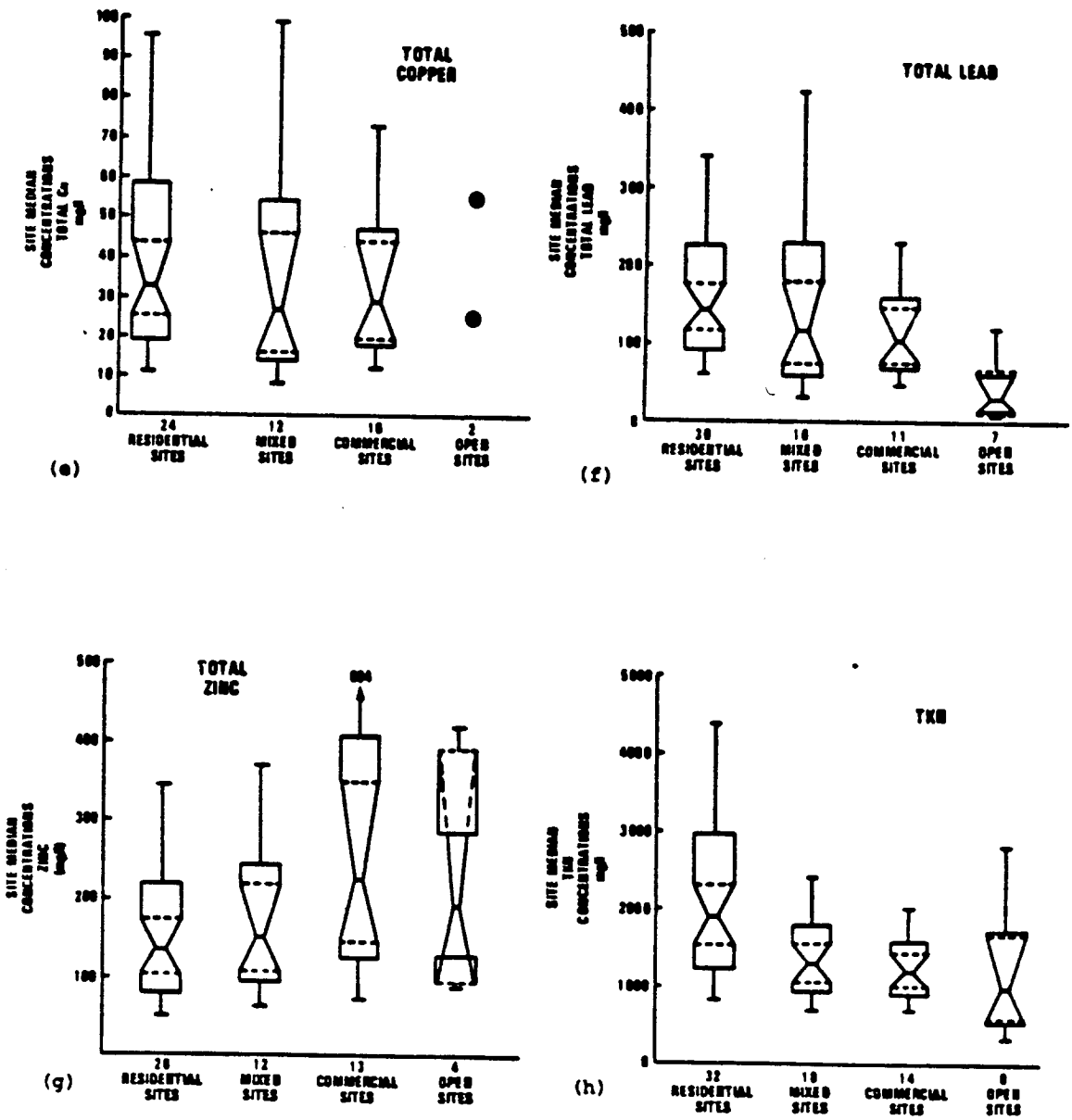

Figure 6-17. Box Plots of Pollutant EMCs for Different Land Uses (Cont'd)

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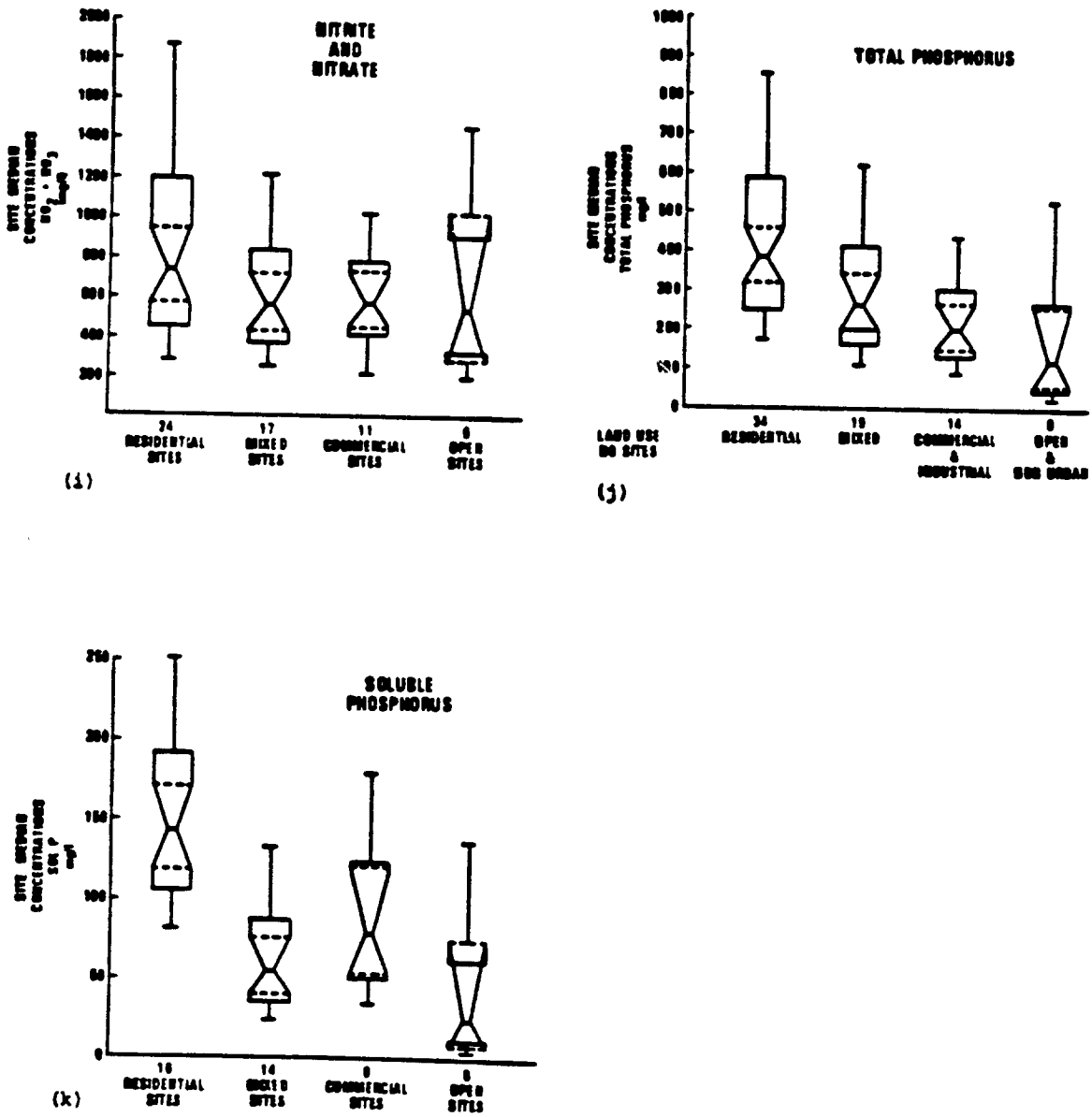

Figure 6-17. Box Plots of Pollutant EMCs for Different Land Uses (Cont'd)

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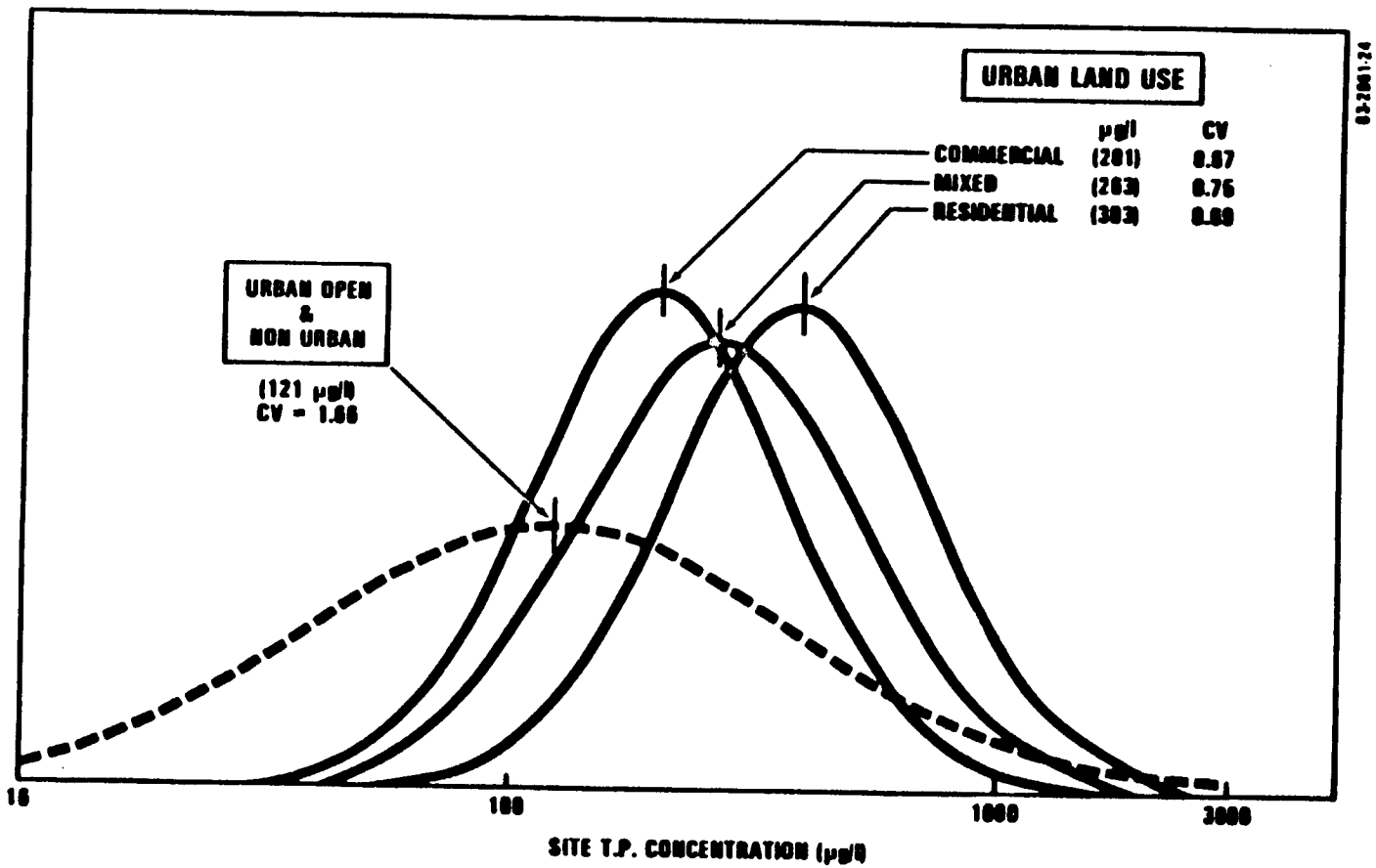

Figure 6-18. Site Median Total P EMC Probability Density Functions for Different Land Uses

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The rejection of the null hypothesis means that there is evidence of a linear dependency between the two variables in the population, but it does not mean that a cause-and-effect relationship has been established.

General guidelines for the use of this test suggest that it be used with caution for values of n less than ten due to the high uncertainties associated with estimates of population variance with small samples. Furthermore, when n is 2 a perfect correlation will result but is meaningless. To include as many sites as possible in this examination, all constituents for which n was 5 or greater were included. At the other extreme, when n is very large, say over 100, correlation coefficients are almost always significant but can be so weak that they are meaningless. For n = 100 the critical value of r at the 90 percent confidence level is 0.164, meaning that the correlation explains less than 3 percent of the concentration variability.

A total of 67 sites from 20 of the NURP projects were examined for possible correlation for nine constituents. Of the 517 linear correlation coefficients calculated (not all constituents were measured at all sites), 116 (22 percent) were significant at the 95 percent confidence level and 154 (30 percent) were significant at the 90 percent confidence level. Of the r values that were significant, 83 and 87 percent were negative at the 90 and 95 percent confidence levels respectively. When sites with fewer than 10 events were dropped, the foregoing was essentially unchanged. Greater detail in terms of the number of significant linear correlation by constituent is provided in Table 6-13. There it can be seen that the greatest tendency for positive values of r occurs with TSS, followed by soluble phosphorus. The correlation coefficients for the other 7 constituents all strongly tend to be negative.

When the results are examined by sites, however, a clearer picture emerges. Although it can be correctly argued that unless a correlation coefficient is statistically significant the number is meaningless, it also follows that in such a case they are as likely to be positive as negative. On the other hand, if all the correlation coefficients (whether significant or not) have the same sign, it suggests a tendency for that site. The sign of the correlation coefficient (if greater than 0.1) for each site and constituent examined is given in Table 6-14. Giving appropriate weight to significant r values but considering others as well, some 37 of the sites tend to have negative correlations, 13 tend to be positive, and the remaining 17 tend to be mixed. Perusal of Table 6-14 reveals that this tendency for sites to have either positive or negative correlation coefficients is quite strong, especially for sites with a large number of significant correlations. Sites where erosion, scour, system lag, and such are present could be expected to exhibit a tendency towards positive correlations. Sites lacking such effects could be expected to have negative correlation due to dilution associated with larger runoff events.

The magnitude of the correlation coefficients is indicated in Table 6-15. Two points stand out in particular. First, the r values are not very large, averaging around 0.55. This means that the correlation is only able to explain about 30 percent of the concentration variability. The few high values are always associated with very few observations (n<10) for which the

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TABLE 6-13. NUMBER OF SIGNIFICANT LINEAR CORRELATIONS BY CONSTITUENT

POLLUTANT	TOTAL # OF SITES	90% SIGNIFICANT CORRELATION			95% SIGNIFICANT CORRELATION		
		TOTAL #	# NEG.	# POS.	TOTAL #	# NEG.	# POS.
(a) ALL SITES							
TSS	67	13 (19%)	4	9	7 (10%)	3	4
COD	64	24 (38%)	23	1	19 (30%)	19	0
TOT. P	67	20 (30%)	16	4	15 (22%)	12	3
SOL. P	34	10 (29%)	6	4	7 (21%)	4	3
TKN	64	19 (30%)	18	1	14 (22%)	14	0
NO_{2+3}-N	57	17 (30%)	15	2	13 (23%)	11	2
TOT. Cu	49	17 (35%)	15	2	13 (27%)	12	1
TOT. Pb	59	15 (25%)	13	2	12 (20%)	11	1
TOT. Zn	56	19 (34%)	18	1	16 (29%)	15	1
TOTAL	517	154	128	26	116	101	15
PERCENT		30%	83%	17%	22%	87%	13%
(b) SITES WITH $n \geq 10$							
TSS	56	9 (16%)	4	5	7 (12%)	3	4
COD	52	21 (40%)	20	1	16 (31%)	16	0
TOT. P	53	17 (32%)	15	2	12 (23%)	11	1
SOL. P	23	8 (35%)	5	3	6 (26%)	4	2
TKN	50	17 (34%)	16	1	12 (24%)	12	0
NO_{2+3}-N	41	14 (34%)	12	2	12 (29%)	10	2
TOT. Cu	31	13 (42%)	12	1	12 (39%)	11	1
TOT. Pb	45	13 (29%)	12	1	11 (24%)	10	1
TOT. Zn	37	14 (38%)	13	1	11 (30%)	10	1
TOTAL	388	126	109	17	99	87	12
PERCENT		32%	87%	13%	26%	88%	12%

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TABLE 6-14. SIGN OF CORRELATION COEFFICIENTS BY SITES

	TSS	COD	TOT. P	SOL. P	TKN	NO_{2+3}-N	TOT. Cd	TOT. Pb	TOT. Zn
CA1 KNOX	+	−	+	(+)		(+)	−	−	
S. VIEW.	(+)	+			(+)		+	−	+
CO1 ASBURY	(+)	+	(+)	+	+	−	(+)	+	+
B. DRY C.		−	−	−	(−)	−	−		−
CHERRY			+	(+)		−	+		
N. AVE.		(−)	(−)	(−)	(−)	(−)	(−)	(−)	(−)
ROONEY	−	(−)	−	−	−	−	−	−	(−)
VILLA M.	−	(−)	(−)	(−)	(−)	(−)	(−)	(−)	(−)
110C	+	−	(+)			−	+		+
DC1 DUPEF	−	(−)	+	−	−	−			−
FAIRVOE		+	+	+	+				+
LAKEWOOD	+		+	(+)		(−)		−	(−)
STEDWICK		−		+		(−)	+	−	(−)
STRATTON	+	−			+		−		−
WESTLEIGH		(−)			−	(−)	(−)	−	(−)
FL1 CHARTERW	−	(−)	(−)		(−)	−	(−)	(−)	(−)
YOUNG		−	−			−	+		
DONNA P.	+	+				+			−
IL1 JOHN H.	+	(−)	(−)		(−)		−	−	
JOHN S.	+	(−)	(−)		−		−		
MATTIS N.		(−)	(−)		(−)		(−)	(−)	
MATTIS S.	−	(−)	(−)		(−)		(−)	(−)	
KS1 92nd	−	+	−	+	+				

	TSS	COD	TOT. P.	SOL. P	TKN	NO_{2+3}-N	TOT. Cd	TOT. Pb	TOT. Zn
KS1 LENEXA	+	(−)	(−)	−	−		(−)		
METCALF		−	−	−	−		−		−
OLAND		(−)	−	(−)			+	−	−
OVERTON	+		+				−	−	(−)
MA1 AUBA	+		+		+	−		−	+
CONVERT	−	+		+	−	−	+		+
JORDAN			+	+	−	(−)	−		(−)
LOCUST	(+)	+	(+)	+	+	(−)	+	(+)	
ST. S	+			+	−	(−)	+	+	
MA2 ADDISON	(+)		−	−	+	−			
HEMLOCK	(+)		+	(+)	+	−			
MD1 BOLTON	(+)	−	+		−	−	(−)	+	−
HAMPDEN		−	(−)				(−)		−
HOMELAND	+	+	+		−	+	−	+	+
MT. WASH.	(+)	−	−		−	−	+	−	−
RES. HILL	+	(−)			(−)		(−)	−	−
NJ1 GRACE S.	+	−	−		−	−	(−)	−	−
GRACE N.	+	−		+					(−)
GRAND		−	−		−		−	−	(−)
MO. NO.	+		+	+		−	−	−	−
WAVERLY		−	−	−	−	−	−		−
NC1 1012		(−)	(−)		(−)	(−)	(−)	(−)	(−)
1023	(+)		+			−	+		
NH1 PHIL	−	(−)	−		(−)	(−)	(−)	(−)	(−)

	TSS	COD	TOT. P	SOL. P	TKN	NO_{2+3}-N	TOT. Cd	TOT. Pb	TOT. Zn
NY1 CARLL R.	+					(−)			
NY2 CEDAR				+		(+)		+	
NY3 CRANSTON	+	+	+		−			−	−
E. ROCK.	−	(−)	(−)		(−)			(−)	(−)
SOUTHGATE	+	−	+	−					−
TN1 CHO	(−)	−	(−)	(−)	(−)	−	(−)	(−)	(−)
R1	(+)	+	+	(−)	+	−	(+)	(+)	(+)
R2	+	−	−	−	(−)	−			−
SC	+		−	(−)	−	(−)		+	
TX1 HART	+	(+)			+	+			
N'WOOD.	−	+			(−)				
WA1 LAKE H.	−	(−)	−		(−)		+	(−)	(−)
SUNNEY D.	−	(−)	(−)		(−)			(−)	(−)
WI1 BURBANK		−	(+)						+
HASTINGS		(−)	−		+	+		(−)	−
LINCOLN		−	−			−		+	
POST O.	(−)	(−)	(−)		(−)	(−)		(−)	−
RUSTLER	(−)	(−)	−		(−)	(−)			−
STATE F.	(−)	(−)	(−)		−	(−)		−	+
WOOD C.					−	−			+

+ INDICATES A POSITIVE R VALUE
− INDICATES A NEGATIVE R VALUE
(+) INDICATES A SIGNIFICANT R VALUE
BLANK INDICATES EITHER R LESS THAN 0.1 OR NO DATA

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TABLE 6-15. CORRELATION COEFFICIENT VALUES BY SITE

	TSS	COD	TOT. P	SOL. P	TKN	NO_{2+3}-N	TOT. CU	TOT. Pb	TOT. ZN
CA1 KNOX				.43		70			
S. VIEW.	67				.40				
CO1 ASBURY	.50		54				.50		
B. BAY C.					.47				
CHERRY				10					
B. AVE.	50	47	43	72	52	47	42	41	
BOONEY	70								70
VILLA N.	70	50	57	50	44	40	50	67	
11BC		50							
DC1 DUFIEF	70								
FAIRIDGE									
LAKERIDGE			42		20			41	
STEDWICK					.30			.20	
STRATTON				.2					
WESTLEIGH	32				.30	54		54	
FL1 CHARTERN	52	.54	0	50		.54	57	.50	
YOUNG			0						
NORMA P.			0						
IL1 JOHN B.	.31	30	0	.20	0			0	
JOHN S.	.30	42	0		0			0	
MATTIS B.	54	50	0	40	0	40	44	0	
MATTIS S.	51	50	0	53	0	34	40	0	
KS1 92nd			0		0				

	TSS	COD	TOT P.	SOL P	TKN	NO_{2+3}-N	TOT. CU	TOT. Pb	TOT. ZN
KS1 LENAXA		70	51	0		0	.50		
METCALF		.40	.40	0		0			
NOLAND		37		62	0	0			
OVERTON					0	0			57
MA1 ADHA									
CONVENT									
JORDAN						60			34
LOCUST	.50		51			.50		.30	
RT. 8						.57			
MA2 ADDISON	.53	0							
HEMLOCK	.44	0		54					
MO1 BOLTON	50			0			47		
HAMPDEN			.42	0			51		
HOMELAND				0					
MT. WASH.	.42			0					
RES. HILL		70		0	50		54		
NH1 GRACE S.							.30		
GRACE N.									50
GRAND									.51
NO. BR.									
WAVERLY									
NC1 1013		50	40	0	57	57	37	30	54
1023	32			0					
NH1 PHS.		50		0	40	40	50	41	50

	TSS	COD	TOT. P	SOL. P	TKN	NO_{2+3}-N	TOT. CU	TOT. Pb	TOT. ZN
NY1 CARLL R.		0		0		70	0		
NY2 CEDAR		0				42	0		
NY3 CRANSTON				0		0	0		
E. ROCK.		70	54	0	.30	0	0	.72	.72
SOUTHGATE				0		0	0		
TN1 CBB	.40		52	.47	50		51	51	50
B1	52			57			73	50	52
B2					51				
SC				40		50			
TX1 HART		.57		0			0		
N'WOOD.				0	.77		0		
WA1 LAKE H.		32		0	.34			.20	.37
SURREY H.		30	30	0	.31		0	.18	.31
WI1 BURBANK			.30	0			0		
HASTINGS		.46		0			0	.32	
LINCOLN				0	0		0		0
POST R.	.30	.20	.24	0	.40	.53	0	.23	
RUSTLER	.37	50		0	.30	.37	0		
STATE F.	.47	.40	.47	0		.32	0		
WOOD C.				0			0		

03-2061:34

○ INDICATES 95% LEVEL OF SIGNIFICANCE. OTHERS ARE AT THE 90% LEVEL
0 INDICATES AN UNMEASURED CONSTITUENT
BLANK INDICATES NO SIGNIFICANT CORRELATION

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test is suspect since one or two events may dominate the correlation or otherwise cause it to be overstated due to uncertainties in parameter estimation. Second, only 25 percent of the sites account for over two-thirds of the significant correlations. In fact, 33 of the 67 sites had at most one significant correlation, 16 had 2 or 3, and 18 had 4 or more significant r values.

Data for the sites with many significant correlations are presented in Table 6-16. It can be noted that the r values for all constituents are around 0.55. Thus, there is no overall tendency to have strong correlations for some constituents and weak correlations for others. On a site by site basis, the strength of the apparent correlation varies inversely with n as does the significance requirement. Discounting the sites with very low or high values of n, however, the r values for the remainder are again around 0.55, which is the average for all 19 of these sites. Turning to land use, it is significant that half of the sites with many significant correlations have a large commercial/industrial component. Discounting sites with a small number of observations ($n \leq 12$), the sites in Table 6-16 are smaller (average size is 41 acres vs 126 acres for all sites), more impervious (average of 65 percent vs 40 percent for all sites), and have higher runoff coefficients (0.5 vs 0.3 for all sites). Thus, one could conjecture that their responses might tend to be somewhat less random and more ameanable to deterministic analysis (i.e., with conventional modeling approaches). Since they represent only around 25 percent of the total number of sites, however, and the correlations are rather weak, any effect of EMC correlation with runoff volume can be ignored without serious overall error.

This finding of no significant linear correlation between EMCs and runoff volumes is important for several reasons. First, in stormwater monitoring programs there is a natural and appropriate bias that favors emphasizing resource allocation to larger storm events. This was generally the case with the NURP projects as well. However, because of differences in local meteorological conditions, degree of site imperviousness, and other factors, there are appreciable differences in the average sizes of storms monitored by site in the NURP database. Since no significant linear correlation was found, such biases and differences are not expected to influence EMC comparisons to any appreciable extent.

Secondly, the probabilistic methodologies for examining receiving water impacts identified in Chapter 5 assume, as they are now structured, that concentration and runoff volume are independent (i.e., that there is no significant correlation). Although the methods can be modified to account for such correlations if they exist, the finding of no significant correlation indicates that such refinement is not warranted at this time.

Other Factors. We have not exhaustively analyzed all potential effects of other factors that might influence and hence modify our interpretations and conclusions regarding site differences. Factors such as slope, population density, soil type, seasonal bias in monitored events, and precipitation characteristics (average rainfall intensity, peak rainfall intensity, rainfall duration, time since last storm event, etc.) all have a potential

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TABLE 6-16. SITES WITH MANY SIGNIFICANT CORRELATIONS

		TSS	COD	TOT. P	SOL. P	TKN	NO_{2+3}-N	Cu	Pb	Zn	AVG r^2	AVG r	n	LAND USE	% IMPERVIOUS	RUNOFF COEFFICIENT
CO1	NORTH AVE.	–	–.58	–.47	–.42	–.72	–.52	–.47	–.42	–.46	.28	.52	32	30%C	50%	.239
	VILLA IT.	–	–.70	–.58	–.87	–.69	–.44	–.46	–.55	–.65	.35	.59	27	100%C	91%	.927
DC1	WESTLEIGH	–	–.32	–	–	–	–.39	–.84	–	–.44	.29	.54	35	93%R	21%	.119
FL1	CHARTERM	–	–.82	–.54	U	–.68	–	–.54	–.87	–.56	.37	.60	12	89%R	16%	.153
IL1	MATTIS N.	–	–.64	–.59	U	–.48	U	–.40	–.46	U	.27	.52	35	50%C	58%	.639
	MATTIS S.	–	–.81	–.55	U	–.53	U	–.34	–.46	U	.26	.51	33	90%R	37%	.330
KS1	LENAXA	–	–.70	–.51	U	–	U	–.80	–	–	.46	.68	16	50%I	44%	.540
MA-1	LOCUST	.80	–	.91	–	–	–.82	–	.78	–	.69	.83	6	85%R	16%	.209
MD-1	RES. HILL	–	–.79	–	U	–.58	–	–.55	–	–	.42	.65	13	100%R	76%	.486
NC1	1013 (CBD)	–	–.58	–.46	U	–.57	–.67	–.32	–.29	–.54	.26	.51	61	100%C	69%	.791
NH1	PKG.	–	–.58	–	U	–.49	–.46	–.50	–.41	–.58	.26	.51	33	100%C	90%	.658
NY3	E. ROCHESTER	–	–.79	–.84	U	–.70	U	U	–.72	–.72	.57	.76	8	100%R	38%	.195
TN1	CBD	–.48	–	–.62	–.47	–.56	–	–.51	–.51	–.65	.30	.55	15	100%C	99%	.206
	R1	.82	–	–	–.62	–	–	.72	.85	.82	.57	.77	11	91%R	33%	.032
WA-1	LAKE H.	–	–.33	–	U	–.34	U	U	–.29	–.37	.11	.33	126	91%R	37%	.199
	SURREY D.	–	–.34	–.30	U	–.21	U	U	–.18	–.23	.07	.26	118	100%R	29%	.177
WI1	P.O.	–.39	–.28	–.24	U	–.46	–.53	U	–.23	–	.14	.37	40	100%C	95%	.899
	RUSTLER	–.37	–.55	–	U	–.39	–.37	U	–	–	.18	.43	20	100%C	95%	.793
	STATE FAIR	–.47	–.48	–.47	U	–	–.72	U	–	–	.30	.55	25	74%C	77%	.822
	AVERAGE r^2	.34	.33	.29	.31	.30	.30	.31	.28	.32						
	AVERAGE r	.58	.58	.53	.55	.55	.55	.56	.53	.57						

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influence on the median and variability of pollutant concentrations at a site.

On the basis of limited screening, however, we have concluded that such factors do not appear to have any real consistent significance in explaining observed similarities or differences among individual sites. Therefore, although more detailed and rigorous analysis and evaluation of the NURP data-base may well provide additional useful insight and understanding of the influence of such other factors, we do not believe that the basic findings and conclusions presented in this report will be significantly altered by the results of such efforts. Furthermore, the value of any such insights as may be developed are likely to have limited influence on general decisions on control of urban runoff. For example, the finding of a strong seasonal effect on EMC values would have little influence on a decision to require detention basins in all newly developing urban areas, nor would it be likely to influence their design.

Urban Runoff Characteristics

Having determined, as discussed in the preceding section, that geographic location, land use category, or other factors appear to be of little utility in explaining overall site-to-site variability or predicting the characteristics of unmonitored sites, the best general characterization of urban runoff can be obtained by pooling the site data for all sites (other than the open/non-urban ones). This approach is appropriate, given the need for a nationwide assessment and the general planning thrust of this report. Recognizing that there tend to be exceptions to any generalization, however realistic and appropriate, in the absence of better information the data given in Table 6-17 are recommended for planning level purposes as the best description of the characteristics of urban runoff.

TABLE 6-17. WATER QUALITY CHARACTERISTICS OF URBAN RUNOFF

Constituent	Event to Event Variability in EMC's (Coef Var)	Site Median EMC	
		For Median Urban Site	For 90th Percentile Urban Site
TSS (mg/l)	1-2	100	300
BOD (mg/l)	0.5-1.0	9	15
COD (mg/l)	0.5-1.0	65	140
Tot. P (mg/l)	0.5-1.0	0.33	0.70
Sol. P (mg/l)	0.5-1.0	0.12	0.21
TKN (mg/l)	0.5-1.0	1.50	3.30
NO_{2+3}-N (mg/l)	0.5-1.0	0.68	1.75
Tot. Cu (µg/l)	0.5-1.0	34	93
Tot. Pb (µg/l)	0.5-1.0	144	350
Tot. Zn (µg/l)	0.5-1.0	160	500

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Coliform Bacteria

Coliform bacteria counts in urban runoff were monitored for a significant number of storm events by seven of the NURP projects at 17 different sites. Data were collected at twelve of these sites for more than five and up to 20 storm events. Data on either Fecal Coliform or both Fecal and Total Coliform counts are available for a total of 156 separate storm events. Although the data base for bacteria is thus considerably more restricted than for other pollutants, useful results have been obtained.

Table 6-18 summarizes the results of an analysis of these data. Some variability exists from site to site, and data are too limited to identify any land use distinctions. However, results from the different sites and projects are consistent in showing a very dramatic seasonal effect. Coliform counts in urban runoff during the warmer periods of the year are approximately 20 times greater than those in urban runoff that occurs during colder periods.

The substantial seasonal differences which are observed do not correspond with comparable variations in urban activities. This suggests that seasonal temperature effects and sources of coliform unrelated to those traditionally associated with human health risk may be significant.

In addition to the summarized data presented here, special study reports prepared by the Long Island and Baltimore projects address the issue of animal and other sources of coliform bacteria using information derived from field monitoring and the technical literature. The Baltimore NURP project also conducted small scale site studies which simulated washoff by storms and identified that quite substantial differences in coliform levels can result from the general cleanliness of an area, which they associate with the socio-economic strata of the neighborhood. A special study by the Long Island NURP project examined salmonella counts in urban runoff and in an adjacent shellfish area influenced by urban runoff. The Knoxville, TN project also conducted a special study on Salmonella. These project reports may be obtained through NTIS.

Other issues related to bacteria as a health risk were raised and warrant further investigation. A better understanding is needed of the contribution of domestic animals or such wildlife as may be expected in urban areas to observed coliform levels.

Though high levels of indicator microorganisms were found in urban runoff, the analysis as well as current literature suggests that indicators such as fecal coliform may not be useful in identifying health risks from urban runoff pollutions.

PRIORITY POLLUTANTS

Background

The NURP priority pollutant monitoring project was conducted to evaluate the presence, concentration, and potential water quality impacts of priority pollutants in urban runoff. A total of 121 urban runoff samples were collected

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TABLE 6-18. FECAL COLIFORM CONCENTRATIONS IN URBAN RUNOFF

Project and Site		Warm Weather			Cold Weather		
		Site No. Obs	Median EMC (1000/ 100 ml)	C.V.	Site No. Obs	Median EMC (1000/ 100 ml)	C.V.
DC1	Burke	1	4.6	-	1	0.02	-
	Westleigh	1	46	-	2	0.35	-
	Stedwick	2	10	-	1	0.2	-
MD1	Homeland	7	11	1.8	-	-	-
	Mt Wash	1	130	-	1	3.3	-
	Res Hill	1	281	-	1	330	-
NC1	(CBD) 1013	11	15	1.6	8	1.0	0.6
	Res 1023	2	23	-	4	2.6	1.1
NH1	Pkg Lot	20	0.3	0.5	-	-	-
NY1	Carll	12	24	0.9	15	1.4	1.5
	Unqua	7	11	1.6	4	0.9	14
SD1	Meade	9	57	0.7	-	-	-
TN1	CBD	7	54	1.5	7	1.0	1.4
	R1	6	56	2.0	4	1.6	1.9
	R2	6	19	6.2	4	0.5	2.4
	SC	7	12	2.8	4	0.9	1.7
		76 Events			52 Events		
All Sites*		11	21	0.8	9	1	0.7

Notes:

* For general characterization of urban runoff, exclude the following sites:

  - NH1 - A small (0.9A) Parking Lot; concentrations low and atypical.

  - Four sites with only one observation for season; variability is too high for any confidence in representativeness of a single value.

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at 61 sites (two storm events per site) in 20 of the NURP projects that participated in this phase of the program. These sites were predominantly in the residential, mixed, or commercial land use areas as defined earlier. Thus, the results of this effort cannot be attributed to runoff from industrial facilities or complexes. Furthermore, an especially exhaustive quality control component, over and above the standard NURP QA/QC effort, was imposed on the priority pollutant portion of the program, resulting in the rejection of nearly 14 percent of the data. Therefore, there is a high level of confidence in the results of this project.

Since only two samples were collected at each site, no meaningful site statistic could be calculated. Therefore the data were pooled for analysis. In view of the discussion in the preceding section, however, this approach seems to be justified.

A detailed compilation of NURP priority pollutant analytical results including city and site where the sample was collected, date of collection; discrete or composite sample, pH, and pollutant concentration can be found in the final report on the NURP Priority Pollutant Monitoring Program soon to be issued by the Monitoring and Data Support Division of the agency. A summary of the findings taken from the December 5, 1983 draft of that report follows.

Pollutants Not Included in NURP. Asbestos and dioxin were excluded from the NURP program. However, standard laboratory methods will reveal the presence of dioxin at concentrations of 1 to 10 µg/l, and most laboratories did scan their chromatograms for the possible presence of this pollutant. All such scans were negative, and on this basis dioxin is included as "not detected".

Results Not Valid. The NURP results for seven priority pollutants cannot be considered valid. Recent EPA investigation has revealed that standard methods are not appropriate for the measurement of hexachlorocyclopentadiene, dimethyl nitrosamine, diphenyl nitrosamine, benzidine, and 1,2-diphenylhydrazine. Two other pollutants, acrolein and acrylonitrile, must be analyzed within three days of sample collection. Such a time constraint was an impractical one for the NURP program.

Pollutants Detected in Runoff

Seventy-seven priority pollutants were detected in the NURP urban runoff samples. This group includes 14 inorganic and 63 organic pollutants (Table 6-19).

Inorganic Pollutants. As a group, the toxic metals are by far the most prevalent priority pollutant constituents of urban runoff. All 14 inorganics (13 metals, plus cyanides; asbestos excluded) were detected, and all but three at frequencies of detection greater than 10 percent. Most often detected among the metals were copper, lead, and zinc, all of which were found in at least 91 percent of the samples. Their concentrations were also among the highest for any pollutant, and reached a maximum of 100, 460, and 2,400 µg/l, respectively. Other frequently detected inorganics included arsenic, chromium, cadmium, nickel, and cyanide (Table 6-20). Twelve of the thirteen toxic metals (antimony excluded) were also sampled in the special

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TABLE 6-19. SUMMARY OF ANALYTICAL CHEMISTRY FINDINGS FROM NURP PRIORITY POLLUTANT SAMPLES[1]

(Includes information received through September 30, 1983)

Pollutant	Cities Where Detected[2]	Frequency of Detection[3]	Range of Detected Concentrations (µg/l)[4]
I. PESTICIDES			
1. Acrolein	Holding times exceeded		
2. Aldrin	4,7,26	6	0.0027-0.1M
3. α-Hexachlorocyclohexane (α-BHC) (Alpha)	7,8,22,26	20	0.0027-0.1M
4. β-Hexachlorocyclohexane (β-BHC) (Beta)	7,8	5	0.018-0.1M
5. γ-Hexachlorocyclohexane (γ-BHC) (Gamma) (Lindane)	7,8,22,26	15	0.007-0.1M
6. δ-Hexachlorocyclohexane (δ-BHC) (Delta)	7,26	6	0.004-0.1M
7. Chlordane	2,8,21,26	17	0.01L-10
8. DDD	Not detected		
9. DDE	26	6	0.007-0.027
10. DDT	7	1	0.1M
11. Dieldrin	26,27	6	0.007-0.1
12. α-Endosulfan (Alpha)	7,26,27	19	0.006-0.2
13. β-Endosulfan (Beta)	Not detected		
14. Endosulfan sulfate	Not detected		
15. Endrin	Not detected		
16. Endrin aldehyde	Not detected		
17. Heptachlor	7,8,27	6	0.01-0.1M
18. Heptachlor epoxide	7,26	2	0.0037-0.1M
19. Isophorone	7	3	10M
20. TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin)	Not included in NURP program		
21. Toxaphene	Not detected		
II. METALS AND INORGANICS			
22. Antimony	7,26,26	13	2.6-23A
23. Arsenic	2,3,7,12,19,20,21,22,26,27	52	1-50.5
24. Asbestos	Not included in NURP program		
25. Beryllium	7,12,20,21	12	1-49
26. Cadmium	1,2,3,7,12,20,21,27	48	0.1M-14
27. Chromium	1,2,7,8,12,17,19,20,21,22,26, 27,28	50	1-190
28. Copper	1,2,3,4,7,8,12,17,19,20,21,22, 23,26,27,28	91	1L-100
29. Cyanides	4,8,19,22,26,27	23	2-300
30. Lead	1,2,3,4,7,8,12,17,19,20,21,22, 26,28	94	6-460
31. Mercury	7,20,28	9	0.6-1.2
32. Nickel	2,3,7,12,20,21,26,27	43	1-187
33. Selenium	7,19,23	11	2-77
34. Silver	3,17,27	7	0.2M-0.8
35. Thallium	7	6	1-14
36. Zinc	1,2,3,7,12,17,19,20,21,22, 23,27,28	94	10-2400
III. PCBs AND RELATED COMPOUNDS			
37. PCB-1016 (Aroclor 1016)	Not detected		
38. PCB-1221 (Aroclor 1221)	Not detected		
39. PCB-1232 (Aroclor 1232)	Not detected		
40. PCB-1242 (Aroclor 1242)	Not detected		
41. PCB-1248 (Aroclor 1248)	Not detected		
42. PCB-1254 (Aroclor 1254)	Not detected		
43. PCB-1260 (Aroclor 1260)	2	1	0.03
44. 2-Chloronaphthalene	Not detected		

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TABLE 6-19. SUMMARY OF ANALYTICAL CHEMISTRY FINDINGS FROM NURP PRIORITY POLLUTANT SAMPLES[1] (Cont'd)

(Includes information received through September 30, 1983)

Pollutant	Cities Where Detected[2]	Frequency of Detection[3]	Range of Detected Concentrations (ug/L)[4]
IV. HALOGENATED ALIPHATICS			
45. Methane, bromo- (methyl bromide)	Not detected		
46. Methane, chloro- (methyl chloride)	Not detected		
47. Methane, dichloro- (methylene chloride)	4,17,22	11	9-14.5A
48. Methane, chlorodibromo-	28	1	2
49. Methane, dichlorobromo-	28	1	2
50. Methane, tribromo - (bromoform)	28	1	1
51. Methane, trichloro- (chloroform)	4,17,20,22,23,27,28	9	0.2T-12L
52. Methane, tetrachloro- (carbon tetrachloride)	4,28	3	1-2
53. Methane, trichlorofluoro-[5]	2,4,24,28	5	0.6T-27
54. Methane, dichlorodifluoro- (Freon-12)[5]	Not detected		
55. Ethane, chloro-	Not detected		
56. Ethane, 1,1-dichloro-	4,28	3	1.5A-3
57. Ethane, 1,2-dichloro-	28	1	4
58. Ethane, 1,1,1-trichloro-	4,2 7,22,24	6	1.6-10M
59. Ethane, 1,1,2-trichloro-	28	2	2-3
60. Ethane, 1,1,2,2-tetrachloro-	4	2	2G-3
61. Ethane, hexachloro-	Not detected		
62. Ethene, chloro- (vinyl chloride)	Not detected		
63. Ethene, 1,1-dichloro-	28	2	1.5-4
64. Ethene, 1,2-trans-dichloro-	20,28	4	1-3
65. Ethene, trichloro-	2,4,8,24,28	6	0.3T-12
66. Ethene, tetrachloro-	8,17,22,28	5	1M-43
67. Propane, 1,2-dichloro-	28	1	3
68. Propene, 1,3-dichloro-	28	2	1-2
69. Butadiene, hexachloro-	Not detected		
70. Cyclopentadiene, hexachloro-	Standard methods inappropriate		
V. ETHERS			
71. Ether, bis(chloromethyl)[5]	Not detected		
72. Ether, bis(2-chloroethyl)	Not detected		
73. Ether, bis(2-chloroisopropyl)	Not detected		
74. Ether, 2-chloroethyl vinyl	Not detected		
75. Ether, 4-bromophenyl phenyl	Not detected		
76. Ether, 4-chlorophenyl phenyl	Not detected		
77. Bis(2-chloroethoxy) methane	Not detected		
VI. MONOCYCLIC AROMATICS (EXCLUDING PHENOLS, CRESOLS, PHTHALATES)			
78. Benzene	4,17,27	5	1-13
79. Benzene, chloro-	7,20,26,28	5	1G-10M
80. Benzene, 1,2-dichloro-	Not detected		
81. Benzene, 1,3-dichloro-	Not detected		
82. Benzene, 1,4-dichloro-	Not detected		
83. Benzene, 1,2,4-trichloro-	Not detected		
84. Benzene, hexachloro-	Not detected		
85. Benzene, ethyl-	4,8,17,20,26,28	6	1-2
86. Benzene, nitro-	Not detected		
87. Toluene	4,17	3	3-9
88. Toluene, 2,4-dinitro-	Not detected		
89. Toluene, 2,6-dinitro	Not detected		

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TABLE 6-19. SUMMARY OF ANALYTICAL CHEMISTRY FINDINGS FROM NURP PRIORITY POLLUTANT SAMPLES[1] (Cont'd)

(Includes information received through September 30, 1983)

Pollutant	Cities Where Detected[2]	Frequency of Detection[3]	Range of Detected Concentrations (µg/L)[4]
VII. PHENOLS AND CRESOLS			
90. Phenol	4,7,26	14	1L-13T
91. Phenol, 2-chloro-	26	1	2
92. Phenol, 2,4-dichloro-	Not detected		
93. Phenol, 2,4,6-trichloro-	Not detected		
94. Phenol, pentachloro-	4,8,19,20,26,27,28	19	1T-11b
95. Phenol, 2-nitro-	8	1	1M
96. Phenol, 4-nitro-	4,7,8,20,26,28	10	1T-37
97. Phenol, 2,4-dinitro-	Not detected		
98. Phenol, 2,4-dimethyl-	4,7,8,26	8	1T-10M
99. m-Cresol, p-chloro-	4	1	1.8A
100. o-Cresol 4,6-dinitro-	Not detected		
VIII. PHTHALATE ESTERS			
101. Phthalate, dimethyl	8	1	1L
102. Phthalate, diethyl	3,4,17,20,21	6	1-10M
103. Phthalate, di-n-butyl	4,22,24	6	0.5T-11
104. Phthalate, di-n-octyl	8,20,26,27,28	6	0.4T-26
105. Phthalate, bis(2-ethylhexyl)	4,12,19,22,21,26	22	4T-62
106 Phthalate, butyl benzyl	2,8,26	6	1-10M
IX. POLYCYCLIC AROMATIC HYDROCARBONS			
107. Acenaphthene	Not detected		
108. Acenaphthylene	Not detected		
109. Anthracene	2,17,20,21,26,28	7	1-10M
110. Benzo (a) anthracene	2,21,27	4	1-10M
111. Benzo (b) fluoranthene	26,27	6	1-5
112. Benzo (k) fluoranthene	2,21,27	3	4-14
113. Benzo (g,h,i) perylene	21	1	5
114. Benzo (a) pyrene	2,21,26,27	6	1-10M
115. Chrysene	2,7,17,21,26,27	10	0.6T-10M
116. Dibenzo (a,h) anthracene	21	1	1T
117. Fluoranthene	2,8,12,17,21,26,27,28	16	0.3T-21
118. Fluorene	26	1	1
119. Indeno (1,2,3-c,d) pyrene	21	1	4
120. Naphthalene	4,24,26,28	9	0.8T-2.3
121. Phenanthrene	2,8,17,20,21,26,27,28	12	0.3T-10M
122. Pyrene	2,3,8,12,17,21,26,27,28	15	0.3T-16

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TABLE 6-19. SUMMARY OF ANALYTICAL CHEMISTRY FINDINGS FROM NURP PRIORITY POLLUTANT SAMPLES[1] (Cont'd)

(Includes information received through September 30, 1983)

Pollutant	Cities Where Detected[2]	Frequency of Detection[3]	Range of Detected Concentrations (µg/l)[4]
X. NITROSAMINES AND OTHER NITROGEN-CONTAINING COMPOUNDS			
123. Nitrosamine, dimethyl (DMN)	Standard methods inappropriate		
124. Nitrosamine, diphenyl	Standard methods inappropriate		
125. Nitrosamine, di-n-propyl	Not detected		
126. Benzidine	Standard methods inappropriate		
127. Benzidine, 3,3'-dichloro-	Not detected		
128. Hydrazine, 1,2-diphenyl-	Standard methods inappropriate		
129. Acrylonitrile	Holding times exceeded		

[1] Based on 121 sample results received as of 9/30/83, adjusted for quality control review.

[2] Cities from which data are available:

1. Durham, NH
2. Lake Quinsigamond, MA
3. Mystic River, MA
4. Long Island, NY
7. Washington, DC
8. Baltimore, MD
12. Knoxville, TN
17. Glen Ellyn, IL
19. Austin, TX
20. Little Rock, AR
21. Kansas City, KS
22. Denver, CO
23. Salt Lake City, UT
24. Rapid City, SD
26. Fresno, CA
27. Bellevue, WA
28. Eugene, OR

Numbering of cities conforms to NURP convention.

[3] Percentages rounded to nearest whole number.

[4] Some reported concentrations are qualified by STORET quality control remark codes, to wit: A = Value reported is the mean of two or more determinations; G = Value reported is the maximum of two or more determinations; L = Actual value is known to be greater than value given; M = Presence of material verified but not quantified; T = Value reported is less than criteria of detection. One value in this column indicates one positive observation or that all observations were equal.

[5] No longer included as a priority pollutant.

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TABLE 6-20. MOST FREQUENTLY DETECTED PRIORITY POLLUTANTS IN NURP URBAN RUNOFF SAMPLES[1]

Priority Pollutants Detected in 75 Percent or More of the NURP Samples

Inorganics	Organics
30. Lead (94%)	None
36. Zinc (94%)	
28. Copper (91%)	

Priority Pollutants Detected in 50 percent to 74 percent of the NURP Samples

Inorganics	Organics
27. Chrominum (58%)	None
23. Arsenic (52%)	

Priority Pollutants Detected in 20 percent to 49 percent of the NURP Samples

Inorganics	Organics
26. Cadmium (48%)	105. Bis(2-ethylhexyl) phthalate (22%)
32. Nickel (43%)	3. α-Hexachlorocyclohexane (20%)
29. Cyanides (23%)	

Priority Pollutants Detected in 10 percent to 19 percent of the NURP Samples

Inorganics	Organics
22. Antimony (13%)	12. α-Endosulfan (19%)
25. Beryllium (12%)	94. Pentachlorophenol (19%)
33. Selenium (11%)	7. Chlordane (17%)
	5. γ-Hexachlorocyclohexane (Lindane) (15%)
	122. Pyrene (15%)
	90. Phenol (14%)
	121. Phenanthrene (12%)
	47. Dichloromethane (methylene chloride) (11%)
	96. 4-Nitrophenol (10%)
	115. Chrysene (10%)
	117. Fluoranthene (16%)

[1] Based on 121 sample results received as of September 30, 1983, adjusted for quality control review. Does not include special metals samples.

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metals project in order to determine the relationships among dissolved, total, and total recoverable concentrations. The discussion and result of this separate effort are in a subsequent section of this chapter.

A comparison of individual urban runoff sample concentrations undiluted by stream flow (i.e., end of pipe concentrations) with EPA water quality criteria and drinking water standards reveals numerous exceedances of these levels, as shown in Table 6-21. Freshwater acute criteria were exceeded by copper concentrations in 47 percent of the samples and by lead in 23 percent. Freshwater chronic exceedances were common for lead (94 percent), copper (82 percent), zinc (77 percent), and cadmium (48 percent). One organ oleptic (taste and odor) criteria exceedance was observed. Regarding human toxicity, the most significant pollutant was lead. Lead concentrations violated drinking water criteria in 73 percent of the observations.

Whenever an exceedance is noted above, it does not necessarily imply that an actual violation of criteria did or will take place in receiving waters. Rather, the enumeration of exceedances is used as a screening procedure to make a preliminary identification of those pollutants for which their presence in urban runoff requires highest priority for further evaluation. Exceedances of freshwater chronic criteria levels may not persist for a full 24-hour period, for example. However, many small urban streams probably carry only slightly diluted runoff following storms, and acute criteria or other exceedances may in fact be real in such circumstances.

Among the inorganics, the most frequently detected pollutants are also those which are found at the highest concentrations, which most frequently exceed water quality criteria and which are the most geographically well-distributed. One additional observation can be made concerning the samples from Washington, D.C. These samples accounted for a preponderance of the detections of many of the less frequently detected inorganics, including antimony, beryllium, mercury, nickel, selenium, and thallium. No sampling or analytical irregularities have been identified which explain this result.

Organic Pollutants. In general, the organic pollutants were detected less frequently and at lower concentrations than the inorganic pollutants. Sixty-three of a possible 106 organics were detected. The most commonly found organic was the plasticizer bis (2-ethylhexyl) phthalate (22 percent) followed by the pesticide α-hexachlorocyclohexane (α-BHC) (20 percent). An additional 11 organic pollutants were reported with detection frequencies between 10 and 20 percent; 3 pesticides, 3 phenols, 4 polycyclic aromatics, and a single haloginated aliphatic (Table 6-20).

Criteria exceedances were less frequently observed among the organics than the inorganics. One unusually high pentachlorophenol concentration of 115 ug/l resulted in the only exceedance of the organoleptic criteria (Table 6-21). This observation and one for the chlordane exceeded the freshwater acute criteria. Freshwater chronic criteria exceedances were observed for pentochlorophenol, bis (2-ethylhexyl) phthalate, γ-hexachlorocyclohexane (Lindane), α-endosulfan, and chlordane. All other organic exceedances were in the human carcinogen category and were most serious for α-hexachlorocyclohexane (α-BHC), γ-hexachlorocyclohexane (γ-BHC or Lindane), chlordane, phenanthrene, pyrene, and chrysene.

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TABLE 6-21. SUMMARY OF WATER QUALITY CRITERIA EXCEEDANCES FOR POLLUTANTS DETECTED IN AT LEAST 10 PERCENT OF NURP SAMPLES: PERCENTAGE OF SAMPLES IN WHICH POLLUTANT CONCENTRATIONS EXCEED CRITERIA[1]

Pollutant	Frequency of Detection (%)	Detections/ Samples[2]	Criteria Exceedances (%)[3]						
			None	FA	FC	OL	HH	HC[4]	Dw
I. PESTICIDES									
3. α-Hexachlorocyclohexane	20	21/106							
5. γ-Hexachlorocyclohexane (Lindane)	15	15/100			8			8,18,20	
7. Chlordane	17	7/42		2	17			8,10,15	
12. α-Endosulfan	19	9/49			10			17,17,17	
II. METALS AND INORGANICS									
22. Antimony	13	14/106	1						
23. Arsenic	62	45/87							
25. Beryllium	17	11/64			6*			52,52,52	1
26. Cadmium[5]	48	44/91		8	48		1	12,12,12	
27. Chromium[6]	58	47/81			1*				1
28. Copper[5]	91	79/87		47	82				1
29. Cyanides	23	16/71		3	22		4		
30. Lead[5]	94	75/80		23	94		73		73
32. Nickel[5]	43	30/91			5		21		
33. Selenium	11	10/88			6		10		10
36. Zinc[5]	94	88/94		14	77				
IV. HALOGENATED ALIPHATICS									
47. Methane, dichloro-	11	3/28						0,0,11	
VII. PHENOLS AND CRESOLS									
90. Phenol	14	13/91	1						
94. Phenol, pentachloro-	19	21/111		1*	11*	1			
96. Phenol, 4-nitro-	10	11/107	1						
VIII. PHTHALATE ESTERS									
105. Phthalate, bis(2-ethylhexyl)	22	35/60			22*				
IX. POLYCYCLIC AROMATIC HYDROCARBONS									
115. Chrysene	10	11/109							
117. Fluoranthene	16	17/104	1					10,10,10	
121. Phenanthrene	12	13/110							
122. Pyrene	15	16/110						17,12,12	
								15,15,15	

* Indicates FTA or FTC value substituted where FA or FC criterion not available (see below).

1 Based on 121 sample results received as of September 30, 1983, adjusted for quality control review.

2 Number of times detected/number of acceptable samples.

3 FA = Freshwater ambient 24-hour instantaneous maximum criterion ("acute" criterion).
FC = Freshwater ambient 24-hour average criterion ("chronic" criterion).
FTA = Lowest reported freshwater acute toxic concentration. (Used only when FA is not available.)
FTC = Lowest reported freshwater chronic toxic concentration. (Used only when FC is not available.)
OL = Taste and odor (organoleptic) criterion.
HH = Non-Carcinogenic human health criterion for ingestion of contaminated water and organisms.
HC = Protection of human health from carcinogenic effects for ingestion of contaminated water and organisms.
Dw = Primary drinking water criterion.

4 Entries in this column indicate exceedances of the human carcinogen value at the 10^{-5}, 10^{-6}, and 10^{-7} risk level, respectively. The numbers are cumulative, i.e., all 10^{-5} exceedances are included in 10^{-6} exceedances, and all 10^{-6} exceedances are included in 10^{-7} exceedances.

5 Where hardness dependent, hardness of 100 mg/l $CaCO_3$ equivalent assumed.

6 Different criteria are written for the trivalent and hexavalent forms of chromium. For purposes of this analysis, all chromium is assumed to be in the less toxic trivalent form.

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An additional 50 organic pollutants were found in one to nine percent of the samples. These frequencies of detection are low, and the pollutant is noted in Table 6-22.

Among the PCB group, there was only a single detection of one PCB type among all the samples. Approximately two-thirds of the halogenated aliphatic compounds were detected. Among those cities reporting these compounds, the city of Eugene, Oregon, figured prominently. For example, eight pollutants from this group were found in Eugene only. None of the pollutants in the ethers group were detected.

Monocyclic aromatics were rarely detected in the samples. However, many reported detections of benzene and toluene, two commonly reported pollutants, had to be withdrawn due to contamination problems.

Of the 11 phenolics, four have not been reported in urban runoff, while three have been observed only once. The remaining four have been found fairly frequently but at low concentrations. Exceedances of criteria were noted only for pentachlorophenol.

All the phthalate esters were detected at least once in the NURP program, with bis (2-ethylhexyl) found most frequently. Several times the reported concentration exceeded the lowest observed freshwater acute toxic concentration for this pollutant. Given the significant blank contamination problems with the phthalates, however, these findings must be interpreted with caution.

Only two of the polycyclic aromatic hydrocarbons were not detected in at least one sample. Crysene, phenanthrene, pyrene, and fluoranthene were each found at least 10 percent of the time. All the observed concentrations for the first three of these pollutants exceeded the criteria for the protection of human health from carcinogenic effects (there are no such criteria for fluoranthene). Results for the polycyclic aromatics were generally free from quality control problems.

There were no detections of nitrosamines or other nitrogen-containing compounds. Due to methodological and holding time problems, however, results for only two compounds can be used. Moreover, for one of these compounds, 3,3-dichlorobenzidine, performance evaluation results were unacceptable in several cases.

Pollutants Not Detected In Urban Runoff

Some 43 priority pollutants were not detected in any acceptable runoff samples (Table 6-22). All of these pollutants are organics. This group of substances should be considered to pose a minimal threat to the quality of surface waters from runoff contamination.

While the priority pollutants which were not detected are of less immediate concern than those pollutants found often, they cannot safely be eliminated from all future consideration. Many of these pollutants have associated water quality criteria which are below the limits of detection of routine

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TABLE 6-22. INFREQUENTLY DETECTED ORGANIC PRIORITY POLLUTANTS IN NURP URBAN RUNOFF SAMPLES[1]

Priority Pollutants Detected in 1 percent to 9 percent of the NURP Samples

51. Trichloromethane (9%)
120. Naphthalene (9%)
98. 2,4-Dimethyl phenol (8%)
109. Anthracene (7%)
2. Aldrin (6%)
6. δ-Hexachlorocyclohexane (6%)
9. DDE (6%)
11. Dieldrin (6%)
17. Heptachlor (6%)
58. 1,1,1-Trichloroethane (6%)
65. Trichloroethene (6%)
85. Ethylbenzene (6%)
102. Diethyl phthalate (6%)
103. Di-n-butyl phthalate (6%)
104. Di-n-octyl phthalate (6%)
106. Butyl benzyl phthalate (6%)*
114. Benzo(a)pyrene (6%)
4. β-Hexachlorocyclohexane (5%)
53. Trichlorofluoromethane (5%)[2]
66. Tetrachloroethene (5%)
78. Benzene (5%)
79. Chlorobenzene (5%)
111. Benzo(b)fluoranthene (5%)*
64. 1,2-trans-dichloroethene (4%)
110. Benzo(a)anthracene (4%)
19. Isophorone (3%)
52. Tetrachloromethane (carbon tetrachloride) (3%)
56. 1,1-Dichloroethane (3%)
87. Toluene (3%)
112. Benzo(k)fluoranthene (3%)
18. Heptachlor epoxide (2%)*
59. 1,1,2-Trichloroethane (2%)*
60. 1,1,2,2-Tetrachloroethane (2%)*
63. 1,1-Dichloroethene (2%)
68. 1,3-Dichloropropene (2%)*
113. Benzo(g,h,i)perylene (2%)
10. DDT (1%)*
43. PCB-1260 (1%)*
48. Chlorodibromomethane (1%)*
49. Dichlorobromomethane (1%)*
50. Tribromomethane (bromoform) (1%)*
57. 1,2-Dichloroethane (1%)*
67. 1,2-Dichloropropane (1%)*
91. 2-Chlorophenol (1%)*
95. 2-Nitrophenol (1%)*
99. p-Chloro-m-creosol (1%)*
101. Dimethyl phthalate (1%)*
116. Dibenzo(a,h)anthracene (1%)*
118. Fluorene (1%)*
119. Indeno(1,2,3-cd)pyrene (1%)*

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TABLE 6-22. INFREQUENTLY DETECTED ORGANIC PRIORITY POLLUTANTS IN NURP URBAN RUNOFF SAMPLES[1] (Cont'd)

Priority Pollutants Not Detected in NURP Samples

8. DDD
13. β-Endosulfan
14. Endosulfan sulfate
15. Endrin
16. Endrin aldehyde
21. Toxaphene
37. PCB-1016
38. PCB-1221
39. PCP-1232
40. PCB-1242
41. PCB-1248
42. PCB-1254
44. 2-Chloronaphthalene
45. Bromomethane (methyl bromide)
46. Chloromethane (methyl chloride)
54. Dichlorodifluoromethane (Freon-12)[3]
55. Chloroethane
61. Hexachloroethane
62. Chloroethene (vinyl chloride)
69. Hexachlorobutadiene
71. Bis(chloromethyl) ether[3]
72. Bis(chloroethyl) ether
73. Bis(chloroisopropyl) ether
74. 2-Chloroethyl vinyl ether
75. 4-Bromophenyl phenyl ether
76. 4-Chlorophenyl phenyl ether
77. Bis(2-chloroethoxy) methane
80. 1,2-Dichlorobenzene
81. 1,3-Dichlorobenzene
82. 1,4-Dichlorobenzene
83. 1,2,4-Trichlorobenzene
84. Hexachlorobenzene
86. Nitrobenzene
88. 2,4-Dinitrotoluene
89. 2,6-Dinitrotoluene
92. 2,4-Dichlorophenol
93. 2,4,6-Trichlorophenol
97. 2,4-Dinitrophenol
100. 4,6-Dinitro-o-cresol
107. Acenaphthene
108. Acenaphthylene
125. Di-n-propyl nitrosamine
127. 3,3'-Dichlorobenzidine

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TABLE 6-22. INFREQUENTLY DETECTED ORGANIC PRIORITY POLLUTANTS IN NURP URBAN RUNOFF SAMPLES[1] (Cont'd)

Priority Pollutants Not Analyzed for or Withdrawn for Methodological Reasons or Holding Time Violations

1. Acrolein
20. TCDD (Dioxin)
24. Asbestos
70. Hexachlorocyclopentadiene
123. Dimethyl nitrosamine (DMN)
124. Diphenyl nitrosamine
126. Benzidine
128. 1,2-Diphenyl hydrazine
129. Acrylonitrile

* Detected in only one or two samples.

[1] Based on 121 sample results received as of September 30, 1983, adjusted for quality control review.

[2] No longer on the priority pollutant list.

analytical methods. Some of these substances may in fact have been present in the NURP samples. Four priority pollutants not detected in runoff were found in street dust sweepings from Bellevue, Washington, suggesting that further urban runoff samplings can be expected to detect more priority pollutants. More sensitive analytical methodologies must be used and dilution effects considered before it can be said with assurance that these pollutants are not found in urban stormwater runoff at levels which, without dilution, pose a threat to human health or aquatic life.

DDD, chloromethane, 1,2-dichlorobenzene, and 2,4-dichlorophenol were detected in runoff samples at least once, but these observations had to be withdrawn for quality control reasons. Therefore, among the not detected pollutants, these four can be considered to have a slightly elevated possibility of actually being present in the runoff samples.

RUNOFF-RAINFALL RELATIONSHIPS

A runoff coefficient (Rv), defined as the ratio of runoff volume to rainfall volume, has been determined for each of the monitored storm events. As with the EMCs, the runoff coefficient values at a particular site are, with relatively few exceptions, well characterized by a lognormal distribution. Table 6-23 summarizes the statistical properties of Rv's at the loading sites in the data base.

Figure 6-19 illustrates the relationship between percent impervious area and the median runoff coefficient for the site. Sites which monitored fewer than 5 storms are excluded. The upper plot (a) groups the results from 16 of the

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TABLE 6-23. RUNOFF COEFFICIENTS FOR LAND USE SITES

	Residential							
	Site	Land Use Code	No. of Events	Drainage Area (Acs)	Population Density (Pers/Acre)	% Impervious	Runoff Coef (Dv) Median	Runoff Coef (Dv) Coef Var
1	CO1 Big Dry Cr	100	16	33	10	01	.37	.47
2	CO1 Cherry	100	16	57	24	30	.16	.45
3	CO1 116/Clinton	100	20	167	14	24	.16	.60
4	DC1 Buford	100	57	12	7	10	.06	2.47
5	DC1 Lakeridge	100	40	40	21	27	.10	1.32
6	DC1 Stratton	100	34	9	2	22	.37	.00
7	FL1 Young Apt	100	12	9	-	-	.06	.06
8	IL1 John D	100	07	54	10	14	.16	.77
9	KS1 Overland	100	13	50	8	30	.08	.01
10	MA2 Hemlock	100	6	50	5	16	.36	.06
11	MD1 Dalton Hill	100	19	14	30	51	.06	.72
12	MD1 Homeland	100	16	73	9	20	.34	.75
13	MD1 Mt Wash	100	20	17	12	20	.16	1.25
14	MD1 Ow Hill	100	13	30	16	26	.40	.56
15	MO1 Carll's O.	100	20	73	13	20	.21	.01
16	OH2 Cromston	100	13	100	5	22	.16	.33
17	OH2 E. Rock.	100	9	240	10	30	.30	.42
18	TX1 Bellingwood	100	9	60	3	21	.02	.24
19	WA1 Surrey	100	100	16	9	20	.30	.16
20	WI1 Burbank	100	40	63	26	50	.27	.02
21	WI1 Hastings	100	33	33	17	53	.27	.37
22	TX1 Hart	90	14	170	9	40	.08	.06
23	WA1 Lincoln	97	19	36	30	57	.32	.56
24	TX1 42	96	11	80	4	13	.04	.67
25	DC1 Westleigh	03	30	41	3	21	.17	1.15
26	KS1 KC - 42nd	97	14	63	-	37	.06	1.00
27	IL1 John S.	91	20	30	10	10	.17	.54
28	TX1 01	91	9	60	11	33	.03	.06
29	WA1 Lake Hills	91	121	107	17	37	.20	.17
30	IL1 Harris S.	90	09	20	22	37	.31	.06
31	FL1 Charter H.	89	11	42	-	16	.15	0.05
32	DC1 Fairidge	87	44	19	-	36	.36	1.17
33	CO1 Asbury	86	10	177	9	22	.10	.07
34	IL2 Camb Estate	85	20	520	6	17	.17	.40
35	WA1 Locust	85	6	154	11	16	.21	.03
36	DC1 [illegible]	84	03	325	6	27	.10	.67
37	WA1 Jordan	79	9	130	10	21	.27	.06
38	DC1 Seminole	70	46	27	15	16	.20	1.07

	Mixed							
	Site	Land Use Code	No. of Events	Drainage Area (Acs)	Population Density (Pers/Acre)	% Impervious	Runoff Coef (Dv) Median	Runoff Coef (Dv) Coef Var
1	KS1 Roland	-	15	36	3	60	.00	1.06
2	MD1 Hampden	-	22	17	40	22	.20	.53
3	IL1 Harris D	-	02	17	3	50	.04	.57
4	MA1 Beverly	-	30	30	11	60	.30	.25
5	TX1 SE	-	12	107	3	43	.13	.00
6	WI1 Wood Cir	-	09	40	12	04	.26	.42
7	MA1 Dr D	-	7	230	7	23	.20	.50
8	MA1 Concord	-	6	100	1	33	.00	.00
9	MA1 Grand D Dr	-	23	463	5	30	.11	.60
10	FL1 Wilder	-	10	100	-	-	.01	1.12
11	MO3 Pitt AA-5	-	6	2000	2	21	.10	.06
12	OH2 Cedar	-	32	36	-	5	.00	1.05
13	FL1 Jewett	-	10	30	-	13	.30	1.03
14	MA1 Dana	-	6	600	0	12	.17	0.04
15	MO3 Pitt AA-8	-	6	2071	2	36	.10	.03
16	MA1 Grove D	-	23	150	5	30	.11	.01
17	MA1 Swift Run	-	5	1200	2	0	.21	.30
18	MA1 Meade	-	16	2000	-	-	.10	.17
19	CA1 Dana	-	42	1600	12	-	.20	.37
20	CO1 North Ave	-	33	60	0	10	.24	.10

	Commercial							
	Site	Land Use Code	No. of Events	Drainage Area (Acs)	Population Density (Pers/Acre)	% Impervious	Runoff Coef (Dv) Median	Runoff Coef (Dv) Coef Var
1	CO1 Villa Italia	300	23	24	0	94	.03	.00
2	DC1 1013 (CBD)	300	112	23	0	00	.70	.00
3	WI1 Southgate	300	13	170	2	21	.20	.20
4	WI1 Post Office	300	54	12	0	100	.10	.19
5	WI1 Rustler	300	30	12	0	100	.70	.10
6	WI1 Peg Lot	300	34	1	0	00	.04	.10
7	TX1 CBD	300	19	35	0	00	.25	.01
8	KS1 KC Metcalf	05	27	50	-	57	.00	.16
9	FL1 Dunne Park	04	12	67	-	46	.00	.06
10	WI1 State Fair	24	27	70	10	77	.52	.24

	Urban Open and Suburban							
	Site	Land Use Code	No. of Events	Drainage Area (Acs)	Population Density (Pers/Acre)	% Impervious	Runoff Coef (Dv) Median	Runoff Coef (Dv) Coef Var
1	CA1 Stratton	100	10	633	-	1	.03	5.06
2	CO1 Dunne Gulch	100	7	605	0	1	.10	5.04
3	MO1 Maxwell	100	13	20,416	-	0	.06	.91
4	OH2 English Dr	10	20	5,700	-	1	.00	4.01
5	OH2 West Dr	07	10	5,330	-	1	.07	1.44
6	OH3 Thomas Cr	01	13	17,770	1	11	.00	.50
7	OH3 Brown Cr	10	5	7,303	-	0	.11	1.07
8	OH2 Sheriff Dock	00	13	550	-	2	.06	1.75

	Industrial							
	Site	Land Use Code	No. of Events	Drainage Area (Acs)	Population Density (Pers/Acre)	% Impervious	Runoff Coef (Dv) Median	Runoff Coef (Dv) Coef Var
1	MA2 Addison	100	6	10	0	60	.10	.13
2	MA1 Indus Drain	100	10	13	0	04	.00	.71
3	KS1 Lenexa	16	10	22	-	46	.10	.37
4	MA1 Grove S.	12	26	25	5	30	.11	.43

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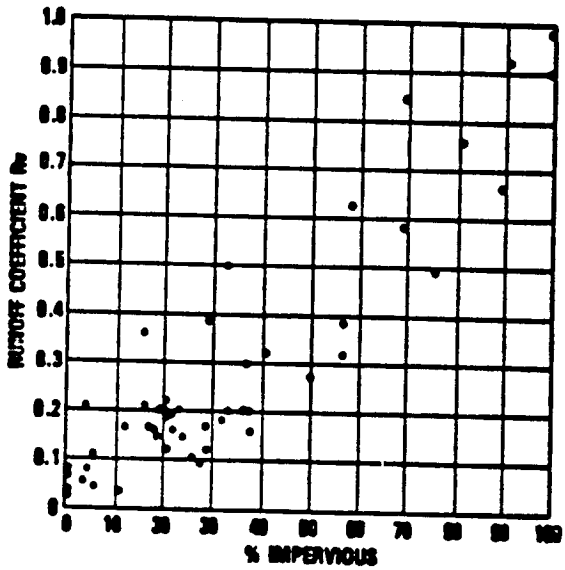
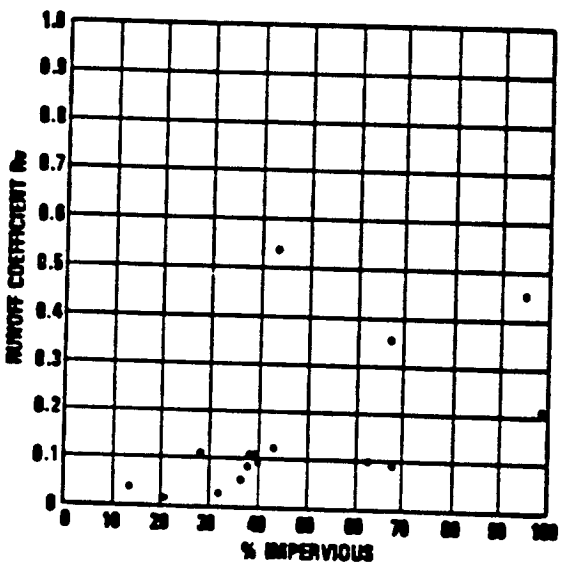


(a) 16 Projects



(b) 4 Projects (KS1, MI1, TN1, TX1)

Figure 6-19. Relationship Between Percent Impervious Area and Median Runoff Coefficient

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20 projects investigated. The lower plot (b) groups results from the remaining four projects (KS1, MI1, TN1, TX1). The reason for the difference is unexplained. However, the separate grouping is based on the fact that the relationship for these sites is internally consistent and significantly different than the bulk of the project results.

Figure 6-20 illustrates the same impervious area/runoff coefficient relationship, but shows the 90 percent confidence limits for median Rv's.

POLLUTANT LOADS

Although the EMC median concentration values are appropriate for many applications (e.g., assessing water quality impacts in rivers and streams), when cumulative effects such as water quality impacts in lakes and comparisons with other sources on a long-term basis (e.g., annual or seasonal loads) are to be examined, the EMC mean concentration values should be used. Taking the EMC median and coefficient of variation values given in Table 6-17, we have converted them into mean values using the relationship given in Chapter 5. These EMC mean concentrations and the values used in the load comparison to follow are listed in Table 6-24.

The range shown for site mean concentrations for both the median and 90th percentile urban sites reflects the difference in means depending on whether the higher or lower value of coefficient of variation listed in Table 6-17 is used to describe event-to-event variability of EMC's at urban sites. The range in values shown for use in the load comparisons below reflects the median and 90th percentile site mean concentrations, using the average of the range caused by coefficient or variation effects.

TABLE 6-24. EMC MEAN VALUES USED IN LOAD COMPARISON

Constituent	Site Mean EMC		
	Median Urban Site	90th Percentile Urban Site	Values Used in Load Comparison
TSS (mg/l)	141 - 224	424 - 671	180 - 548
BOD (mg/l)	10 - 13	17 - 21	12 - 19
COD (mg/l)	73 - 92	157 - 198	82 - 178
Tot. P (mg/l)	0.37 - 0.47	0.78 - 0.99	0.42 - 0.88
Sol. P (mg/l)	0.13 - 0.17	0.23 - 0.30	0.15 - 0.28
TKN (mg/l)	1.68 - 2.12	3.69 - 4.67	1.90 - 4.18
NO_{2+3}-N (mg/l)	0.76 - 0.96	1.96 - 2.47	0.86 - 2.21
Tot. Cu (µg/l)	38 - 48	104 - 132	43 - 118
Tot. Pb (µg/l)	161 - 204	391 - 495	182 - 443
Tot. Zn (µg/l)	179 - 226	559 - 707	202 - 633

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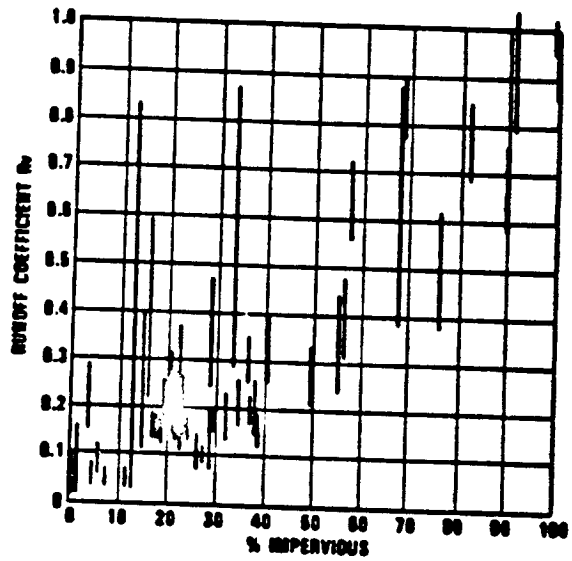
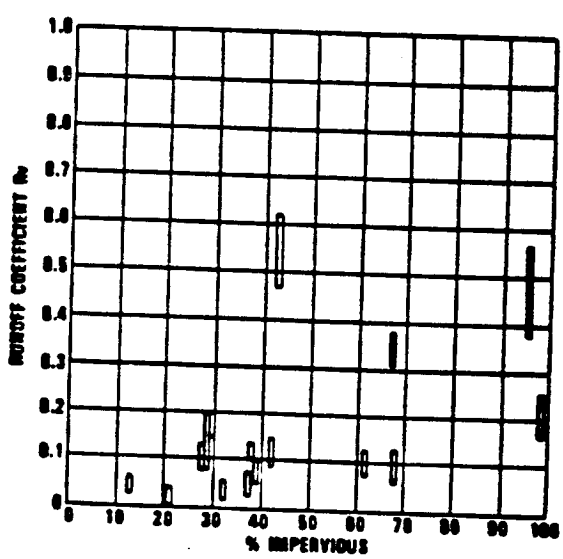


(a) 16 Projects



(b) 4 Projects (KS1, MI1, TN1, TK1)

Figure 6-20. 90 Percent Confidence Limits for Median Runoff Coefficients

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It is a straightforward procedure to calculate mean annual load estimates for urban runoff constituents on a Kg/Ha basis by assigning appropriate rainfall and runoff coefficient values and selecting EMC mean concentration values from Table 6-24. In and of themselves, however, such estimates seem to be of little utility.. Therefore, it was decided to do a comparison of the mean annual loads from urban runoff with those of a "well run" secondary treatment plant. We chose to use TSS = 25 mg/l, BOD = 15 mg/l, and Tot. P = 8 mg/l for the effluents from such plants for the purposes of this order of magnitude comparison. For a meaningful comparison for a specific situation, locally appropriate values should be used. Based upon Table 6-24, the corresponding urban runoff mean concentrations used were TSS = 180 mg/l, BOD = 12 mg/l, and Total P = 0.4 mg/l as typical and TSS = 548 ug/l, BOD = 19 mg/l, and Tot. P = 0.88 mg/l as a "worst case" for comparison purposes.

The value of 0.35 was selected as a typical mean runoff coefficient. It is the median of the NURP mean runoff coefficient database for the twenty projects discussed earlier; their average is 0.42, but we believe that this number is overly weighted by the disproportionate number of highly impervious sites in the database. Assuming an average population density of 10 persons per acre (the average of the NURP sites) and a mean annual rainfall of 40 inches per year, urban runoff averages 104 gallons per day per capita. This is also a reasonable estimate of sewage generation in an urban area. Therefore, as a first cut, the ratio of mean pollutant concentrations of urban runoff and POTW effluents will also be the ratio of their annual loads. Thus, we have;

$$TSS = \frac{180}{25} \approx 7 \; ; \; BOD = \frac{12}{15} \approx 0.8 \; ; \; Tot.\ P = \frac{0.4}{8} \approx 0.05$$

using typical urban runoff values, and;

$$TSS = \frac{548}{25} \approx 22 \; ; \; BOD = \frac{19}{15} \approx 1.3 \; ; \; Tot.\ P = \frac{0.88}{8} \approx 0.1$$

using the "worst case" values. These numbers suggest that annual loads from urban runoff are approximately one order of magnitude higher than those from a well run secondary treatment plant for TSS, the same order of magnitude for BOD, and an order of magnitude less for Tot. P.

If the hypothetical urban area just described were to go to advanced waste treatment and achieve an effluent quality of TSS = 10 mg/l, BOD = 5 mg/l, and Total P = 1 mg/l and no urban runoff controls were instituted, the mean annual load reductions to the receiving water would be:

$$TSS = \frac{25 - 10}{180 + 25} \approx 7\% \; ; \; BOD = \frac{15 - 5}{12 + 15} \approx 37\% \; ; \; Tot.\ P = \frac{8 - 1}{0.4 + 8} \approx 83\%$$

for our typical case, and;

$$TSS = \frac{25 - 10}{548 + 25} \approx 3\% \; ; \; BOD = \frac{15 - 5}{19 + 15} \approx 29\% \; ; \; Tot.\ P = \frac{8 - 1}{0.88 + 8} \approx 79\%$$

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for our "worst case." On the other hand, if urban runoff controls that reduced TSS by 90 percent, BOD by 60 percent, and Total P by 50 percent were instituted, (typical results from a well-designed detention basin), the mean annual load reductions to the receiving water would be:

$$TSS = \frac{180 - 18}{180 + 25} \approx 79\% \; ; \; BOD = \frac{12 - 7}{12 + 15} \approx 19\% \; ; \; Total\ P = \frac{0.4 - 0.2}{0.4 + 8} \approx 2\%$$

for our typical case, and;

$$TSS = \frac{548 - 55}{548 + 25} \approx 86\% \; ; \; BOD = \frac{19 - 8}{19 + 15} \approx 32\% \; ; \; Total\ P = \frac{0.88 - 0.44}{0.58 + 8} \approx 5\%$$

Thus, if these pollutants are causing receiving water quality problems, consideration of urban runoff control appears warranted for TSS, both urban runoff control and AWT might be considered for BOD, and only AWT would be effective for Total P.

The foregoing should be viewed as illustrative of a preliminary screening for trade-off studies that can be performed using appropriate values for a specific urban area, rather than as description of any particular real-world case. They are, however, believed useful in providing order of magnitude comparisons. Local values for annual rainfall, runoff coefficient, or point source characteristics that are different than those used in the illustration will of course change the results shown; although in most cases the changes would not be expected to cause a significant change in the general relationship.

As a final perspective on urban runoff loads, Table 6-25 presents an estimate of annual urban runoff loads, expressed as Kg/Ha/year, for comparison with other data summaries of nonpoint source loads which state results in this manner. Load computations are based on site mean pollutant concentrations for the median urban site and on the specified values for annual rainfall and runoff coefficient. Typical values for mean runoff coefficient (based on NURP data) have been assigned for residential land use (Rv = 0.3), commercial land use (Rv = 0.8), and for an aggregate urban area which is assumed to have representative fractions of the total area in residential, commercial, and open uses (Rv = 0.35).

Several useful observations can be made. The annual load estimates which results are comparable to values and ranges reported in the literature. Although the findings presented earlier in this chapter indicated that the land use category does not have a significant influence on site concentrations of pollutants, on a unit area basis total pollutant loads are significantly higher for commercial areas because of the higher degree of imperviousness typical of such areas. For broad urban areas, however, the relatively small fraction of land with this use considerably mitigates such an effect.

Finally, the annual loads shown by Table 6-25 have been computed on the basis of a 40 inch annual rainfall volume. For urban areas in regions with higher

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TABLE 6-25. ANNUAL URBAN RUNOFF LOADS KG/HA/YEAR

Constituent	Site Mean Con. µg/l	Residential	Commercial	All Urban
Assumed Rv		0.3	0.8	0.35
TSS	180	550	1460	640
BOD	12	36	98	43
COD	82	250	666	292
Total P	0.42	1.3	3.4	1.5
Sol. P	0.15	0.5	1.2	0.5
TKN	1.90	5.8	15.4	6.6
NO_{2+3}-N	0.86	2.6	7.0	3.6
Tot. Cu	0.043	0.13	0.35	0.15
Tot. Pb	0.182	0.55	1.48	0.65
Tot. Zn	0.202	0.62	1.64	0.72

NOTE. Assumes 40 inches/year rainfall as a long-term average.

or lower rainfall, these load estimates must be adjusted. The results presented earlier suggest that pollutant concentrations are not sensitive to runoff volume; however, total loads (the product of concentration and volume) are strongly influenced by the volume of runoff. For estimates using equivalent site conditions (Rv), loads for areas with other rainfall amounts are obtained by factoring by the ratio of local rainfall volume to the 40 inch volume used for the table. Planners who believe that the average annual runoff coefficients in their local areas are substantially different from those used in the table can make similar adjustments.

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CHAPTER 7
RECEIVING WATER QUALITY EFFECTS OF URBAN RUNOFF

INTRODUCTION

The effects of urban runoff on receiving water quality are very site specific. They depend on the type, size, and hydrology of the water body, the designated beneficial use and the pollutants which affect that use, the urban runoff (URO) quality characteristics, and the amounts of URO dictated by local rainfall patterns and land use.

A number of the NURP projects examined receiving water impacts in some detail, others less rigorously. Because of the uniqueness of URO water quality impacts, individual project results are considered best used for confirmation and support, rather than as a basis for broad generalizations.

Accordingly, this chapters is structured to address each of the principal categories of receiving water bodies separately; streams and rivers, lakes, estuaries and embayments, and groundwater aquifers. Some can be addressed more thoroughly than others at this time. The approach taken to develop a general, national scale screening assessment of the significance of URO pollutant discharges is to compute anticipated effects using analysis methodologies identified in Chapter 5, where these are appropriate and to compare anticipated effects indicated by such generalizations to specific experiences and conclusions drawn by relevant individual NURP projects.

As with any generalization, there will be exceptions. Specific local situations can be expected which are either more or less favorable than the general case. The results presented herein should therefore be interpreted as representative estimates of a substantial percentage of urban runoff sites, but not all of them.

Receiving waters have distinctive general characteristics which depend on the water body type (e.g., stream, lake, estuary) and relatively unique individual characteristics which depend on geometry and hydrology. Given a minimum acceptable amount of data on water bodies and their setting, it appears possible to make useful generalizations regarding the quantitative effects of urban runoff on concentrations of various pollutants in the receiving waters and to draw inferences concerning the influence urban runoff may have on the beneficial uses of the water bodies. However extending the results of such an analysis to an assessment of the prevalence of urban runoff induced "problems" on a national scale cannot be accomplished in a way would provide an acceptable level of confidence in any conclusions drawn therefrom. In addition to the importance of local hydrology, meteorology, and urban characteristics, the emphasis placed on each of the three elements that influence problem definition;

(1) Denial or serious impairment of beneficial use;

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(2) Violation of ambient water quality standards; and

(3) Local perception;

will result in a high degree of site-specificity to the determination of the existence of a problem.

RIVERS AND STREAMS

General

Flowing streams carry pollutant discharges downstream with the stream flow. For intermittent stormwater discharges, a specific stream location and the biota associated with it are exposed to a sequence of discrete pulses contaminated by the pollutants which enter with urban runoff. Because of the inherent variability of urban runoff (URO), the average concentrations in such pulses vary, as do their duration and the interval between successive pulses. Table 7-1 summarizes average values for storm duration and intervals between storm events for selected locations in the U.S., based on analysis of long term rainfall records using a methodology (SYNOP) presented in an earlier NURP document (the NURP Data Management Procedures Manual). The information presented provides a sense of the temporal aspects of such intermittent pulses and, by inference, the intermittent exposure patterns to which stream biota are subjected. For many locations, storm pulses are produced for about six hours every three days or more, on average.

A probabalistic methodology has been used to examine the concentration characteristics of the storm pulses produced in streams, given the variability of the relevant processes which are directly involved. Stream flow rates, runoff flow rates, and concentrations vary and result in variable stream concentrations. For streams, it is not the runoff volume per se that is important. The combination of stream and runoff flow rates (together with runoff concentration) determine the pollutant concentration in the stream pulse. The duration of the runoff event and the stream velocity dictate the spatial extent of the storm pulse in the stream. The analysis presented in this section addresses the frequency and magnitude of pollutant concentrations in the instream storm pulses which are produced.

Runoff and Stream Flow Rates

The local combination of stream and runoff flow rates for an urban location are, as indicated, important determinants of the stream concentrations which will result. For long-range projections, the most appropriate data sources for characterizing these parameters are long-term stream flow gauging records (USGS) and long-term rainfall records (USWS).

Figure 7-1(a) illustrates the regional variation of average daily stream flows expressed as cfs/sq mile of drainage area, based on long-term (50 years or more) gauging records at over 1000 stations. Figure 7-1(b) presents a somewhat simplified regional pattern for average rainfall intensity. The data base for this plot is considerably smaller, consisting of rainfall records (usually 10 to 30 years of record) for approximately 40 cities. Localized peturbations exist, but are smoothed out by contours presented.

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TABLE 7-1. AVERAGE STORM AND TIME BETWEEN STORMS FOR SELECTED LOCATIONS IN THE UNITED STATES

Location	Average Annual Values in Hours	
	Storm Duration	Time Between Storm Midpoints
Atlanta, GA	8.0	94
Birmingham, AL	7.2	85
Boston, MA	6.1	68
Caribou, ME	5.8	55
Champaign-Urbana, IL	6.1	80
Chicago, IL	5.7	72
Columbia, SC	4.5	68
Davenport, IA	6.6	98
Detroit, MI	4.4	57
Gainesville, FL	7.6	106
Greensboro, SC	5.0	70
Kingston, NY	7.0	80
Louisville, KY	6.7	76
Memphis, TN	6.9	89
Mineola, NY	5.8	89
Minneapolis, MN	6.0	87
New Orleans, LA	6.9	89
New York City, NY	6.7	77
Steubenville, OH	7.0	79
Tampa, FL	3.6	93
Toledo, OH	5.0	62
Washington, DC	5.9	80
Zanesville, OH	6.1	77
Mean	6.1	81
Denver, CO	9.1	144
Oakland, CA	4.3	320
Phoenix, AZ	3.2	286
Rapid City, SD	8.0	127
Salt Lake City, UT	7.8	133
Mean	6.5	202
Portland, OR	15.5	83
Seattle, WA	21.5	101
Mean	18.5	92

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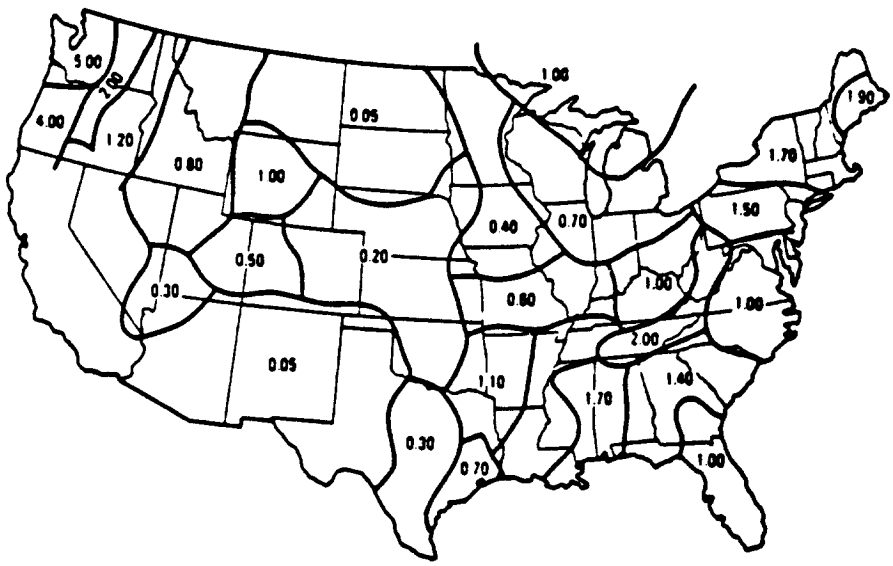

Figure 7-1(a). Regional Value of Average Annual Streamflow (cfs/sq mi)

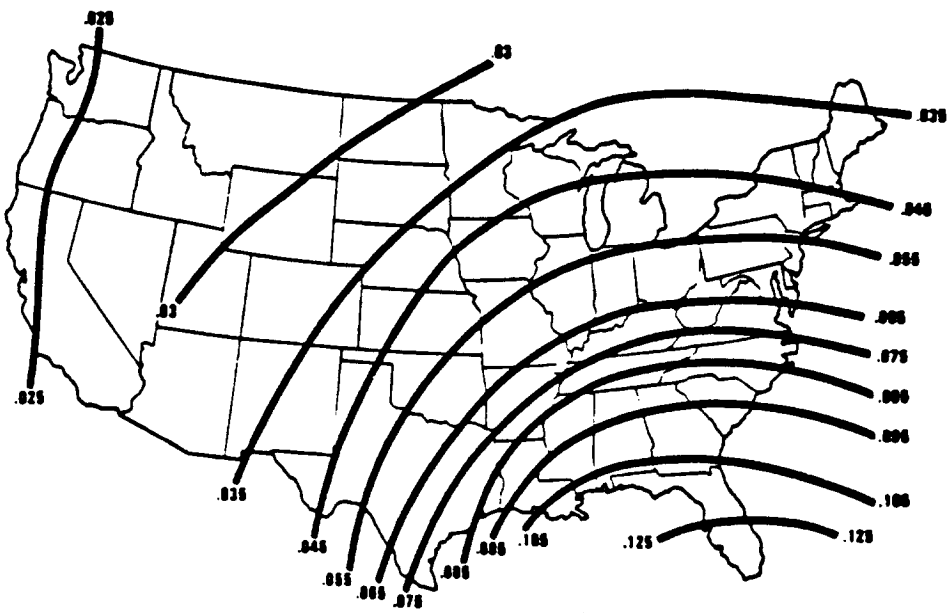

Figure 7-1(b). Regional Value of Average Storm Event Intensity (inch/hr)

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Variability of daily stream flows was determined for a smaller sample (about 150 sites) of the stream sites. Variability of storm event average intensities was determined for all of the rain gauge locations in the current data base. These results are summarized in Table 7-2.

Total Hardness of Receiving Streams

Where the beneficial use of principal concern is the protection of aquatic life, the URO pollutants of major concern appear to be heavy metals, particularly copper, lead and zinc. The potential toxicity of these pollutants are strongly influenced by total hardness, as indicated by Table 5-1 in Chapter 5. Other beneficial uses deal with pollutants and effects that are not influenced by total hardness or (as with drinking water supplies) do not modify the assigned significance of heavy metal concentrations on the basis of total hardness.

As with stream flow and precipitation, distinct regional patterns also exist for receiving water total hardness concentrations. Figure 7-2 delineates the national pattern of regional differences. These patterns impose an additional regional influence on the potential of urban runoff to create problem conditions in streams and rivers.

Technical Approach To Screening Analysis

The magnitude and frequency of occurrence of intermittent stream concentrations of pollutants of interest, that result from urban runoff, has been computed using the probabilistic methodology discussed in Chapter 5.

The input data required for application of the methodology includes representative values for the mean and variability of stream flow, runoff flow, and runoff pollutant concentrations. The material presented earlier in this chapter provides the basis for assigning values for the flows; the results summarized in Chapter 6 provides the basis for specifying pollutant concentration inputs. In order to translate the probability distribution of stream concentrations (which is the basic output of the analysis methodology) to an average recurrence interval, which is considered to provide a more understandable basis for comparisons, the average number of storms per year is also required. This is estimated directly from the average interval between storm midpoints generated by the statistical analysis of hourly rainfall records.

For a general screening on a national scale, an estimate of typical values for a selected geographic location must be made. This has been done, and the set of input values considered to be typical of geographical location are described and summarized below. The values used should be considered reasonably representative of the majority of sites in the area, but it should be recognized that not all potential sites will have conditions either as favorable or unfavorable as those listed.

We have worked with a limited sample in assigning typical values. A greater data base on rainfall and stream flow would permit greater spatial definition

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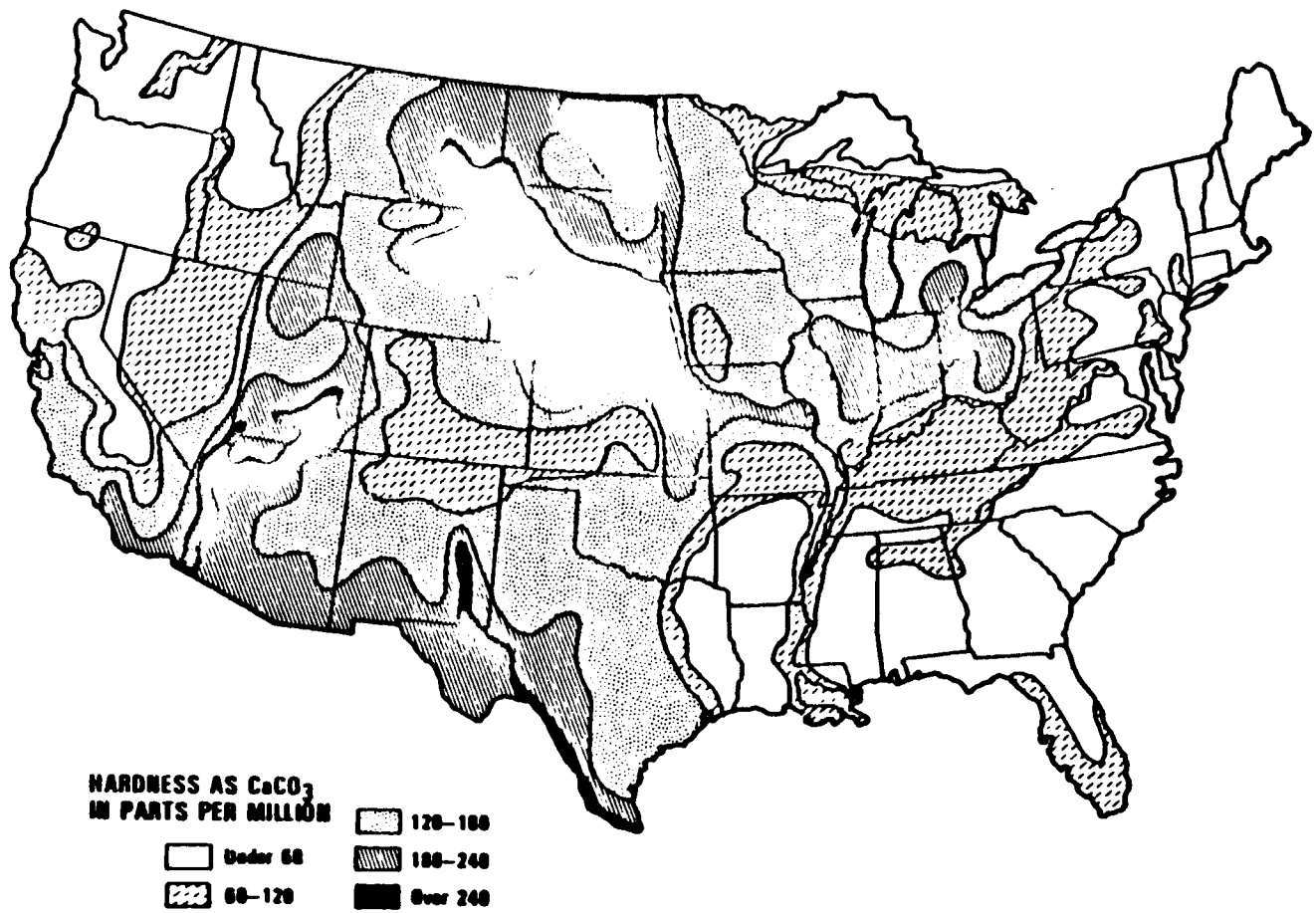

Figure 7-2. Regional Values for Surface Water Hardness

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than shown in the results. Specific regions or states could, with development of a more detailed spatial definition of stream flows and rainfall, extend the analysis presented to provide a considerably more comprehensive assessment of problem potential for local areas. This would involve the development of input parameters (rainfall and streamflow) readily derived from available long term USGS stream flow records and USWS rainfall records and their use in the methodology with quality parameters based either on the NURP analysis presented in Chapter 6, or on local monitoring activities.

The analysis methodology presently available permits computation of the probability distribution of instream concentrations, incorporating the effect of upstream (background) concentrations of the pollutant of interest. The results presented here assume upstream concentrations of zero, principally because of our inability at present to make reliable estimates of typical values for the magnitude and variability for pollutants of interest, especially on the broad national scale being examined. As a result, the summaries will show the effects of urban runoff contributions only. In cases where the background is small relative to the URO contribution, the summaries will represent actual conditions quite closely. However, where background is high and has appreciable variability, the implications of the URO contribution will be overstated, particularly the inferred improvement which could result from control of URO.

In order to perform a national screening of regional influences on urban runoff impacts, eight geographical regions illustrated by Figure 7-3 have been delineated. Using the information summarized by Figures 7-1 and 7-2, typical values for the pertinent rainfall/runoff and stream parameters have been assigned for each of the regions. Table 7-2 summarizes the values for these parameters which are used in the screening analysis.

TABLE 7-2. TYPICAL REGIONAL VALUES

Area	Event Average Rainfall Intensity		Average Number of Events/year	Average Runoff Flow Rate		Stream Flow Rate (Daily Avg Flows)		Stream Total Hardness (mg/l)
	Mean (in/hr)	c.v.		Mean Event (cfs/sq mi)	c.v.	Mean (cfs/sq mi)	c.v.	
1	0.04	1.00	110	5	0.85	1.75	1.25	50
2	0.10	1.35	100	12	1.15	1.25	1.25	50
3	0.08	1.35	90	10	1.15	1.00	1.25	50
4	0.055	1.25	110	7	1.05	0.75	1.25	200
5	0.04	1.10	63	5	0.95	0.35	1.25	200
6	0.03	1.10	70	4	0.95	0.05	1.25	300
7	0.045	1.20	30	5	1.00	0.05	1.25	200
8	0.025	0.85	80	3	0.75	4.50	1.25	50

Average stream flow and rainfall intensity were taken from the plots, which are based on sources previously described. The estimate for variability of daily stream flows (coefficient of variation) is based on computed values for a sample of about 150 perennial streams. Results for a number of regional

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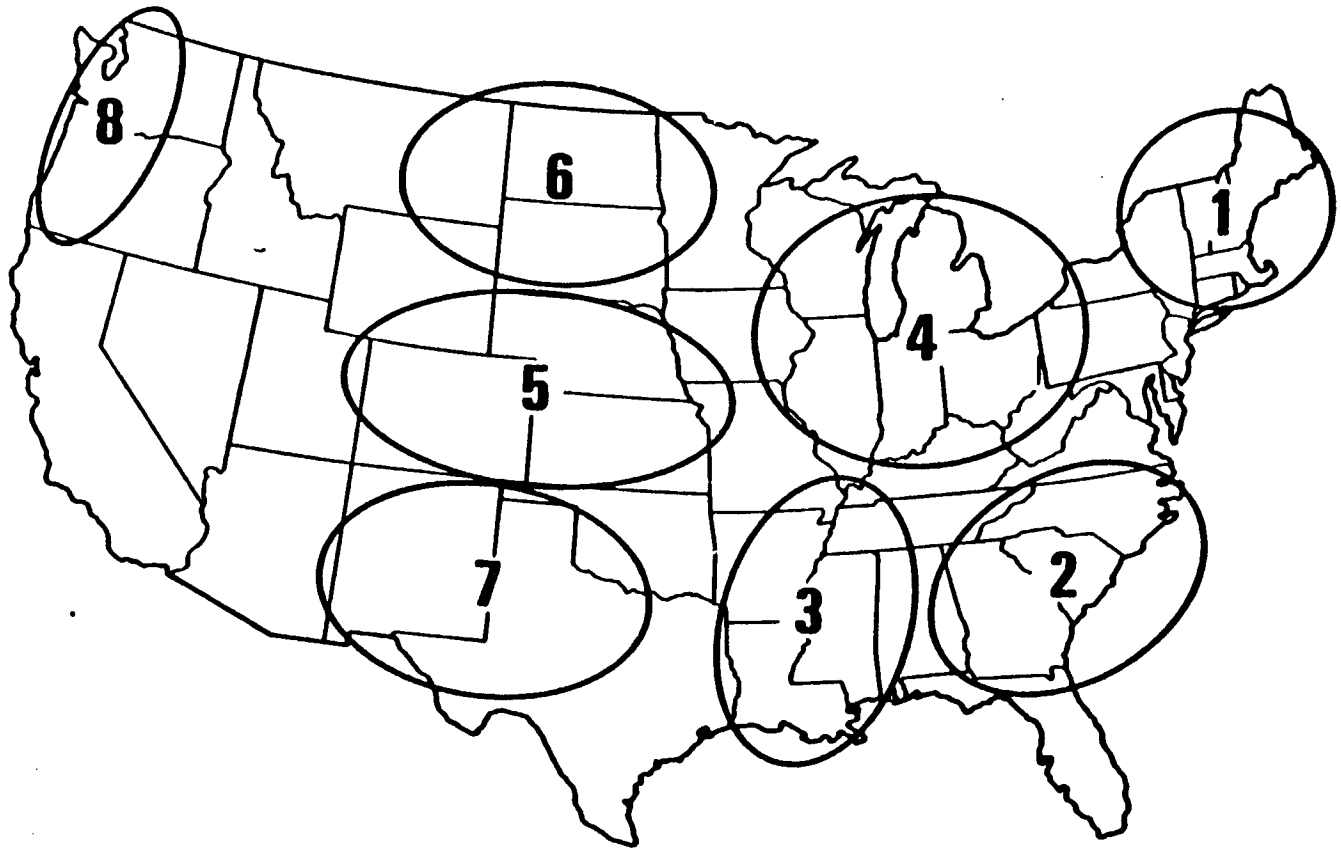

Figure 7-3. Geographic Regions Selected for Screening Analysis

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groupings indicated median values for coefficient of variation to fall between approximately 1 and 1.5. Since there were no clear regional patterns apparent, a uniform value for coefficient of variation of stream flows of 1.25 was assigned.

The coefficient of variation of rainfall intensities was taken directly from the statistical analysis of the rainfall records examined. This was reduced by 15 percent to provide estimates of the coefficient of variation of runoff flow rates, based on a recent published report, "Comparison of Basin Performance Modeling Techniques", Goforth, Heaney and Huber, ASCE JEED, November 1983, using the SWMM model on a long-term rainfall record.

The quality characteristics of urban runoff used in the screening analysis are listed in Table 7-3, and are based on the results summarized in Chapter 6. The analysis results have been rounded in the selection of representative site median EMCs and are interpreted as being representative of an array of urban sites discharging into the receiving stream being analyzed.

Average site conditions are based on the 50th percentile of all urban sites. Since the data analysis indicated that sites at some locations tend to cluster at either the higher or lower ends of the range for all sites, high range and low range site conditions were also selected for use in the screening analysis. High range site conditions are nominally based on the 90th percentile of all site median concentrations; the low range on the 10th percentile site. The variability of EMCs from storm to storm at any site is based on the median of the coefficients of variation of EMCs at sites monitored by NURP. This value was used for the low range and average site condition and was increased nominally for the high range site condition.

TABLE 7-3. URBAN RUNOFF QUALITY CHARACTERISTICS
USED IN STREAM IMPACT ANALYSIS
(Concentrations in µg/l)

	COPPER		LEAD		ZINC	
	Site Median EMC	Coef Var	Site Median EMC	Coef Var	Site Median EMC	Coef Var
Low Range of Site Conditions	15	0.6	50	0.75	75	0.7
Average Site Conditions	35	0.6	135	0.75	165	0.7
High Range of Site Conditions	90	0.7	350	0.85	450	0.8

An illustrative example of a site-specific application of the probabilistic analysis methodology employed is presented in order to:

1. Illustrate the nature of the computational results produced;

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2. Assist in the interpretation of the tabulations presented later which summarize results of the national scale screening analysis;

3. Indicate how magnitude/frequency of instream concentrations may be interpreted for inferences concerning the absence or presence of a "problem" and where a problem is concluded to exist, its degree of security; and

4. Demonstrate how alternative URO control options may be evaluated in terms of their expected impact on both water quality impacts and potential effect on problem severity.

From selected representative values for mean and variability of stream and runoff conditions, the probability distribution of resulting instream concentrations during storm events can be computed. Figure 7-4 illustrates a plot of such an output. Uncertainty in estimates for specific inputs can be accommodated by sensitivity analyses which incorporate upper and lower bounds for specific parameter values. Results are then presented as a band rather than a specific projection. The probabilities which are the basic output of the analysis may be converted to average recurrence intervals to provide what is believed to be a more understandable basis for interpreting and evaluating results.

Figure 7-5 presents results converted to the average recurrence interval of which specific stream concentrations will be produced during storm runoff periods.

The significance of a particular magnitude/frequency pattern of stream concentrations caused by urban runoff can be evaluated by comparing them with concentrations which are significant for the beneficial use of the water body. In the example presented, we have excluded comparisons with drinking water criteria on the basis that urban streams are not generally used as domestic water sources, and in any event, the criteria relate to finished water, and surface water supplies almost invariably receive treatment.

Protection of aquatic life is selected for the screening analysis of the impact of urban runoff because it is believed to be the predominant potential beneficial use for urban streams on a national scale. The concentrations which result from urban runoff are compared with stream target concentrations associated with different degrees of adverse impact, as discussed and tabulated in Chapter 5.

In the site specific situation illustrated, the stream concentrations of copper caused by untreated urban runoff discharges exceed the "EPA Maximum" criterion more than ten times per year on average. The concentration level suggested by the NURP analysis to be the Threshold level of adverse biological impacts is exceeded an average of five times per year (recurrence interval 0.2 year), and significant mortality of more sensitive biological species occurs about once every three years on average. Although this stress level may not be great enough to result in a total denial of the use, there are many who would argue that it represents an unacceptably severe degree of impairment of this beneficial use.

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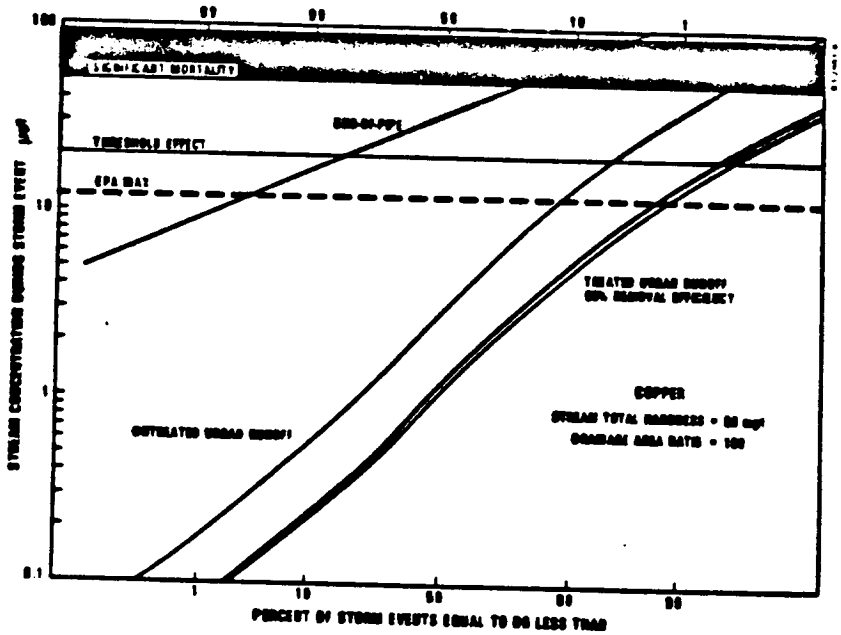

Figure 7-4. Probability Distributions of Pollutant Concentrations During Storm Runoff Periods

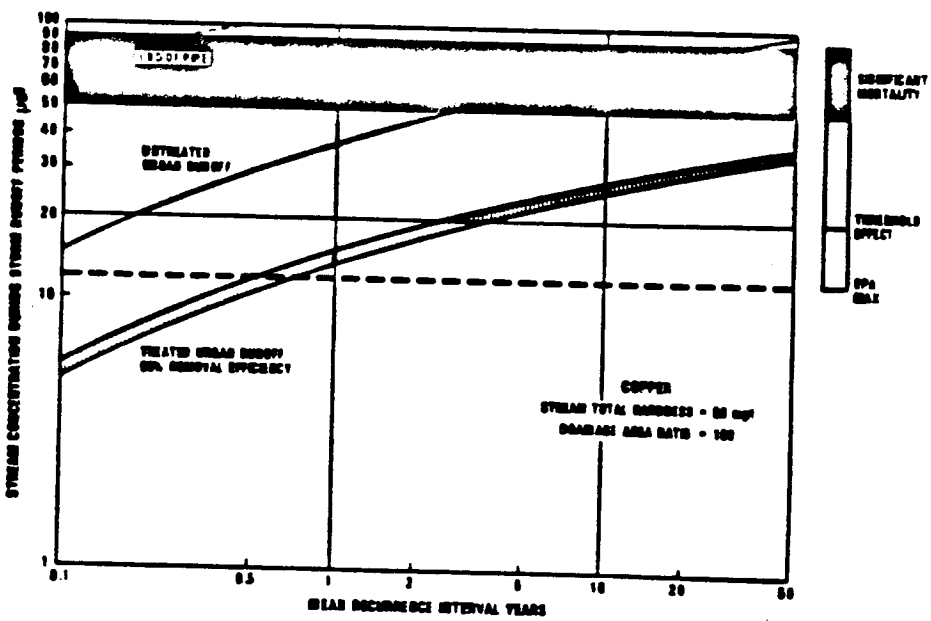

Figure 7-5. Recurrence Intervals for Pollutant Concentrations

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The projection labeled "treated urban runoff" may be taken to represent the in-stream result for either the originally considered discharge following the application of controls which effect a 60 percent reduction, or of an uncontrolled urban runoff site with lower levels of copper in the runoff. In this case, threshold levels are reached only once every 3 or 4 years on average, and significant mortality levels are virtually never reached. Even though the ambient "EPA MAX" criterion is exceeded once or twice a year on average, one might conclude that the implied degree of stress is tolerable and is not interpreted to represent a significant degree of impairment of the use.

The Threshold and Significant Mortality levels are estimates, which have been explained earlier. In addition, the "acceptable" frequency at which specific adverse effects can be tolerated is subjective at this time, since there are no formal guidelines. However, an approach of this nature must be taken in any evaluation of the significance of urban runoff and the importance of applying control measures. There are two reasons why this is necessary. First, because of the stochastic nature of the system we are dealing with, virtually any target concentration we elect to specify will be exceeded at some frequency, however rare. Secondly, from a practical point of view, there are limits to the capabilities of controls, however rigorously applied. In the illustration presented, the untreated urban runoff site assigned urban runoff copper concentrations equivalent to the average urban site. Since NURP analysis data indicate that the copper in urban runoff has a soluble fraction of about 40 percent, the level of removal used in the example reflects a control efficiency approaching the practical limit. Receiving water impacts are significantly reduced, but not totally eliminated.

Results of Screening Analysis

A projection of stream water quality responses has been made for each of the eight geographical areas shown by Figure 7-3. The rainfall, runoff, and stream flow estimates used in the computations are those summarized in Table 7-2. The urban runoff quality characteristics used are those presented in Table 7-3.

To consolidate screening analysis results for easier comparison, results are not presented as continuous concentration/frequency curves as used in the illustrative example presented above. Instead, the comparison plots which follow show only the recurrence interval at which specified biological effects levels are exceeded. The concentrations which correspond with these effects are strongly influenced by stream total hardness, and hence vary regionally. Table 7-4, based on information presented in Chapter 5, summarizes the stream target concentrations used in the screening analysis summary.

Analysis results are presented for Copper (Figure 7-6), Lead (Figure 7-7) and Zinc (Figure 7-8). Each individual bar represents a different geographical region, and the analysis is performed for two drainage area ratios. Since regional stream flow differences are based on unit flows (cfs/sq mile of drainage area), actual flow in a receiving stream at a particular location is

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TABLE 7-4. REGIONAL DIFFERENCES IN TOXIC CONCENTRATION LEVELS
(Concentrations in µg/l)

Pollutant	Stream Total Hardness µg/l	Geo-graphic Regions	EPA MAX	Suggested Values For		
				Threshold Effects[1]	Significant Mortality[2] (a)	(b)
Copper	50	1,2,3,8	12	20	50	90
	200	4,5,7	42	80	180	350
	300	6	62	115	265	500
Lead	50	1,2,3,8	74	150	350	3200
	200	4,5,7	400	850	1950	17,850
	300	6	660	1400	3100	29,000
Zinc	50	1,2,3,8	180	380	870	3200
	200	4,5,7	570	1200	2750	8000
	300	6	800	1700	3850	11,000

[1] Threshold Effects - mortality of the most sensitive individual of the most sensitive species.

[2] Significant Mortality

Level (a) - mortality of 50 percent of the most sensitive species.

Level (b) - mortality of the most sensitive individual of 25th percentile sensitive species.

a function of both the unit flow rate and the size of the contributing drainage area. The "drainage area ratio" (DAR) used in the analysis is

$$DAR = \frac{\text{Urban Area Contributing Runoff}}{\text{Stream Drainage Area Upstream of Urban Input}}$$

It is a measure of the location of the urban area relative to the headwaters of the receiving stream.

The shading scheme used on the bars duplicates that used earlier in the illustrative example (Figure 7-5), and identifies the recurrence interval for each of the target concentrationa. For example, instream copper concentrations during storm runoff periods in geographic region 1, with average site conditions for copper concentrations in urban runoff, and a DAR = 10, are projected to be as follows (middle plot, Figure 7-6).

- EPA MAX - ambient criterion is exceeded at a frequency of 0.02 year (= 50 times/year) or about every other storm event on average.

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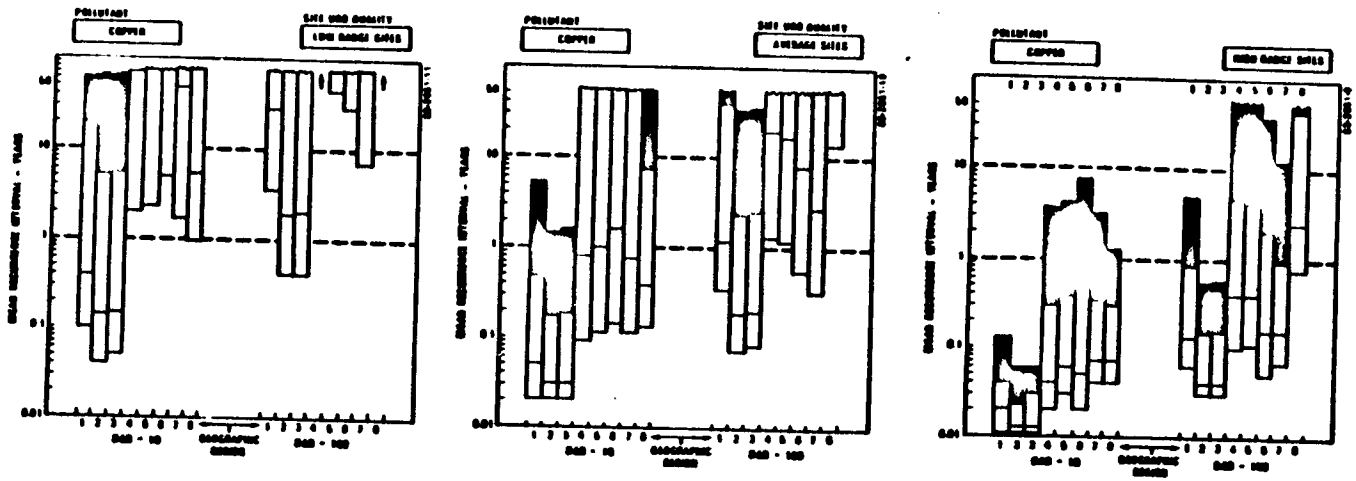

Figure 7-6. Exceedance Frequency for Stream Target Concentration
COPPER

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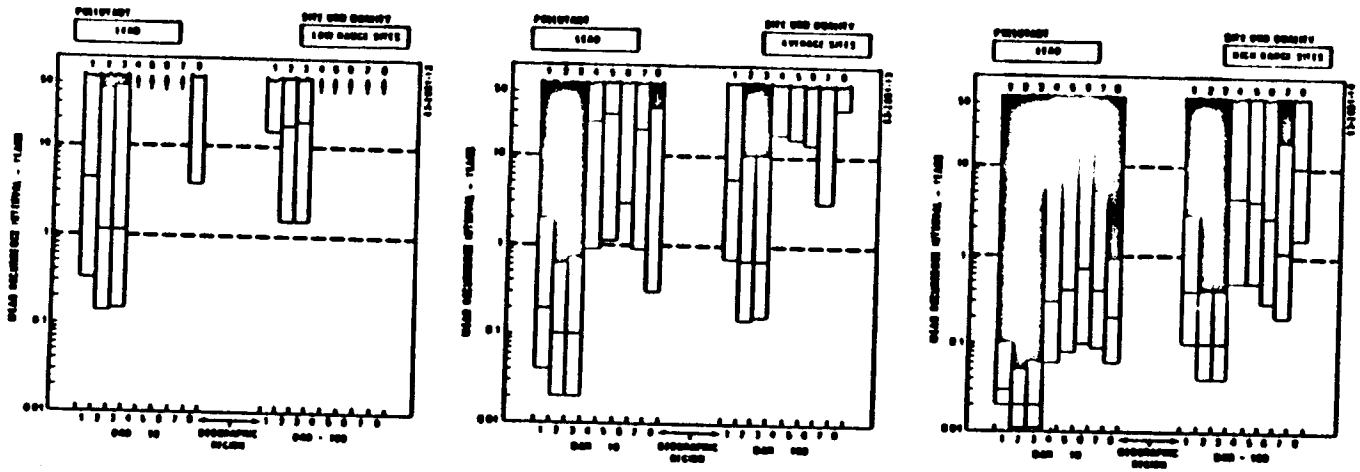

Figure 7-7. Exceedance Frequency for Stream Target Concentration
LEAD

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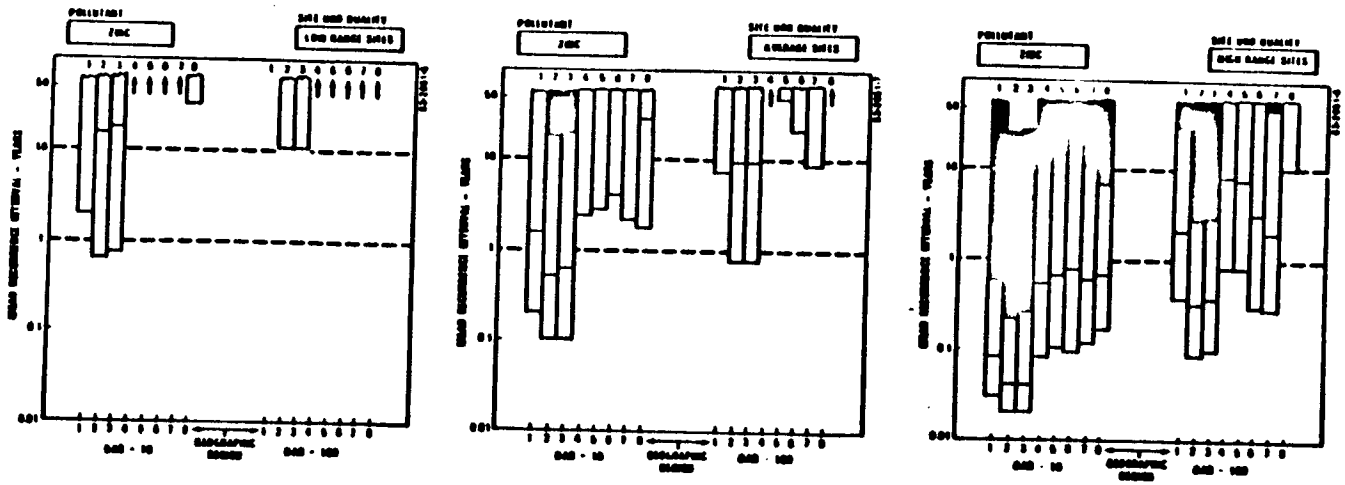

Figure 7-8. Exceedance Frequency for Stream Target Concentration
ZINC

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- Threshold concentration levels at which adverse biological stress for short duration exposures is projected to occur have a recurrence interval of about 0.05 years (20 times/year).

- Significant mortality levels are exceeded at intervals of about 0.5 year (twice/year) for the less severe effect, to about once in 5.5 year for the more severe impact specified.

The plot is terminated at an upper level for recurrence interval of 50 years. Although the analysis procedure computes specific recurrence intervals in excess of this value, a realistic interpretation suggests that such conditions are for practical purposes quite unlikely to ever be reached or exceeded. At computed recurrence intervals of about 10 years or more estimates are not considered to be reliable and are very probably conservative. Therefore, indicated mean recurrence intervals in excess of 10 years probably (and 50 years certainly) should be interpreted as "unlikely" or "highly unlikely".

Discussion

An inspection of the screening analysis results (Figures 7-6 through 7-8) indicates the reason why it is unrealistic to attempt a broad generalization on whether urban runoff is, or is not a "problem" in rivers and streams. Water quality impacts can vary widely, depending on regional rainfall and stream hydrology, urban site quality characteristics, drainage area ratio (reflecting the size of the receiving stream relative to the urban area), and the total hardness of the receiving stream. While the screening analysis results provide an informative and useful perspective on the issue, it should be recognized that any specific site may differ considerably from the typical conditions used to characterize rainfall and stream flow for the area, and further, that local variations in runoff quality characteristics within the range defined by the NURP data can also have significant influence. The dominant indication of the analysis is that the problem potential for urban runoff is highly site-specific. Nevertheless some useful generalizations can be made.

Perhaps the major factor which dictates whether urban runoff discharges of copper, lead, or zinc will adversely impact aquatic life is the natural hardness of the receiving streams. As a result, the southeast and gulf coast areas are consistently indicated to be more sensitive than other areas of the country. Of the remaining soft water areas, the northeast is somewhat less sensitive; the Pacific northwest markedly less. This is attributed to significantly lower storm intensities in these areas, coupled in the northwest with appreciably higher stream flows.

Drainage area ratios have an important effect, reflecting as they do the magnitude of stream flow at the urban location. The effect is much greater for geographical regions with high unit flow (cfs/sq mile) than for lower stream flow regions.

Finally, the quality characteristics of the urban sites have a significant influence. Stream concentrations differ markedly depending on whether the local urban sites tend to cluster toward the lower or higher end of the range of site median concentrations indicated by the NURP data base.

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A comparison of the relative position of the bars on Figures 7-6, 7-7 and 7-8, is sufficient to indicate the comparative sensitivity to urban runoff pollutant discharges. However, it is also desirable to decide whether a given stream effect constitutes a serious degree of impairment of an aquatic life beneficial use. There are no formal guidelines, and interpretations that are either more liberal or more restrictive than those suggested below may be preferred by others dealing with specific stream segments. For the interpretation of the national scale screening analysis, the following decision basis has been used to identify the situations in which urban runoff is likely to result in a water use "problem", (i.e., cause an unacceptable degree of use impairment):

- Threshold effects - (mortality of the most sensitive individual of the most sensitive species) occur more often than about once a year on average.

- Significant mortality - using the lower of the two levels (i.e., 50 percent mortality of the most sensitive species), occurs more often than about once every 10 years on average.

Using these guidelines for assessing the occurrence of problem situations, copper is shown to be the most significant of the three heavy metals consistently found in urban runoff at elevated concentration levels. Where site concentrations are at the high range of observed urban site conditions, problems are expected in all geographic regions at a DAR = 10, and in all geographic regions except region 8 at DARs as high as 100. When site concentrations are in the average range of observed conditions, problem situations are restricted to geographic regions 2 and 3 (plus region 1 at DAR = 10). When site copper concentrations are in the lower range of observed site conditions, problem situations are restricted to geographic regions 2 and 3 at low DARs. They are marginal (significant mortality once every 5 years) but remain a problem according to the definition adopted. The "marginal" attribution is used here, because the more severe degree of significant mortality (most sensitive individual of 25th percentile sensitive species) is indicated by the analysis virtually never to occur.

Thus, copper discharges in urban runoff are indicated to represent a significant threat to aquatic life use in regions 2 and 3 (southeast and Gulf Coast) under almost all possibilities for urban site runoff quality. In region 1 (northeast), problems would be expected at all but the lower range of site concentrations. In the hard water areas (regions 4, 5, 6, 7) problems are expected only where site runoff quality is in the high end of the range of observed site median concentrations.

It should be noted that the analysis has been based on <u>total</u> copper concentrations in urban runoff. Toxic effects are usually considered to be exerted by the soluble form of the metal, and EPA defines an "active" fraction based on a mild digestion which converts some of the inactive particulates to soluble forms, to account for transformations which may occur in the natural water systems. Copper in urban runoff has a typical soluble fraction of about 50 percent, and the active fraction would therefore fall somewhere between 50 and 100 percent of the total concentration used in the analysis. The analysis has been performed using the total fraction, since adequate

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information is not available at present to reliably adjust these values. However, although the problem assessment presented above may be somewhat conservative, further refinement along these lines would not change the inferences drawn from the screening analysis results.

Zinc, like copper, has an indicated soluble fraction in the order of 50 percent, and the screening analysis indications will also be unaffected by this consideration. It is indicated to be unlikely to pose a significant threat to aquatic life in most urban runoff situations. Exceptions are restricted to soft water areas in the east and south, lower DARs, and sites with high zinc concentrations in urban runoff.

Lead results must be viewed with greater caution, because soluble fractions in urban runoff are indicated to be quite low (less than 10 percent). Problem indications are therefore likely to be reasonably conservative, i.e., overstate the problem potential. Problem situations may be expected to be restricted to soft water areas in the east and Gulf areas when urban sites have average site concentrations and DARs are low, and even at high DARs when site concentrations are in the high range. Lead is not indicated to be a threat to aquatic life in the hard water areas of the country or in the Pacific northwest, except for the combination of low DAR and high site concentration.

In performing the screening analysis, upstream concentrations were assumed to be zero; that is, the receiving stream had only a diluting effect on the urban runoff pollution. In actual cases background concentrations will be greater than zero, and in some instances upstream contributions (e.g., agricultural runoff, another city) could be significant and result in more severe conditions than those identified in the screening analysis.

On the basis of the foregoing, it appears appropriate to identify copper as the key toxic pollutant in urban runoff, for the following reasons:

- Problem situations anticipated for lead and zinc do not occur under any conditions for which copper does not show up as a problem as well - and with more severe impacts. On the other hand, copper is indicated to be a problem in situations where lead or zinc do not.

- Based on the ratios between concentrations producing increasingly severe effects, copper is suggested to be a more generic toxicant. It has an effect on a broad range of species. This in contrast to lead and zinc for which a substantially greater degree of species selectivity is indicated. Some species are sensitive, others relatively insensitive to lead and zinc.

- From the NURP data, locations which tend to have site median concentrations in the low, average, or high end of the range have generally consistent patterns for each of the three heavy metals.

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- Control measures which produce reductions in copper discharges to receiving waters could be expected to result in equivalent reductions in zinc, and greater reductions in lead, by virtue of its significantly greater particulate fraction.

Copper is accordingly suggested to be an effective indicator for all heavy metals in urban runoff relative to aquatic life. It might be used as the focus for control evaluations, site specific bioassays, monitoring activities, and the like.

It should be noted that while immediate water column impacts of lead are not as significant as those for copper, the high particulate fraction of lead would tend to result in greater accumulations in the stream bed. This aspect has not been addressed by the NURP program in sufficient detail to warrant any comment on its potential significance.

The results of the screening analysis summarized by Figures 7-6 through 7-8 are approximate, because they are influenced by the suitability of the typical values for stream and runoff flows which were assigned. This however can be refined by the use of appropriate values which can be developed from readily available data bases, and thus adjusted for local variations which are to be expected. A second issue relative to the reliability of the projections is the validity of the computations, given that the input parameters are representative. This has been confirmed by a number of validation tests, discussed in the NURP supporting document referenced earlier, which addresses the stream analysis methodology.

The remaining issue for evaluating the reliability of the indications of problem potential produced by the screening analysis is the reasonableness of the intermittent exposure concentration levels, which have been associated with various biological effects levels, and the guidelines adopted for this discussion, which determine whether or not a problem is expected. While rather tenuous at this time, the information available does provide support.

Two of the NURP projects examined aquatic life effects in streams receiving runoff from monitored sites.

- Bellevue, WA concluded that whatever adverse effects were observed were attributable to habitat impacts (stream bed scour and deposition) as opposed to chemical toxicity. For this project, heavy metal concentrations in the monitored urban runoff sites were typical of the average for all urban sites. The screening analysis results under these conditions do not indicate the expectation of a problem.

- Tampa, FL conducted extensive bioassay tests but failed to show any adverse effect of water column concentrations of pollutants in urban runoff. The screening analysis results presented in Figure 7-6 indicate marginal problem conditions at low DAR for this geographic region. At this project however, all monitored sites show heavy metal concentrations significantly lower than the low range conditions used in the screening analysis. When

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the screening analysis is repeated using site concentrations representative of Tampa monitoring results, a problem situation is not predicted, even at DARs lower than is probably the case for this location.

LAKES

Because lakes provide extended residence times for pollutants, the significant time scale for evaluating urban runoff impacts is at least seasonal, and usually annual or longer, rather than the storm event scale used for streams. The screening methodology identified in Chapter 5, uses annual nutrient loads to assess the tendency for development of undesirable eutrophication effects.

Figure 7-9 illustrates the effect of urban runoff on average lake phosphorus concentration. The very significant influence of area ratio is evident. The larger the urban area which drains into a lake of a given size, the greater the annual loading, and the higher will be the lake phosphorus concentration and the eutrophication effects produced.

The phosphorus concentrations characteristic of the urban sites surrounding a particular lake are also seen to be significant. The three bands shown reflect the range of possibilities, based on the NURP data. The same basis is used to estimate the phosphorus loads from average urban sites and those at the higher and lower ends of site conditions, as was described for heavy metals in the previous section. In this case, because it is annual mass loads which are of interest, site median concentrations have been converted to site mean values for use in the computations.

Lake phosphorus concentrations are also influenced by the annual runoff volume (annual precipitation and runoff coefficient). The results illustrated are based on an annual rainfall of 30 inches and an overall average runoff coefficient of 0.2. Plotted results may be scaled up or down in proportion to the ratio between local values for these parameters and those used in the illustration.

Finally, the lake morphology and hydrology influence the outcome; specifically depth (H) and residence time (τ). This is reflected by the width of each of the bands, which are based on a range of values for H/τ (1 to 10) estimated to be fairly typical for lakes in urban settings.

If an average lake phosphorus concentration of 20 µg/l is used as a reference concentration to assess the tendency for producing undesirable levels of biostimulation, it is apparent that only lakes with rather small area ratios are likely to be unaffected by urban runoff nutrient discharges. Since the three bands represent different concentration levels of phosphorus in urban runoff, qualitative inferences may be drawn concerning the beneficial use impacts of control activities. More detailed estimates may of course be made by use of the methodology with site specific parameters.

The salient feature of the situation, as generalized by the analysis summarized by Figure 7-9, is that the problem potential of urban runoff for lakes is quite site specific. The illustration considers only urban runoff loads; in an actual situation, all nutrient sources (point and nonpoint)

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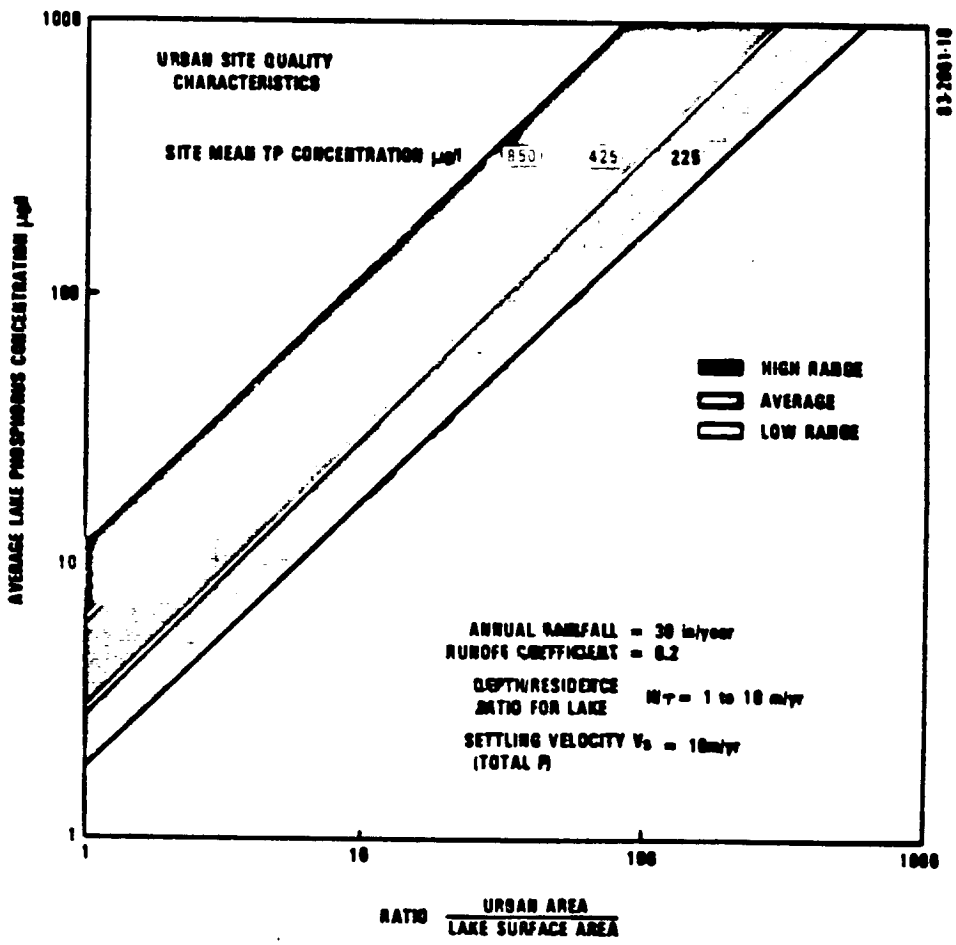

Figure 7-9. Effect of Urban Runoff on Lake Phosphorus Concentrations

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would be considered, and this would tend to modify the relative significance of urban runoff on lake conditions.

Several of the NURP projects addressed unpacts on lake quality in some depth. These projects include the following:

- Irondequoit Bay, NY - Lake has been highly eutrophic, due to point and nonpoint discharges. Sewage treatment plant and combined sewer overflow discharges have been removed, so that residual sources are recycle from lake sediments and nonpoint sources, including urban runoff, from the contributing drainage area. Further reductions are considered necessary to meet targets. (Area ratio is high at this location.)

- Lake George, NY - Lake is oligotrophic; the study addressed the concern that urban runoff from present and potential future development would unacceptably accelerate degradation of existing water quality. (Area ratio is low at this location.)

- Lake Quinsigamond, MA - Urban runoff was determined to be one of a number of sources preventing water quality objectives from being met. Some control of urban runoff phosphorus loads was recommended as one of the elements of an overall management plan.

Each of the above situations is sufficiently unique, and the mix of urban runoff and other load sources is sufficiently different to suggest that it is inappropriate to attempt a broad generalization. The interested reader may refer to the individual project documents which are available through NTIS for more information.

ESTUARIES AND EMBAYMENTS

These water bodies are normally of sufficient size and complexity that simple screening analyses have not been considered to be sufficiently useful or effective to justify their use.

The Long Island, NY NURP project examined and confirmed that urban runoff sources of coliform bacteria are the principal contributors to the water column concentrations that result in closure of shellfish beds in a number of embayments (principally the Great South Bay). Estimates of control activities that would allow the opening of presently closed areas were also made. The reader is referred to the project documents for further information.

The significance of urban runoff and other nonpoint source loads on eutrophic levels in the Potomac estuary is being investigated under a study which is not associated with the NURP program. However, among other objectives of the WASHCOG NURP project, estimates of urban nonpoint source loads have been developed to support this study.

Although specific situations where urban runoff is significant have been identified, no general assessment for water bodies of this type can be made at this time.

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GROUNDWATER AQUIFERS

Much of the precipitation which falls on an area either percolates directly into the ground, or does so after relatively short overland flow distances. This condition is essentially uncontrollable and distinctly different from the case where urban runoff from impervious areas is deliberately collected and routed to a recharge device which causes it to percolate to groundwaters.

This type of control approach is a practical and effective technique for reducing pollutant loads which would otherwise reach surface waters as discussed in Chapter 8. The concern addressed here is with the extent to which groundwater aquifers may be contaminated by this practice.

The Long Island, NY and Fresno, CA NURP projects examined this issue through extensive tests utilizing recharge basins ranging from recent installations to others which have been in service in excess of 20 years. A somewhat simplified consolidation of the salient findings of these two projects is presented below. The interested reader is referred to the individual project report documents, available through NTIS, for the important details and qualifications.

- Most pollutants of importance in urban runoff are intercepted during the process of infiltration and quite effectively prevented from reaching the groundwater aquifers underlying recharge basins. The pollutants tested and found to behave in this manner include the heavy metals, an appreciable number of the organic priority pollutants and pesticides, and coliform bacteria.

- Chlorides, which are sometimes present in urban runoff at elevated concentrations due to road deicing practices, are not attenuated during recharge.

- Pollutants accumulate in the upper soil layers. The concentrations found are a function of the length of time a basin has been in service. Effective retention of pollutants takes place with all soil types tested, ranging from clays to sands. The depth of pollutant penetration is affected by soil type; however in no case did contaminant enrichment of soil exceed several meters depth, and highest concentrations were found near the surface.

- The limit of the ability of the soil to retain the pollutants of interest is unknown. Additional study of this aspect is appropriate. However given the long service periods of a number of the recharge basins studied, this does not appear to represent an imminent concern.

- At both of these NURP locations, groundwater surfaces were at least 20 feet, and often appreciably more, below the base of the recharge device. The indicated findings may not be applicable at locations with shallow depths to groundwater.

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- No significant differences in interception/retention of pollutants is apparent for basins with bare versus vegetated recharge surfaces. However vegetation does apparently help to maintain infiltration rates normal for the soil type.

- Surface soil accumulations of priority pollutants in dual purpose installations used for both recharge and recreational use warrants further investigation to determine whether such practice creates unacceptable health risks.

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CHAPTER 8
URBAN RUNOFF CONTROLS

INTRODUCTION

This chapter summarizes the information developed by the individual NURP project studies relating to performance characteristics of selected techniques for the control of urban runoff quality. The number of control practices addressed here is considerably smaller than the array of best management practices suggested in prior studies and publications. This is not intended to exclude consideration of other approaches. However, the techniques discussed in this chapter may be taken as an expression of controls considered by the agencies involved to be potentially attractive and practicable at localized planning levels. They represent the practices for which performance data were obtained under the NURP program and which can be analyzed and evaluated in this report.

Most of the NURP projects provide in their project reports a detailed analysis and evaluation of the controls that were studied. These reports are available through NTIS. In addition to this information source, an analysis was performed by EPAs NURP headquarters team, using results available from all project studies. The objective was to provide an overview and a generic description of performance characteristics in a format considered to be useful for planning activities. Thus, in addition to providing a consolidated summary of project results, this chapter presents a summary of the results of applying analysis methodologies developed under the NURP program. Further detail on the former can be obtained by reference to relevant project report documents; a more comprehensive development of the latter is provided in separate NURP documents ("Detention and Recharge Basins for Control of Urban Runoff Quality", and "Street Sweeping for Control or Urban Runoff Quality").

The types of control techniques which received attention (to a greater or lesser degree) in the NURP program can be grouped into four general categories.

- Detention Devices - These include normally dry detention basins typically designed for runoff quantity control, normally wet detention basins, dual purpose basins, over-sized drain pipes, and catchbasins.

- Recharge Devices - These include infiltration pits, trenches, and ponds; open-bottom galleries and catchbasins; and porous pavements.

- Housekeeping Practices - These are principally street sweeping, but also include sidewalk cleaning, litter containers, catchbasin cleaning, etc.

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- Other - These include the so-called "living filter" approaches, grassed swales, wetlands, etc.

DETENTION DEVICES

General

Detention basins proved to be one of the most popular approaches to urban runoff quality control selected at the local level, based on the number of individual projects which elected to study them and the number of detention devices tested in the study. It is perhaps instructive to note that nearly all the detention facilities studied were either already in place, or required only modifications of outlet structures before initiation of the NURP-supported studies. In general, detention devices proved to provide a highly effective approach to control of urban runoff quality, although the design concept has a significant bearing on performance characteristics.

Table 8-1 lists the NURP projects that included detention devices as elements of their study program. Both the number of devices, and the number of storms analyzed vary considerably, as indicated in Table 8-1, depending on project priorities and other relevant activities. As a result, not all of the sites are incorporated in the summary presented below. The Washington Area Council of Governments (WASHCOG) conducted a particularly thorough and comprehensive investigation of control techniques, particularly detention basins. They have prepared several useful and informative analyses of performance results on these devices.

Dry Basins

This is a type of detention basin which is currently in fairly extensive service in various parts of the country. The performance objective of such basins is commonly called "peak shaving", that is, to limit the maximum rate of runoff to some preselected magnitude, usually a maximum pre-development rate. The purpose is to control flooding and erosion potential in areas downstream of new development. Such basins employ a bottom outlet having a hydraulic capacity restricted to the maximum allowable flow. Runoff from smaller storms flows along the bottom of the basin and is discharged without restriction. Flows in excess of design are backed up in the basin temporarily and ponding occurs only during larger storms and for relatively short periods of time. This class of retention basin is thus normally dry.

Performance of such basins, from a pollutant removal aspect, range from insignificant to quite poor. Accordingly, the limited data available are not discussed in this chapter.

Wet Basins

This designation covers detention basins which maintain a permanent pool of water. They may vary considerably in appearance, ranging from natural ponds or small lakes dedicated urban runoff control to enlarged sections in

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TABLE 8-1. DETENTION BASINS MONITORED BY NURP STUDIES

Project	Site	Design Type	No. Events in/out
CO1 Denver	North Ave	Dry Basin	39/21
DC1 Washington, D.C.	Burke	Wet Basin	60/35
	Lakeridge	Dry Basin	49/41
	Stedwick	Dual-Purpose	48/34
	Westleigh	Wet Basin	41/45
IL2 N. Illinois	Lake Ellyn	Wet Basin	29/23
MI1 Lansing	Dryer Farms	Dry Basin	2/8
	Grace St. N*	Wet Basin	23/21
	Grace St. S*	Wet Basin	20/22
	Waverly Hills	Wet Basin	35/30
MI3 Ann Arbor	Pitt-AA	Wet Basin	6/6
	Traver	Wet Basin	5/5
	Swift Run	Wet Basin	5/5
NY1 Long Island	Unqua Pond	Wet Basin	8/8

* These are oversized storm drains installed below street level. Inverts of control sections are below the general grade line, so a permanent pool is maintained.

constructed drainage systems. Runoff from an individual storm displaces all or part of the prior volume, and the residual is retained until the next storm event. This pattern may or may not be modified by natural base inflows during dry weather depending on the local situation.

Detention basins utilizing this design concept have been shown by the NURP studies to be capable of highly effective performance in urban runoff applications, as summarized below. Although performance characteristics of individual basins ranged from poor to excellent, analysis shows these differences to be attributable to the size of the basin relative to the connected urban area and local storm characteristics. Performance data also indicate that in addition to removal of particulate forms or pollutants by sedimentation, some basins exhibit substantial reductions in soluble nutrients (soluble phosphorus, nitrate + nitrite nitrogen). This is attributed to biological processes which are permitted to proceed in the permanent water pool.

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There are a number of ways to characterize detention basin performance. The primary basis selected by NURP for doing so is to define performance efficiency on the basis of the total pollutant mass removed over all storms. This provides a meaningful general measure for comparison, is relevant for water quality effects associated with extended time scales (e.g., nutrient load impacts on lakes), and conforms with the capabilities of the NURP analysis methodology developed to provide a planning-level basis for estimating cost/benefit differences in size or application density of this type control.

Table 8-2 tabulates performance in terms of reduction in pollutant mass loads over all monitored storm events. The analysis methodology developed under the NURP program activities suggests that performance should be expected to improve as the overflow rate (QR/A = mean runoff rate ÷ basin surface area) decreases and as the volume ratio (VB/VR = basin volume ÷ mean runoff volume) increases. The NURP basins used in the analysis are listed in increasing order of expected performance capabilities.

The wide range of relative basin sizes provided by this data base is apparent, and performance is seen to generally correspond with expectations. The poorest performance occurs in a basin with an average overflow rate during the mean storm of about six times the median settling velocity (1.5 ft/hr) of particles in urban runoff. In addition, less than 5 percent of the mean storm runoff volume remains in this basin following the event, to be susceptible to additional removal by quiescent settling during the interval between storms. The basins which exhibit high removal efficiencies, at the other end of the scale, have size relationships which result in the mean storm displacing only about 10 percent of the available volume, and producing overflow rates which are only a small fraction of the median particle settling velocity.

This rationale is described more completely in the supporting NURP document on detention basins identified earlier. The testing of the methodology against the NURP monitoring data is presented, and the basis for the performance projections illustrated below is documented.

Figure 8-1 presents a projection of removal efficiency of urban runoff detention devices as a function of basin size relative to the contributing catchment area and regional differences in typical rainfall patterns. The removal rates apply for TSS, which are all settleable, and must be factored by the particulate/soluble fraction of other pollutants which have significant soluble fractions in urban runoff. It applies for the specific basin average depth and area runoff coefficient indicated (which are fairly typical based on NURP data). However performance relationships could be different than indicated based on relevant local values for the controlling parameters.

An alternate approach for characterizing performance of detention basins concentrates on the variable characteristics of individual storm events and how these are modified by the detention device. A comparison of the mean and coefficient of variation of basin inflow and discharge concentrations provides another measure of performance of an urban runoff detention device.

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TABLE 8-2. OBSERVED PERFORMANCE OF WET DETENTION BASINS
REDUCTION IN PERCENT OVERALL MASS LOAD

Project and Site	No. of Storms	Size Ratios		Average Mass Removals - All Monitored Storms (Percent)									
		QR/A	VB/VR	TSS	BOD	COD	TP	Sol.P	TKN	NO_{2+3}	T.Cu	T.Pb	T.Zn
Lansing Grace St. N.	18	8.75	0.05	(-)	14	(-)	(-)	(-)	(-)	(-)	(-)	9	(-)
Lansing Grace St. S.	18	2.37	0.17	32	3	(-)	12	23	7	1	(-)	26	(-)
Ann Arbor Pitt-AA	6	1.86	0.52	32	21	23	18	(-)	14	7	•	62	13
Ann Arbor Traver	5	0.30	1.16	5	(-)	15	34	56	20	27	•	•	5
Ann Arbor Swift Run	5	0.20	1.02	85	4	2	3	29	19	80	•	82	(-)
Long Island Unqua	8	0.08	3.07	60	(TOC=7)		45	•	(-)	(-)	•	80	•
Washington, D.C. Westleigh	32	0.05	5.31	81	•	35	54	71	27	•	•	•	26
Lansing Waverly Hills	29	0.04	7.57	91	69	69	79	70	60	66	57	95	71
NIPC Lake Ellyn	23	0.10	10.70	84	•	•	34	•	•	•	71	78	71

Notes: (-) Indicates apparent negative removals.

• Indicates pollutant was not monitored.

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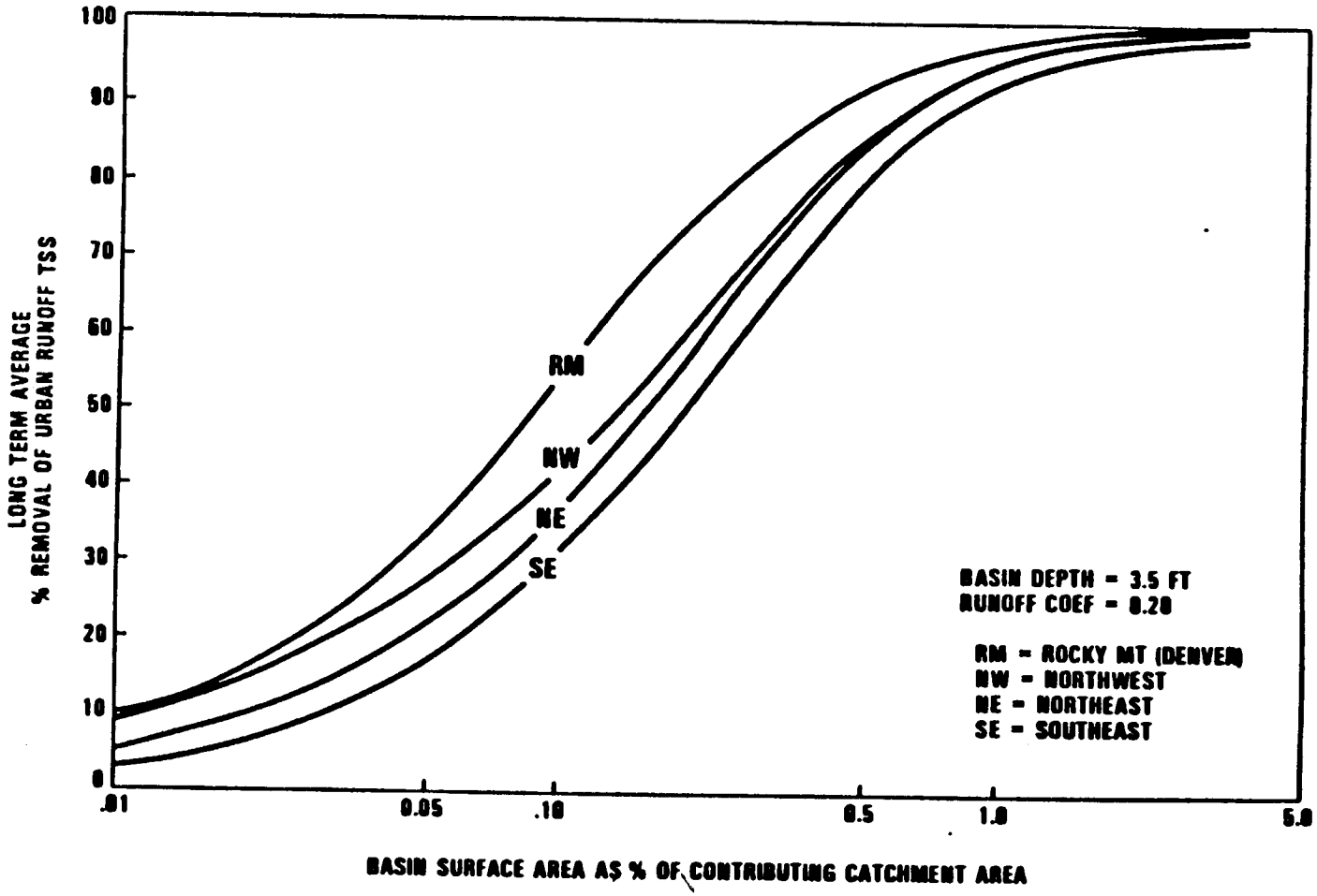

Figure 8-1. Regional Differences in Detention Basin Performance

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This approach provides more useful information for subsequently evaluating the effect of controls on water quality impacts on rivers and streams. As evident from the discussion in Chapter 6, reductions in the mean and variability of runoff concentrations (and the inferred reduction in mean and variability of runoff rates) will have a significant beneficial effect on the severity of impacts on flowing streams.

Table 8-3 summarizes detention basin performance when assessed in this manner. It should be noted that in most cases more inlet storm events were monitored than discharge events, and that some inlet events do not have a matching discharge event and vice-versa. Further, for the larger basins where storm inflow displaces only a fraction of the basin volume, it is unlikely that influent and effluent for a specific event represent the same volume of water. The tacit assumption in this analysis is that the inflow events which were monitored provide a representative sample of the total population of all influent event mean concentrations (EMCs). Similarly, the monitored effluent events are assumed to be a representative sample of all basin discharge EMCs. The appropriateness of this assumption is obviously more uncertain where the number of individual storm events monitored is small.

For each basin influent and effluent, the arithmetic mean and variance were computed based on the relationships for lognormal distributions. The percent reduction in the mean concentration and the coefficient of variation are tabulated (Table 8-3). Note that where the number of monitored events shown in this table differ from those listed in Table 8-2, it is because the mass removal computations were restricted to synoptic storms (i.e., matching influent and effluent results were available for an event).

Performance characteristics are generally consistent using either approach, even though each displays a different type of information. Performance improves with detention basin size relative to catchment size and hence the magnitude of the runoff processed. Giving greater weight to the sites monitoring large numbers of storms, indications are that for most pollutants wet ponds also generally result in a considerable reduction in the variability of pollutant concentrations.

A significant exception to this tendency to reduce variability is shown for the soluble nitrogen forms (NO_2 + NO_3). The positive removal efficiency indicated by reduction of mean concentrations must be attributed to biological processes rather than sedimentation. A substantial increase in variability is consistently indicated by the data. Among the heavy metals, lead which is nearly all in particulate form shows significant reductions in variability. Copper and zinc which have high (40 to 60 percent) soluble fractions show an ambiguous pattern with regard to changes in variability.

In a few of the cases where atypical results are indicated, unique local conditions suggest plausible explanations. For example, at the Ann Arbor (Traver) site, erosion from an unstabilized bank at the outlet of this newly constructed basin is attributed to the poor suspended solids removal observed. The poor removal characteristics at the Unqua site for TKN and nitrate may be associated with the significant wildfowl population at this site.

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TABLE 8-3. OBSERVED PERFORMANCE OF WET DETENTION BASINS
(PERCENT REDUCTION IN POLLUTANT CONCENTRATIONS)

(a) Mean EMC

Project and Site	No. of Storms (1)	Percent Reduction in Mean EMC									
		TSS	BOD	COD	TP	Sol.P	TKN	NO_{2+3}	T.Cu	T.Pb	T.Zn
Lansing Grace St. N.	23/20	(6)	(26)	15	(10)	(26)	11	(1)	(9)	39	(9)
Lansing Grace St. S.	18/17	22	4	(3)	6	0	(5)	(20)	25	14	7
Ann Arbor Pitt-AA	6/6	38	17	23	28	(2)	11	8	•	59	22
Ann Arbor Traver	5/5	0	(66)	12	37	63	19	28	•	•	19
Ann Arbor Swift Run	5/5	83	11	(3)	(38)	21	25	77	•	86	•
Long Island Unqua	8/8	34	(TOC=26)		38	•	(31)	(10)	•	78	•
Washington, D.C. Westleigh	40/40	83	•	33	59	70	19	28	10	•	10
Lansing Waverly Hills	35/30	87	52	52	69	56	30	54	53	93	58
RIPC Lake Ellyn	25/20	92	•	64	61	62	•	82	88	91	87

(b) Coefficient of Variation of EMCs

Project and Site	No. of Storms (1)	Percent Reduction in Coef of Variation of EMCs									
		TSS	BOD	COD	TP	Sol.P	TKN	NO_{2+3}	T.Cu	T.Pb	T.Zn
Lansing Grace St. N.	23/20	14	49	35	(7)	(13)	30	0	0	45	(31)
Lansing Grace St. S.	18/17	(7)	(59)	39	13	0	20	21	17	18	15
Ann Arbor Pitt-AA	6/6	17	(6)	10	28	(84)	37	0	•	53	(5)
Ann Arbor Traver	5/5	14	(109)	58	(3)	42	(150)	(82)	•	•	0
Ann Arbor Swift Run	5/5	(5)	39	50	(150)	0	20	(150)	•	28	•
Long Island Unqua	8/8	(87)	(TOC=66)		47	•	19	(66)	•	68	•
Washington, D.C. Westleigh	40/40	46	•	(26)	15	20	41	(280)	0	•	(14)
Lansing Waverly Hills	35/30	38	5	69	34	26	(8)	(198)	(22)	34	(36)
RIPC Lake Ellyn	25/20	44	•	41	71	48	•	(115)	60	19	41

Notes: (1) In/Out; numbers are approximate, and vary with pollutant. Removals in parentheses indicate negative removal.

Dot (•) indicates pollutant either not monitored or number of observations is too small for reliable estimate of percent reduction.

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The ability of detention basins to reduce coliform bacteria concentrations is also of considerable interest because of the significant impact these urban runoff contaminants exert on recreational or shellfish harvesting beneficial uses. Other than at the Unqua site of the Long Island NURP project, the number of observations made for indicator bacteria were too few to support a reliable assessment of the ability of detention basins to effect quality improvements. However, extensive data of this nature were secured on detention basin influent and effluent during all monitored storms at the Unqua site.

Since coliform bacteria have a high rate of die-off in natural waters, performance characteristics based on total mass reductions are not particularly meaningful. The Unqua site data were analyzed to evaluate performance in terms of reductions in concentration levels. Over eight monitored storms at this site, covering a wide range in storm size, the mean EMC (MPN/100 ml) was reduced by 94 percent for total coliform, 91 percent for fecal coliform, and 95 percent for fecal streptococcus bacteria. Variability of bacteria concentrations in the pond outlet increased, with effluent coefficients of variation ranging from about 10 to 100 percent greater than influents. Accordingly, detention basins employing permanent pools (wet ponds) are indicated to be capable of substantial reductions in indicator bacteria.

Dual Purpose Basins

In the absence of a well defined terminology, we have adopted this designation to define basins that are normally dry, and hence retain their full potential for flood control, but which have outlet designs that result in a slow release rate for detained storm flows. Detention time is extended considerably compared with that provided by dry basins employing conventional outlet designs.

One of the detention basins examined by the WASHCOG NURP project, was of this type. This project designates such designs as "Extended Detention Dry Ponds." The pond was converted from a conventional dry pond by replacing the outlet pipe with a perforated riser enclosed in a gravel jacket. The modification was designed to detain stormwater runoff for up to 24 hours, instead of the 1 to 2 hours typically observed in conventional dry ponds.

For undetermined reasons, average detention periods during the study were in the order of 4 to 8 hours, and hence considerably shorter than the design objective. Nevertheless, based on monitoring of more than 30 storm events, the removal of particulate forms of urban pollutants was typically high and comparable to the performance efficiency of wet ponds.

Observed removals for this site (Stedwick) are summarized by Table 8-4, showing percent reductions in both mass and concentration distributions. The principal differences in performance of dual purpose basins compared with wet basins are suggested by the available data to consist of the following:

- Soluble pollutants (e.g., soluble P and Nitrate/Nitrite) are not effectively reduced because of the absence of a permanent pool within which biological reactions have an opportunity to occur in addition to sedimentation.

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TABLE 8-4. PERFORMANCE CHARACTERISTICS OF A DUAL-PURPOSE DETENTION DEVICE

(Stedwick Site - Washington Area NURP Project)

Pollutant	Percent Reduction In		
	Pollutant Mass Load Over All Monitored Storms	Pollutant EMC's Mean	Pollutant EMC's Coef Var
TSS	64	63	(31)
COD	30	41	17
Total P	< 15	11	0
Sol P	1	(4)	(13)
TKN	•	8	(11)
Organic N	30	•	•
NO_{2+3}	10	13	6
T. Cu	•	•	•
T. Pb	84	•	•
T. Zn	57	43	33

- The variability of pollutant EMC's does not appear to be modified to the extent that this occurs in wet ponds.

Although the performance characteristics of basins of this type are indicated to be somewhat inferior to the potential offered by wet ponds, there are a number of considerations which make dual purpose basins highly attractive candidates for quality control of urban runoff. These include the fact that flood control requirements are likely to be more economically obtained than with wet basins and that many existing stormwater management basins may be readily modified to significantly enhance their capability for improving the quality of urban runoff. In areas where ordinances requiring conventional stormwater management ponds are already in existence, the only changes required would be an alternate specification of the outlet design.

Costs

The information presented here is intended to provide an order of magnitude estimate of the cost of providing different levels of control of urban runoff pollutant discharges, when wet detention devices are used as the best management practice (BMP). The summary is based on the size versus performance relationship presented earlier in Figure 8-1 and on the size versus cost relationships presented below.

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The analysis is based on cost information developed by the WASHCOG NURP project and discussed in detail in one of their project reports produced for the NURP effort. Construction cost estimates as a function of basin volume are shown by Figure 8-2, adopted from this source. This estimate compares quite favorably with a similar cost/size relationship developed previously by the Soil Conservation Service (SCS).

The cost relationship shown by this figure applies to "dry pond" designs and relates only to expected cost of construction activities. For specific cost estimates, the results derived from Figure 8-2 should be modified as appropriate, in accordance with the following:

- The highly variable capital cost of land acquisition is not included in the construction costs.

- Outlet modifications to provide a dual purpose basin design will increase construction costs by about 10 to 12 percent.

- Pond designs which meet the peak shaving requirements of conventional (dry) pond designs, but also provide a permanent pool of water may have costs up to 40 percent greater than indicated by the cost relationship shown by Figure 8-2.

- An additional allowance equal to 25 percent of construction costs is suggested to allow for planning, design, administration, and construction related contingencies.

- Operation and maintenance costs are estimated to involve an annual expenditure of approximately 3 to 5 percent of base construction cost, that is, before application of the 25 percent factor for design, planning, and administration. The total is composed of two elements: 2 to 3 percent of construction cost estimates the annual cost of routine maintenance and upkeep; an additional 1 to 2 percent of construction cost estimates the annualized cost of sediment removal operations for a 10 year clean-out cycle.

Planning agencies often distinguish between "on-site" controls, which are applied to relatively small urban catchments, often installed by the developer of an urban property, and "off-site" controls, which involve larger basins and serve substantially larger urban drainage areas. Because of the appreciable economy of scale inherent in the cost relationship defined by Figure 8-2, this factor must be taken into account in developing cost/performance summaries for urban runoff quality control using detention basins. Accordingly, the control costs presented below for wet basin designs indicate the differences based on the size of the urban catchment the basin is designed to serve.

Figure 8-3 presents a planning level approximation of both present value and annual cost of wet detention basins. Amoritization of costs is based on a 20 year basin life and an interest rate of 10 percent.

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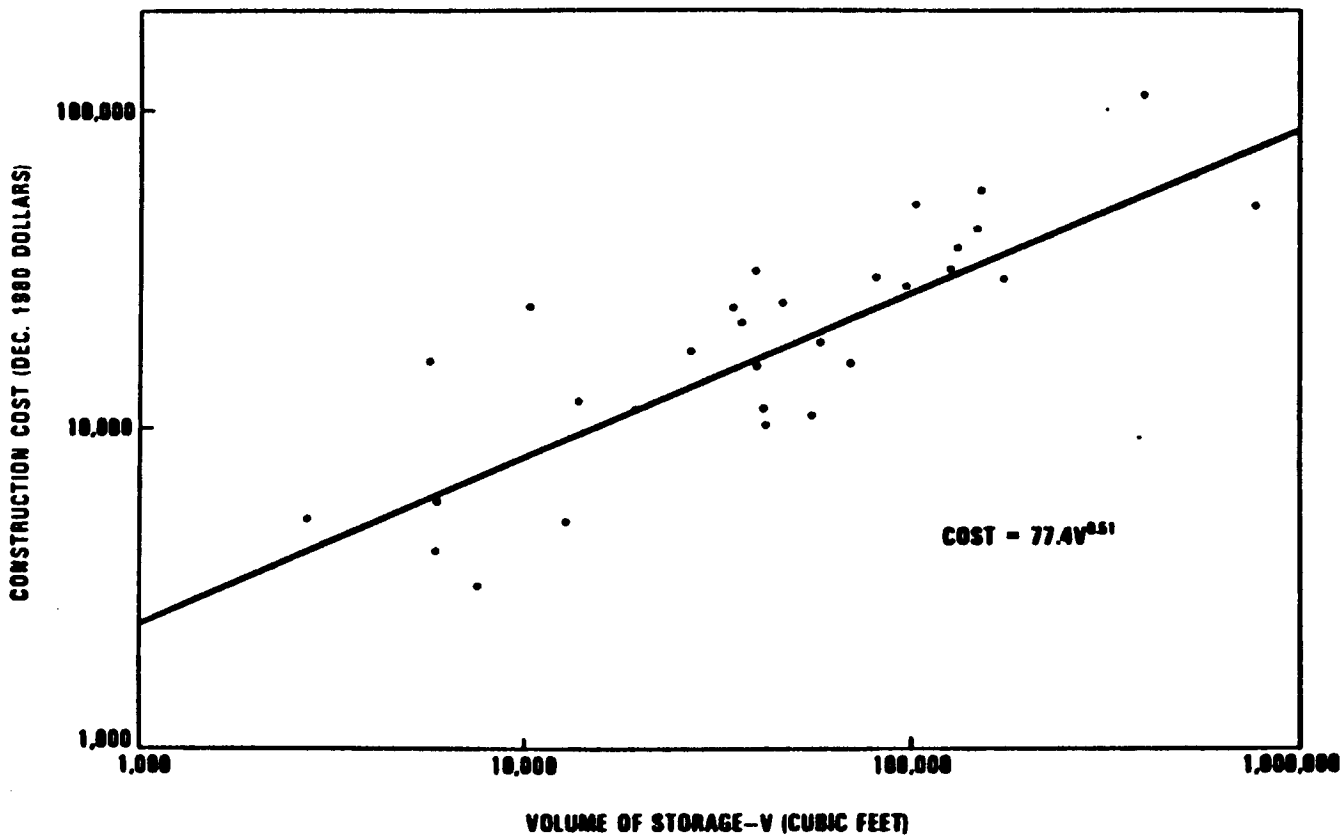

Figure 8-2. Average Stormwater Management (Dry) Pond Construction Cost Estimates Vs. Volume of Storage

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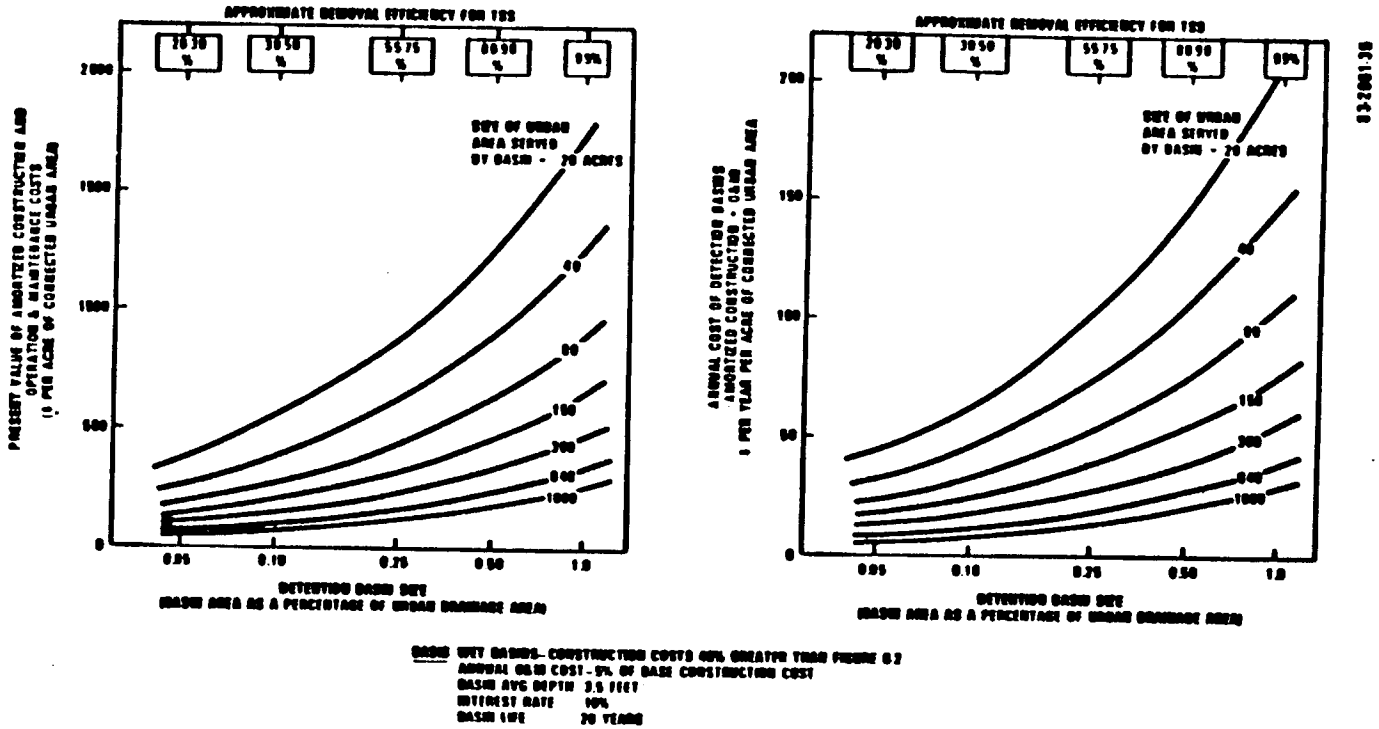

Figure 8-3. Cost of Urban Runoff Control Using Wet Detention Basins

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The performance levels associated with a particular basin size are shown at the top of the plots as a range for long-term average removal efficiencies for TSS. The range associated with a particular size reflects the regional differences in performance which can be expected (Figure 8-1) as a result of regional differences in storm characteristics. Approximate removal efficiencies for pollutants other than TSS can be estimated by factoring the indicated TSS removal by the particulate fraction of the pollutant of interest. The supplementary NURP document dealing with detention basins provides information to permit further refinement. A more concise local summary of cost/performance relationships can be developed using the NURP data and analysis methods, if local rainfall and land use characteristics, and design and planning preferences are utilized.

The generalized relationships shown by Figure 8-3 can be summarized as follows, if an urban catchment size of 20 to 40 acres is taken to represent a typical "on-site" control application, and an "off-site" application is reflected by detention basins serving 640 to 1000 acres.

Control Application	Approximate Level of Control (% TSS Reduction)	Cost Per Acre of Urban Area (Approximate)	
		Present Value	Annual Cost
On-site	50	$500 - $700	$60 - $80
	90	$1000 - $1500	$125 - $175
Off-site	50	$100	$10
	90	$250	$25

RECHARGE DEVICES

Control measures which enhance the infiltration of urban runoff are indicated by the NURP studies to be techniques which are practical to apply and capable of effective reductions in urban runoff quantity and quality. This finding is based on project reports and on the results of a screening analysis using a probabilistic methodology described in a supplementary NURP document on detention basins.

The issue of the potential contamination of groundwater aquifers due to enhanced infiltration of urban storm runoff has been discussed in the previous chapter dealing with receiving water impacts. The favorable findings support further consideration of this technique. At the same time, it must be emphasized that specific local conditions may make recharge inappropriate. Such conditions can include steep slopes, soil conditions, depth to groundwater, and the proximity of water supply wells. Sound planning and engineering judgement must be applied to determine the acceptability of this control approach in a local situation.

However, where local conditions premit, a wide variety of design concepts are available for use. These range from off-site applications consisting of

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large retention basins, to small individual on-site units which include infiltration pits and trenches, percolating catch basins, and porous pavement. The operating principle is the same regardless of size or design concept. The important elements are the surface area provided for sub-surface percolation and the storage volume of the device. Overall performance will be related to the size of the recharge device relative to the urban catchment it serves and the permeability (infiltration rate) of the soil.

The context in which the performance capabilities of recharge devices are evaluated is the extent to which urban runoff is "captured" and prevented from discharging directly to surface waters. Pollutant removals are reduced in direct proportion to the runoff volume which is intercepted and recharged. Load reductions will be further enhanced if quality improvements occur in the portion of the runoff which is not captured. The combination of soil infiltration rate and percolating area provided determines the "treatment rate" of a specific recharge device. When storm runoff is applied to the device at rates of flow equal to or less than this rate, 100 percent of the runoff is captured during that event. At higher applied rates, the fraction of the runoff flow in excess of the treatment rate will escape and discharge to surface waters.

Most recharge devices other than porous pavement also provide storage volume. This improves performance capability because portions of the excess runoff can be retained for subsequent percolation when applied rates subside. Overflow to surface water occurs only when the available storage is exceeded.

The Long Island and Metropolitan Washington, D.C. (WASHCOG) NURP projects examined the performance of on-site recharge devices. An interconnected system of percolating catch basins in Long Island was estimated to reduce surface water discharges of storm runoff by more than 99 percent. The WASHCOG project found that a porous pavement site produced pollutant load reductions on the order of 85 to 95 percent depending on the specific pollutant considered. An infiltration trench studied by this project produced reductions in the order of 50 percent.

The NURP analysis methodology was employed in a screening analysis to assist planning evaluations by establishing the relationship between performance level and device size and soil percolation rates. Figure 8-4 presents a planning level estimate of the influence of size, soil characteristics, and regional rainfall differences on the performance of recharge devices.

The upper plot illustrates the significant effect regional differences in rainfall characteristics can have on the performance of identical recharge devices. Basin depth, soil percolation rate, and runoff coefficient for the urban catchment are the same for each case. The performance differences result from differences in the intensity and volume of the average storms in each region. Basin size is represented on the horizontal axis by expressing the percolation area that is provided as a percentage of the area of the contributing urban catchment. For example, a recharge device with a percolating surface area equal to 0.10 percent of an urban catchment represents a design which provides (43,560 sq ft/acre x 0.10/100% =) 43.5 square feet of

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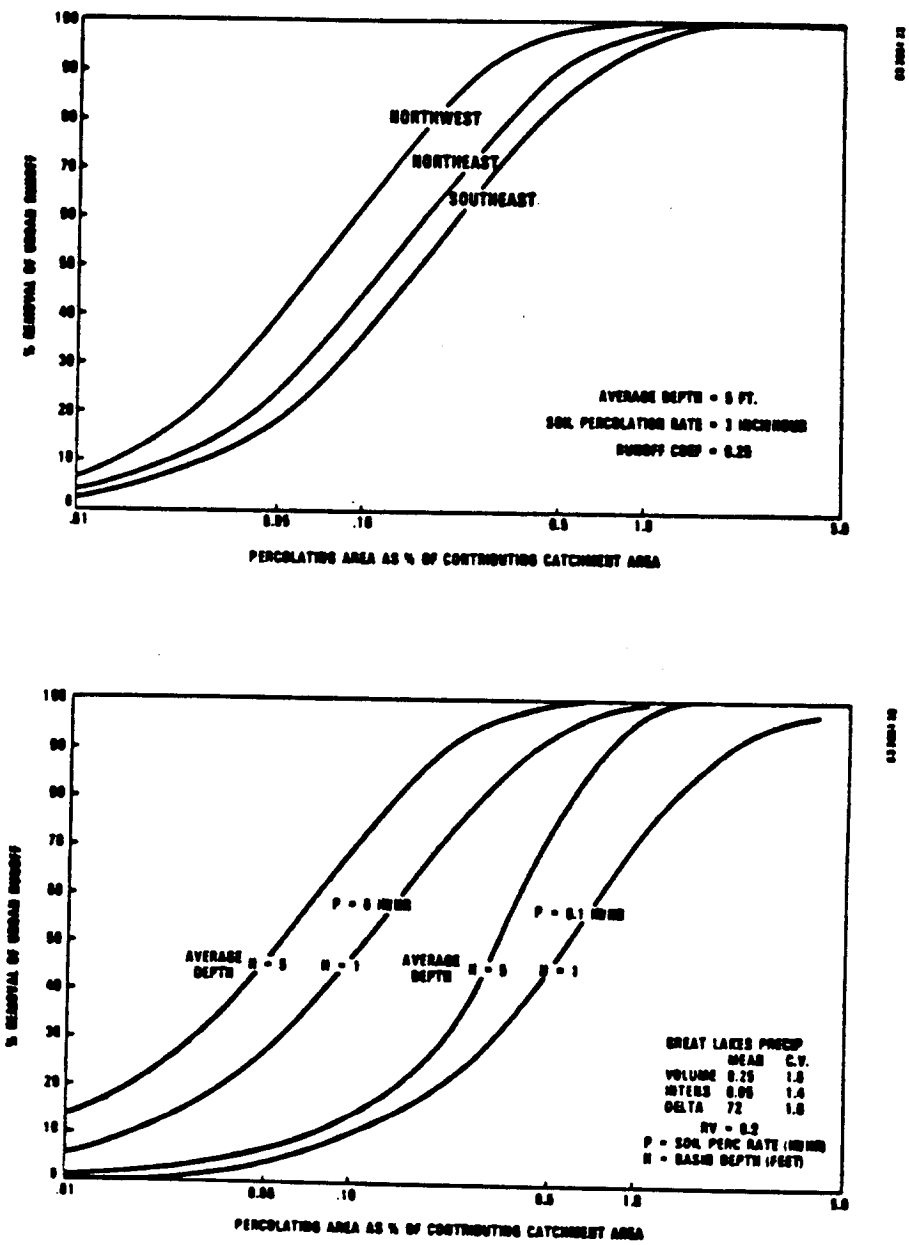

Figure 8-4. Long Term Average Performance of Recharge Devices

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percolating surface area for each acre of urban catchment it serves. The long-term average reductions in urban runoff volume and pollutant load which can be expected will be approximately 35 percent in the southeast, 45 percent in the northeast and 65 percent in the Pacific northwest.

The lower plot illustrates the much more significant influence of the amount of storage volume provided (incidated by basin average depth), and the permeability of the soil through which the storm runoff must percolate. The rainfall characteristics used in this analysis are typical of the Great Lakes region of the United States and are roughly comparable to those in the northeastern part of the country. As might be expected, the permeability of the soil in which the recharge device is constructed has a dominant influence on performance capability. However significant compensation for low percolation rates can be achieved by increases in percolation area and storage volume.

When the screening analysis results are considered along with the favorable results from the NURP studies, the NURP findings indicate that with a reasonable degree of design flexibility to compensate for soils with lower percolation rates, recharge devices provide a very effective method for control of urban runoff.

STREET SWEEPING

End-of-pipe urban runoff pollutant concentrations have been commonly viewed as being a function of two prime factors -- accumulation of contaminants on street surfaces and rainfall/runoff washoff. The postulated beneficial effect of street sweeping was to reduce contaminant accumulation. Prior to NURP, emphasis of street sweeping investigations was placed on street surface mechanisms (e.g., accumulation and washoff) and sweeper equipment performance in removing street dirt. While these studies provided valuable insights into the possible benefits of street sweeping, measurements of end-of-pipe concentrations are the only direct measures of street sweeping effectiveness in water quality terms.

Recognizing this, NURP was designed to provide a large data base of urban runoff water quality concentrations for both swept and unswept conditions. In addition, the NURP street sweeping projects gathered and evaluated data on atmospheric deposition (i.e., wetfall and dryfall), street surface accumulation and washoff, and street sweeper removal rates and costs. The individual project reports look at these other issues, and the results are not repeated herein. Of prime interest and provided below is the effectiveness of street sweeping in reducing end-of-pipe urban runoff pollutant concentrations (and ultimately receiving water impacts). The findings presented below are based upon the analyses performed by the individual projects, as well as other statistical techniques, and are generally consistent with the projects' conclusions.

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Five of the 28 NURP prototype projects had the evaluation of street sweeping as a central element of their work plans. These projects were as follows:

Project	Number of Sites
Castro Valley, CA	1
Milwaukee, WI	8
Champaign-Urbana, IL	4
Winston-Salem, NC	2
Bellevue, WA	2

Long Island, NY and Baltimore, MD also collected limited street sweeping data. The experimental designs of the projects varied in detail, but essentially followed either a paired basin or serial basin approach to gather test and control data, with some projects using both approaches. The general concept was that during a test period street sweeping would be more intensive (up to daily) and thorough (e.g., with operator training, parking bans, etc.) than during control periods when the streets were to be swept as usual or not at all.

In the paired basin approach, two adjacent or close-by basins were operated in a "control" or unswept mode for certain periods of time to establish a baseline comparison, and then street sweeping was performed in a "test" basin while the other remained as a control. The data provided an overall comparison between basins as well as a series of synoptic events for both basins. In the serial approach, a basin was periodically operated in either a control or test mode, with the periods adjusted so that all seasons of the year were represented in each mode. Here, rather than synoptic data pairs, one has data strings for both "swept" and "unswept" conditions.

There are no well established or prescribed procedures for evaluating the possible reduction in runoff concentrations due to street sweeping. Issues of concern include storm size and intensity effects, time since last rain, ability to select truly paired basins, seasonal effects, etc. In an attempt to sort out these issues, an exploratory data analysis was performed, and the following findings were established:

- Street sweeping has not been found to change the basic probability distribution of event mean concentrations. That is, the fundamental assumption of random, lognormal behavior is valid during sweeping operations.

- The runoff quality characteristics of a basin during swept or unswept conditions is best measured by the maximum likelihood estimator of the median EMC, with the uncertainty indicated by the 90 percent confidence interval of the median.

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- There is in most cases no significant correlation (and in a few cases a weak negative correlation) between EMCs and storm runoff volume. EMCs and storm runoff intensities are also generally uncorrelated (but in isolated cases exhibit a weak positive correlation). The implication of these findings is that differences in concentrations between swept and unswept conditions will be largely unaffected by the size of the storms during the monitoring periods. Because of this independence between concentration and volume, effects of sweeping on EMCs will also indicate effects on mass pollutant loads.

- EMCs for synoptic events on paired basins are, in general, not significantly correlated or in some cases are weakly correlated; however, over the longer term (e.g., mean, frequency distribution, etc.), there are no significant differences between the distribution of EMCs of paired basins. These results show that basins are independent from storm to storm, and thus, comparisons between basins should not be attempted using synoptic events, but the basins do have similar statistical properties and thus can be considered paired.

To evaluate the effectiveness of street sweeping, a series of bivariate plots were constructed for projects using the serial basin approach. The site median EMCs for swept and unswept conditions form the data pairs of the plots. Bivariate plots are presented in Figure 8-5 for TSS, COD, TP, TKN, and Pb concentrations, respectively. Each plot contains swept or unswept conditions for multiple project sites. The assumption of the analysis is that a large enough data base was collected to negate any temporal effects such as seasonal, land use conditions, parking patterns, and other possible factors (as noted earlier, storm volume and intensity effects are not believed to be significant). Examining the bivariate plots, it is observed that, for the NURP data, the median concentrations are as likely to be increased as decreased by street sweeping. Further, street sweeping never produced a dramatic (e.g., >50 percent) reduction in concentrations (or loads).

Street sweeping performance, as measured by the percent change in the site median EMC, for selected NURP sites is graphically displayed in Figure 8-6. The results are for five constituents (TSS, COD, TP, TKN, and Pb) at 10 sites nationwide). For each site, the median EMC is based on data from between 10 and 60 events, with 30 events typical. Based on Figure 8-6 a number of important observations are evident.

- Performance as measured by change in site median EMC is highly variable.

- Where reductions occur, they generally occur for all constituents.

- Reductions never exceed 50 percent.

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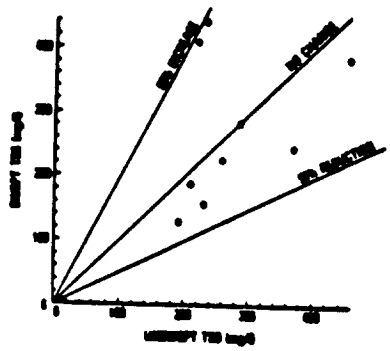
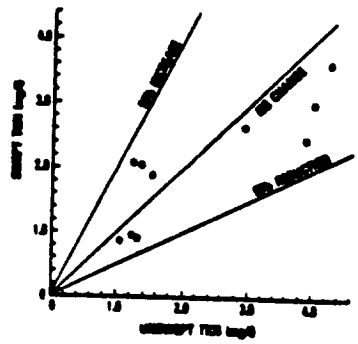
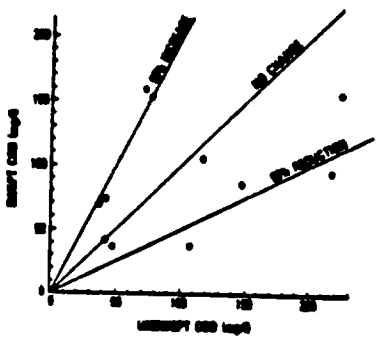
(TSS Concentrations



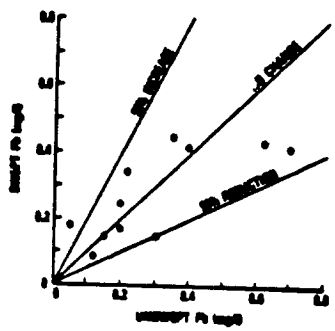
(TKN Concentrations)



(COD Concentrations)



(Pb Concentrations)



(TP Concentrations)

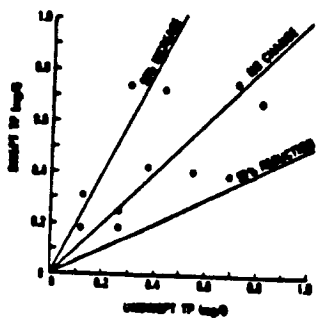


Figure 8-5. Bivariate Plots of Median EMCs for Swept and Unswept Conditions

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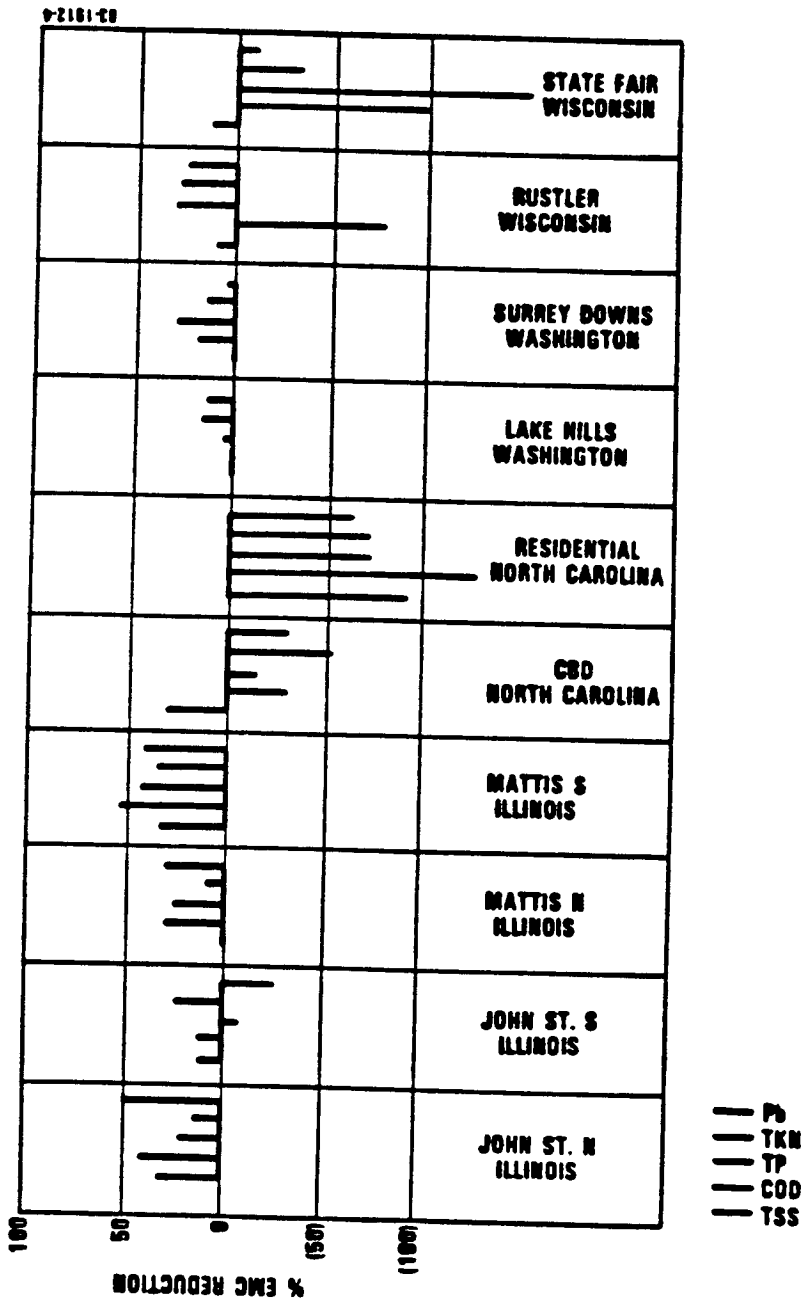

Figure 8-6. Street Sweeping Performance

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In evaluating the results, it is critical that the uncertainty in the estimate of median EMCs based on limited observed data, and thus the uncertainty in performance estimates, be assessed. This is especially true for the cases of apparent increases in concentrations indicated by Figure 8-6.

For each of the 10 sites considered, the 90 percent confidence intervals of the site median EMCs were computed as indicated in Figure 8-7. This analysis indicates that there is generally no significant difference between median EMCs for swept and unswept conditions. The implications of this analysis of uncertainty are as follows:

- Based on statistical testing, no significant reductions in EMCs are realized by street sweeping.

- The indicated changes in site median EMCs (increases or decreases) are much more likely due to random sampling than actual effects of sweeping operations.

- Benefits of street sweeping (if any) are masked by the large variability of the EMCs, therefore the benefit is certainly not large (e.g., >50 percent), and an even larger site data base is required to further identify the possible effect.

- In the above context, the hypothesis that street sweeping increases EMCs is generally not shown by the data, though it could occur in isolated, site specific cases.

Urban runoff loads are the product of long term (e.g., annual) runoff volume and event mean concentration. Under this definition, statements concerning EMCs also hold for loads.

OTHER CONTROL APPROACHES

Several best management practices (BMPs) in addition to those discussed above should be identified on the basis that local planning efforts determined them to be practical to apply and to have the potential to provide significant improvements in the quality characteristics of urban runoff. They are grouped together in this section and discussed only briefly, principally because, for one reason or another, sufficient data to characterize their performance capabilities was not developed during the NURP program.

Grass Swales

Three grass swales were monitored by the Washington, D.C. area NURP project. No significant improvement is urban runoff quality was indicated for pollutants analyzed. Increases in zinc concentration which were observed were attributed to mobilization of zinc from the galvanized culverts which carried runoff under the driveways at the monitored residential sites. However the project study report concluded that modifications which would increase residence of runoff in the swales and enhance infiltration capability could make this BMP effective for control of urban runoff.

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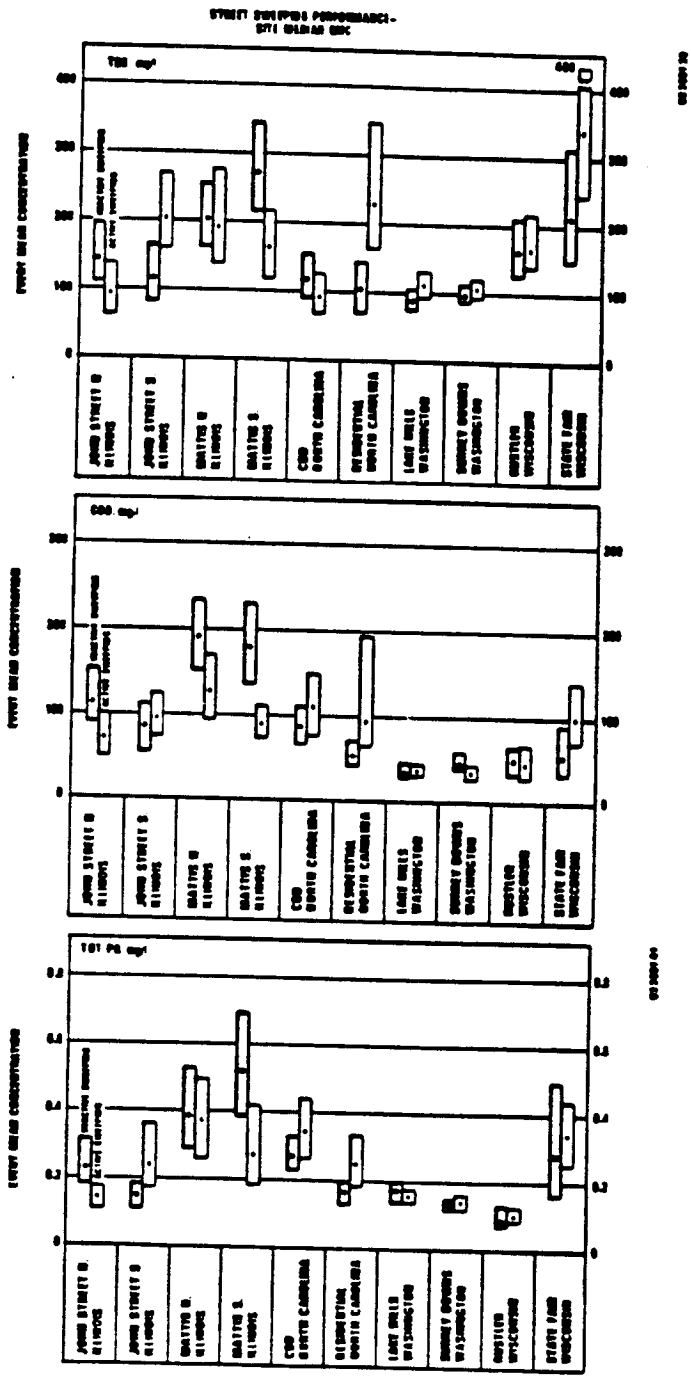

Figure 8-7. Effect of Street Sweeping on Site Median EMC Values

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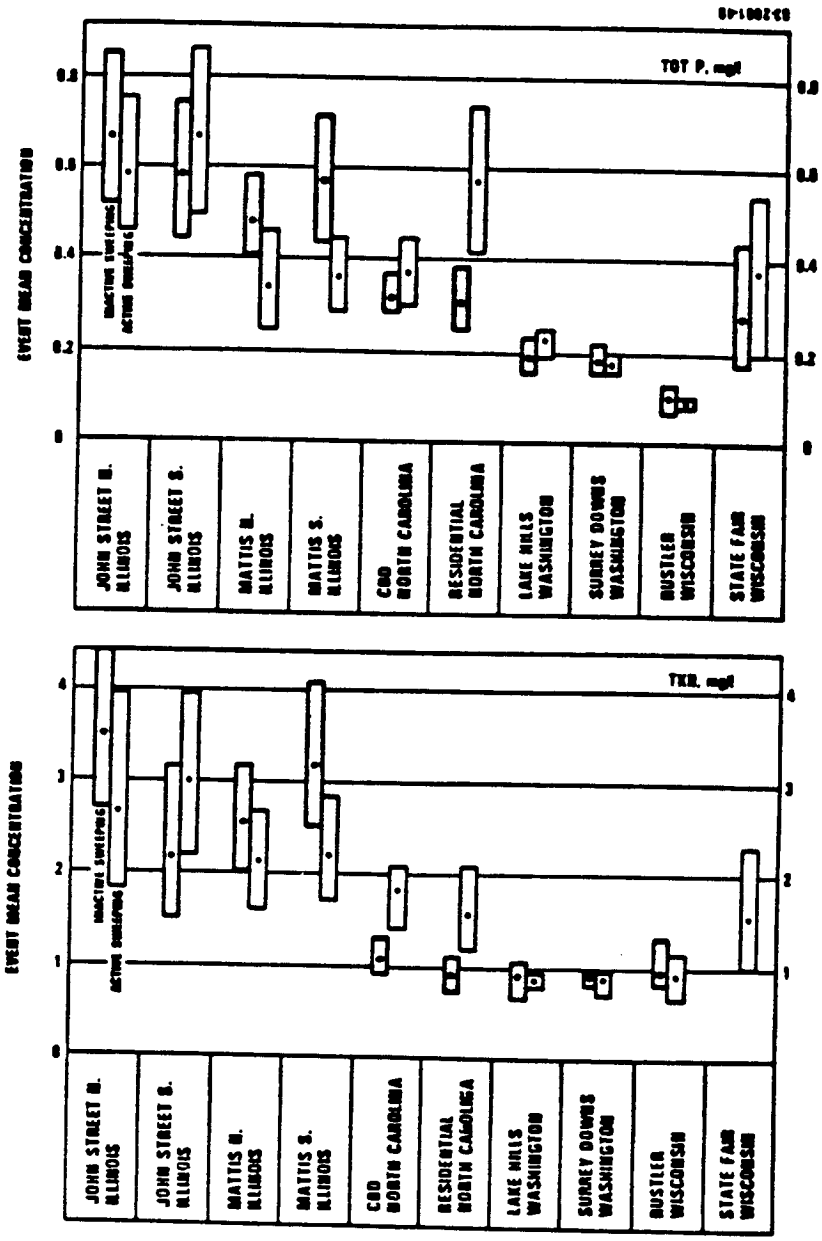

Figure 8-7. Effect of Street Sweeping on Site Median EMC Values (Cont'd)

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The Durham, New Hampshire NURP project monitored performance of a carefully designed artificial swale which received runoff from a commercial parking lot. Over 11 monitored storms, both soluble and particulate fractions of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. Reductions in COD, nitrate, and ammonia were on the order of 25 percent. The swale did not prove to be effective in reducing concentrations or organic nitrogen, phosphorus, or bacterial species. It should be noted that the performance capabilities indicated are based only on the concentration changes produced in the stormwater which passes completely through the swale. To the extent that infiltration of a portion of the runoff is effected by a swale, load reductions would be increased in proportion.

The NURP results suggest that grass swales represent a practical and potentially effective technique for control of urban runoff quality; that design conditions are of major significance; and that additional study is necessary to establish such parameters.

Wetlands

The potential of either natural or artificially created wetland areas to effect favorable modification of urban runoff pollutant loads (particularly sediment, nutrients, and heavy metals) has been widely suggested. The NURP experience reinforces this expectation, but has not developed the detailed performance data to permit either characterizing general performance capabilities or identifying general design principles and parameters. Additional study will be required to develop such information.

Miscellaneous

This category encompasses a variety of BMPs which were identified at the local level as techniques of quality control which appeared to be relevant for the circumstances which were operative. They are grouped under this category because (a) their applicability tends to be site-specific rather than general, and (b) while their effectiveness as a BMP may be substantial on a relatively small spatial scale, the broad-scale effect on urban runoff loads has not been possible to document.

BMPs in this category include erosion control practices and urban housekeeping practices. As an example of the former, the Little Rock, Arkansas NURP project widened and stabilized (with rip rap) a segment of an urban stream to reduce erosion potential. The Baltimore NURP project data clearly indicated the substantial difference in urban runoff quality that can result from the general level of cleanliness maintained in an urban neighborhood.

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CHAPTER 9
CONCLUSIONS

INTRODUCTION

The Nationwide Urban Runoff Program has addressed such issues as quantifying the characteristic of urban runoff, assessing the water quality effects on receiving water bodies attributable to urban runoff discharges, and examining the effectiveness of control practices in removing the pollutants found in urban runoff. This chapter summarizes NURP's conclusion relating to these issues and is based on the results presented in Chapters 6, 7, and 8 of this report. Conclusions reached by the individual NURP projects are also presented to further support the results of the national level analysis.

URBAN RUNOFF CHARACTERISTICS

General

Field monitoring was conducted to characterize urban runoff flows and pollutant concentrations. This was done for a variety of pollutants at a substantial number of sites distributed throughout the country. The resultant data represent a cross-section of regional climatology, land use types, slopes, and soil conditions and thereby provide a basis for identifying patterns of similarities or differences and testing their significance.

Urban runoff flows and concentrations of contaminants are quite variable. Experience shows that substantial variations occur within a particular event and from one event to the next at a particular site. Due to the high variability of urban runoff, a large number of sites and storm events were monitored, and a statistical approach was used to analyze the data. Procedures are available for characterizing variable data without requiring knowledge of or existence of any underlying probability distribution (nonparametric statistical procedures). However, where a specific type of probability distribution is known to exist, the information content and efficiency of statistical analysis is enhanced. Standard statistical procedures allowed probability distributions or frequency of occurrence to be examined and tested. Since the underlying distributions were determined to be adequately represented by the lognormal distribution, the log (base e) transforms of all urban runoff data were used in developing the statistical characterizations.

The event mean concentration (EMC), defined as the total constituent mass discharge divided by the total runoff volume, was chosen as the primary water quality statistic. Event mean concentrations were based on flow weighted composite samples for each event at each site in the accessible data base. EMCs were chosen as the primary water quality characteristic subjected to detailed analysis, even though it is recognized that mass loading characteristics of urban runoff (e.g., pounds/acre for a specified time interval) is

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ultimately the relevant factor in many situations. The reason is that mass loadings are very strongly influenced by the amount of precipitation and runoff. All other things being equal, local meterology creates important differences, and estimates of typical annual mass loads will be biased by the size of monitored storm events. The most reliable basis for characterizing annual or seasonal mass loads will be on the basis of EMC and site-specific rainfall/runoff characteristics.

Establishing the fundamental distribution as lognormal and the availability of a sufficiently large population of EMCs to provide reliability to the statistics derived has yielded a number of benefits, including the ability to provide:

- Concise summaries of highly variable data
- Meaningful comparisons of results different sites, events, etc.
- Statements concerning frequency of occurrence. One can express how often values will be expected to exceed various magnitudes of interest.
- A more useful method of reporting data than the use of ranges; one which is less subject to misinterpretation
- A framework for examining "transferability" of data in a quantitative manner

Conclusions

1. Heavy metals (especially copper, lead and zinc) are by far the most prevalent priority pollutant constituents found in urban runoff. End-of-pipe concentrations exceed EPA ambient water quality criteria and drinking water standards in many instances. Some of the metals are present often enough and in high enough concentrations to be potential threats to beneficial uses.

   All 13 metals on EPAs priority pollutant list were detected in urban runoff samples, and all but three at frequencies of detection greater than 10 percent. Most often detected among the metals were copper, lead, and zinc, all of which were found in at least 91 percent of the samples.

   Metal concentrations in end-of-pipe urban runoff samples (i.e., before dilution by receiving water) exceeded EPAs water quality criteria and drinking water standards numerous times. For example, freshwater acute criteria were exceeded by copper concentrations in 47 percent of the samples and by lead in 23 percent. Freshwater chronic exceedances were common for lead (94 percent), copper (82 percent), zinc (77 percent), and cadmium (48 percent). Regarding human toxicity, the most significant pollutants were lead and nickel, and for human carcinogenesis, arsenic and beryllium. Lead concentrations violated drinking water criteria 73 percent of the samples.

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It should be stressed that the exceedances noted above do not necessarily imply that an actual violation of standards will exist in the receiving water body in question. Rather, the enumeration of exceedances serves a screening function to identify those heavy metals whose presence in urban runoff warrants high priority for further evaluation.

Based upon the much more extensive NURP data set for total copper, lead, and zinc, the site median EMC values for the median urban site are: Cu = 34 µg/l, Pb = 144 µg/l, and Zn = 160 µg/l. For the 90th percentile urban site the values are: Cu = 93 µg/l, Pb = 350 µg/l, and Zn = 500 µg/l. These values are suggested to be appropriate for planning level screening analyses where data are not available.

Some individual NURP project sites (e.g., at DC1, MD1, NH1) found unusually high concentrations of certain heavy metals (especially copper and zinc) in urban runoff. This was attributed by the projects to the effect of acid rain on materials used for gutters, culverts, etc.

2. The organic priority pollutants were detected less frequently and at lower concentrations than the heavy metals.

Sixty-three of a possible 106 organics were detected in urban runoff samples. The most commonly found organic was the plasticizer bis (2-ethylhexl) phthalate (22 percent), followed by the pesticide α-hexachlorocyclohexane (α-BHC) (20 percent). An additional 11 organic pollutants were reported at frequencies between 10 and 20 percent; 3 pesticides, 3 phenols, 4 polycyclic aromatics, and a single halogenated aliphatic.

Criteria exceedances were less frequently observed among the organics than the heavy metals. One unusually high pentachlorophenol concentration of 115 µg/l resulted in exceedances of the freshwater acute and organoleptic criteria. This observation and one for chlordane also exceeded the freshwater acute criteria. Freshwater chronic criteria exceedances were observed for pentachlorophenol, bis (2-ethylhexyl) phthalate, gamma-BHC, chlordane, and alpha-endosulfan. All other organic exceedances were in the human carcinogen category and were most serious for alpha-hexachlorocyclohexane (alpha-BHC), gamma-hexachlorocyclohexane (gamma-BHC or Lindane), chlordane, phenanthrene, pyrene, and chrysene.

The fact that the NURP priority pollutant monitoring effort was limited to two samples at each site leaves us unable to make many generalizations about those organic pollutants which occurred only rarely. We can speculate that their occurrences tend to be very site specific as opposed to being a generally widespread phenomena, but much more data would be required to conclusively prove this point.

3. Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in many surface waters, even those providing high degrees of dilution.

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Fecal coliform counts in urban runoff are typically in the tens to hundreds of thousand per 100 ml during warm weather conditions, with the median for all sites being around 21,000/100 ml. During cold weather, fecal coliform counts are more typically in the 1,000/100 ml range, which is the median for all sites. Thus, violations of fecal coliform standards (typically 200/100 ml) were reported by a number of NURP projects. High fecal coliform counts may not cause actual use impairments, in some instances, due to the location of the urban runoff discharges relative to swimming areas or shellfish beds and the degree of dilution/dispersal and rate of die off. The same is true of total coliform counts, which were found to exceed EPA water quality criteria in undiluted urban runoff at virtually every site every time it rained.

The substantial seasonal differences noted above do not correspond with comparable variations in urban activities. The NURP analyses as well as current literature suggest that fecal coliform may not be the most appropriate indicator organism for identifying potential health risks when the source is stormwater runoff.

4. Nutrients are generally present in urban runoff, but with a few individual site exceptions, concentrations do not appear to be high in comparison with other possible discharges to receiving water bodies.

NURP data for total phosphorus, soluble phorous, total kjeldahl nitrogen, and nitrate plus nitrite as nitrogen were carefully examined. Median site EMC median concentrations in urban runoff were TP = 0.33 mg/l, SP = 0.12 mg/l, TKN = 1.5 mg/l, and NO_{2+3} - N = 0.68 mg/l. On an annual load basis, comparison with discharges from a well run secondary treatment plan suggests that mean annual nutrient loads from urban runoff are around an order of magnitude less than those from a POTW.

5. Oxygen demanding substances are present in urban runoff at concentrations approximating those in secondary treatment plant discharges. If dissolved oxygen problems are present in receiving waters of interest, consideration of urban runoff controls as well as advanced waste treatment appears to be warranted.

Urban runoff median site EMC median concentrations of 9 mg/l BOD and 65 mg/l COD are reflected in the NURP data, with 90th percentile site EMC median values being 15 mg/l BOD and 140 mg/l COD. These concentrations suggest that, on an annual load basis, urban runoff is comparable in magnitude to secondary treatment plant discharges.

It can be argued that urban runoff is typically well oxygenated and provides increases stream flow and, hence, in view of relatively long travel times to the critical point, that dissolved oxygen problems attributable solely to urban runoff should not be widespread occurrences. No NURP project specifically identified a low DO condition resulting from

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urban runoff. Nonetheless, there will be some situations where consideration of urban runoff controls for oxygen demanding substances in an overall water quality management strategy would seem appropriate.

6. Total suspended solids concentrations in urban runoff are fairly high in comparison with treatment plant discharges. Urban runoff control is strongly indicated where water quality problems associated with TSS, including build-up of contaminated sediments, exist.

There are no formal water quality criteria for TSS relating to either human health or aquatic life. The nature of the suspended solids in urban runoff is different from those in treatment plant discharges, being higher in mineral and man-made products (e.g., tire and street surface wear particles) and somewhat lower in organic particulates. Also, the solids in urban runoff are more likely to have other contaminants adsorbed onto them. Thus, they cannot be simply considered as benign, nor do they only pose an aesthetic issue. NURP did not examine the problem of contaminated sediment build-up due to urban runoff, but it undeniably exists, at least at some locations.

The suspended solids in urban runoff can also exert deleterious physical effects by sedimenting over egg deposition sites, smothering juveniles, and altering benthic communities.

On an annual load basis, suspended solids contributions from urban runoff are around an order of magnitude or more greater than those from secondary treatment plants. Control of urban runoff, as opposed to advanced waste treatment, should be considered where TSS-associated water quality problems exist.

7. A summary characterization of urban runoff has been developed and is believed to be appropriate for use in estimating urban runoff pollutant discharges from sites where monitoring data are scant or lacking, at least for planning level purposes.

As a result of extensive examination, it was concluded that geographic location, land use category (residential, commercial, industrial park, or mixed), or other factors (e.g., slope, population density, precipitation characteristics) appear to be of little utility in consistently explaining overall site-to-site variability in urban runoff EMCs or predicting the characteristics of urban runoff discharges from unmonitored sites. Uncertainty in site characteristics caused by high event-to-event variability at most sites eclipsed any site-to-site variability that might have been present. The finding that EMC values are essentially not correlated with storm runoff volumes facilitates the transfer of urban runoff characteristics to unmonitored sites. Although there tend to be exceptions to any generalization, the suggested summary urban runoff characteristics are recommended for planning level purposes as the best estimates, lacking local information to the contrary.

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RECEIVING WATER EFFECTS

General

The effects of urban runoff on receiving water quality are highly site-specific. They depend on the type, size, and hydrology of the water body; the urban runoff quantity and quality characteristics; the designated beneficial use; and the concentration levels of the specific pollutants that affect that use.

The conclusions which follow are based on screening analyses performed by NURP and observations and conclusions drawn by individual NURP projects that examined receiving water effects in differing levels of detail and rigor. Conclusions are organized on the basis of water body type: rivers and streams, lakes, estuaries and embayments, and groundwater aquifers. Site-specific exceptions should be expected, but the statements presented are believed to provide an accurate perspective on the general tendency of urban runoff to contribute significantly to water quality problems.

Rivers and Streams

1. Frequent exceedances of heavy metals ambient water quality criteria for freshwater aquatic life are produced by urban runoff.

   The Denver NURP project found that in-stream concentrations of copper, lead, zinc, and cadmium exceeded ambient water quality standards during essentially all storm events.

   NURP screening analyses suggest that this condition should be expected on a relatively general basis.

2. Although a significant number of problem situations could result from heavy metals in urban runoff, levels of use impairment suggested by the magnitude and frequency of ambient criteria exceedances were not observed.

   The Bellevue, Washington NURP project concluded that toxic effects of urban runoff pollutants did not appear to be a significant factor.

   The Tampa, Florida NURP project conducted biological studies of the impact of stormwater runoff upon the biological community of the Hillsborough River. They conducted animal bioassay experiments on five sensitive species in two samples of urban runoff from the Arctic Street drainage basin. Thirty-two bioassay experiments were completed including 22 acute tests and 10 chronic tests. Neither sample of stormwater was acutely toxic to test organisms. Long-term chronic experiments were undertaken with two species and resulted in no significant effects attributable to stormwater exposure.

   NURP screening analyses suggest that the potential of urban runoff to seriously impair this beneficial use will be strongly influenced by local conditions and the frequency of occurrence of concentration levels which produce toxic effects under the intermittent, short duration exposures typically produced by urban runoff.

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While the application of the screening analysis to the Bellevue and Tampa situations supports the absence of a problem situation in these cases, it also suggests that a significant number of problem situations should be expected.

Accordingly, it is concluded that there are almost certainly site-specific situations in which urban runoff causes significant impairment of freshwater aquatic life uses; however, this is not a general, ubiquitous situation. NURP project studies did not report significant use impairment problems associated with urban runoff, and the screening analysis suggests that there are many urban situations where problems of this nature should not, in fact, be anticipated.

Adaptation of current ambient quality criteria to better reflect use impacts where pollutant exposures are intermittent and of short duration appears to be a useful area for further investigation.

3. Copper, lead and zinc appear to pose a significant threat to aquatic life uses in some areas of the country. Copper is suggested to be the most significant of the three.

Regional differences in surface water hardness, which has a strong influence on toxicity, in conjunction with regional variations in stream flow and rainfall results in significant differences in susceptibility to adverse impacts around the nation.

The southern and Gulf Coast regions of the country are the most susceptible to aquatic life effects due to heavy metals, with the northeast also a sensitive area, though somewhat less so.

Copper is the major toxic metal in urban runoff, with lead and zinc also prevalent but a problem in more restricted cases. Copper discharges in urban runoff are, in all but the most favorable cases, a significant threat to aquatic life uses in the southeast and Gulf Coast regions of the country. In the northeast, problems would be expected only in rather unfavorable conditions (large urban area contribution and high site concentrations). In the remainder of the country (and for the other metals) problems would only be expected under quite unfavorable site conditions. These statements are based on total metal concentration, rather than the soluble fraction typically considered in toxic effects. Therefore, the above conclusions may be conservative, but it is believed that refinements to consider the soluble fraction would not change the inferences drawn.

4. Organic priority pollutants in urban runoff do not appear to pose a general threat to freshwater aquatic life.

This conclusion is based on limited data on the frequency with which organics are found in urban runoff discharges and measured end-of-pipe concentrations relative to published toxic criteria. One unusually high pentachlorophenol concentration of 115 µg/l resulted in the only exceedance of the organoleptic criteria. This observation and one for chlordane exceeded the freshwater acute criteria. Freshwater

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chronic criteria exceedances were observed for pentochlorophenol, bis (2-ethylhexyl) phlhalate, γ-hexachlorocyclohexane (lindane), α-endosulfan, and chlordane.

5. The physical aspects of urban runoff, e.g., erosion and scour, can be a significant cause of habitat disruption and can affect the type of fishery present. However, this area was studied only incidentally by several of the projects under the NURP program and more concentrated study is necessary.

The Metropolitan Washington Council of Governments (MWCOG) NURP project did an analysis of fish diversity in the Seneca Creek Watershed, 20 miles northwest of Washington, D.C. In this study, specific changes in fishery diversity were identified due to urbanization in some of the sub-watersheds. Specifically, the number of fish species present are reduced and the types of species present changed dramatically, e.g., environmentally sensitive species were replaced with more tolerant species. For example, the Blacknose Dace replaced the Mottled Sculpin. MWCOG concluded that the changes in fish diversity were due to habitat deterioration caused by the physical aspects of urban runoff.

The Bellevue, Washington NURP project concluded that habitat changes (streambed scour and sedimentation) had a more significant effect than pollutant concentrations, for the changes produced by urbanization.

6. Several projects identified possible problems in the sediments because of the build-up of priority pollutants contributed wholly or in part by urban runoff. However, the NURP studies in this area were few in number and limited in scope, and the findings must be considered only indicative of the need for further study, particularly as to long-term impacts.

The Denver NURP project found significant quantities of copper, lead, zinc, and cadmium in river sediments. The Denver Regional Council of Governments is concerned that during periods of continuous low flow, lead may reach levels capable of adversely affecting fish.

The Milwaukee NURP project reported the observation of elevated levels of heavy metals, particularly lead, in the sediments of a river receiving urban runoff.

7. Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in most rivers and streams.

Violations of the fecal coliform standard were reported by a number of NURP projects. In some instances, high fecal coliform counts may not cause actual use impairments due to the location of the urban runoff discharge relative to swimming areas and the degree of dilution or dispersal and rate of die off.

The use of coliforms as an indicator of health risk when the sole source is urban runoff warrants further investigation.

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8. Domestic water supply systems with intakes located on streams in close proximity to urban runoff discharges are encouraged to check for priority pollutants which have been detected in urban runoff, particularly those in the organic category.

Sixty-three of a possible 106 organics were detected in urban runoff samples. The most commonly found organic was the plasticizer bis (2-ethylhexl) phthalate (22 percent), followed by the pesticide α-hexachlorocyclohexane (α-BHC) (20 percent). An additional 11 organic pollutants were reported at frequencies between 10 and 20 percent; 3 pesticides, 3 phenols, 4 polycyclic aromatics, and a single halogenated aliphatic.

Lakes

1. Nutrients in urban runoff may accelerate eutrophication problems and severely limit recreational uses, especially in lakes. However, NURP's lake projects indicate that the degree of beneficial use impairment varies widely, as does the significance of the urban runoff component.

The Lake Quinsigamond NURP project in Massachusetts identified eutrophication as a major problem in the lake, with urban runoff being a prime contributor of the critical nutrient phosphorus. Point source discharges to the lake have been eliminated almost entirely. However, in spite of the abatement of point sources, survey data indicate that the lake has shown little improvement over the abatement period. In particular, the trophic status of the lake has shown no change, i.e., it is still classified as late mesotrophic-early eutrophic. Substantial growth is projected in the basin, and there is concern that Lake Quinsigamond will become more eutrophic. A proposed water quality management plan for the lake includes the objective of reducing urban runoff pollutant loads.

The Lake George NURP project in New York State also identified increasing eutrophication as a potential problem if current development trends continue. Lake George is not classified as eutrophic, but from 1974 to 1978 algae production in the lake increased logarithmically. Lake George is a very long lake, and the limnological differences between the north and south basins provide evidence of human impact. The more developed, southern portion of the lake exhibits lower transparencies, lower hypolimnetic dissolved oxygen concentrations, higher phosphorus and chlorophyll a concentrations, and a trend toward seasonal blooms of blue-green algae. These differences in water quality indicators are associated with higher levels of cultural activities (e.g., increased sources of phosphorus) in the southern portion of the lake's watershed, and continued development will tend to accentuate the differences.

The Lake George NURP project estimated that urban runoff from developed areas currently accounts for only 13.6 percent of the annual phosphorus loadings to Lake George as a whole. In contrast, developed areas contribute 28.9 percent of the annual phosphorus load to the NURP study areas at the south end of the Lake. These data illustrate the significant impact of urbanization on phosphorus loads.

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The NURP screening analysis suggests that lakes for which the contributions of urban runoff are significant in relation to other nonpoint sources (even in the absence of point source discharges) are indicated to be highly susceptible to eutrophication and that urban runoff control may be warranted in such situations.

2. Coliform bacteria discharges in urban runoff have a significant negative impact on the recreational uses of lakes.

The Lake Quinsigamond NURP project in Massachusetts found that bacterial pollution was widespread throughout the drainage basin. In all cases where samples were taken, fecal coliforms were in excess of 10,000 counts per 100 ml, with conditions worse in the Belmont street storm drains. This project concluded that the high fecal coliform counts in stormwater are due to sewage contamination throughout the catchment.

The sources of sewage contamination are leaking septic tanks, infiltration from sanitary sewers into storm sewers, and leakage at manholes. In the northern basin, the high fecal coliform counts are attributed to known sewage contamination sources on Poor Farm Brook. The data from the project suggest that it would be unwise to permit body contact recreation in the northern basin of the lake during or immediately following significant storm events. The project concluded that disinfection at selected storm drains should be considered in the future if the sewage contamination cannot be eliminated.

The Mystic River NURP project in Massachusetts found various areas where fecal coliform counts were extremely high in urban stormwater. Fecal coliform levels of up to one million with an average of 178,000/100 ml were recorded in Sweetwater Brook, a tributary to Mystic River, during wet weather. These high fecal coliform levels were specifically attributed to manhole overflows. Fecal coliform levels above the class B fecal coliform standard of 200 per 100 ml were found in approximately one-third of the samples tested in the upper and lower forebays of the Upper Mystic Lake and occasionally near the lake's outlet. In addition, Sandy Beach, a public swimming area on Upper Mystic Lake, exceeded the State fecal coliform criteria in July of 1982 and warnings that swimming may be hazardous to public health were posted for several days. It is important to note that sewage contamination of surface waters is a major problem in the watershed. The project concluded that urban runoff contributes to the bacteria load during wet weather but, comparatively, is much less significant than the sanitary sources.

Estuaries and Embayments

1. Adverse effects of urban runoff in marine waters will be a highly specific local situation. Though estuaries and embayments were studied to a very limited extent in NURP, they are not believed to be generally threatened by urban runoff, though specific instances where use is impaired or denied can be of significant local and even regional importance. Coliform bacteria present in urban runoff is the primary pollutant of concern, causing direct impacts on shellfish harvesting and beach closures.

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The significant impact of urban runoff on shellfish harvesting has been well documented by the Long Island, New York NURP project. In this project, stormwater runoff was identified as the major source of bacterial loading to marine waters and, thus, the indirect cause of the denial of certification by the New York State Department of Conservation for about one-fourth of the shellfishing area. Much of this area is along the south shore, where the annual commercial shellfish harvest is valued at approximately $17.5 million.

The Myrtle Beach, South Carolina NURP project found that stormwater discharges from the City of Myrtle Beach directly onto the beach showed high bacterial counts for short durations immediately after storm events. In many instances these counts violated EPA water quality criteria for aquatic life and contact recreation. The high bacteria counts, however, were associated with standing pools formed at the end of collectors for brief periods following the cessation of rainfall and before the runoff percolated into the sand. Consequently, the threat to public health was not considered great enough to warrant closure of the beach.

Groundwater Aquifers

1. Groundwater aquifers that receive deliberate recharge of urban runoff do not appear to be imminently threatened by this practice at the two locations where it was investigated.

Two NURP projects (Long Island and Fresno) are situated over sole source acquifers. They have been practicing recharge with urban runoff for two decades or more at some sites, and extensively investigated the impact of this practice on the quality of their groundwater. They both found that soil processes are efficient in retaining urban runoff pollutants quite close to the land surface, and concluded that no change in the use of recharge basins is warranted.

Despite the fact that some of these basins have been in service for relatively long periods of time and pollutant breakthrough of the upper soil layers has not occurred, the ability of the soil to continue to retain pollutants is unknown. Further attention to this issue is recommended.

CONTROL EFFECTIVENESS

General

A limited number of techniques for the control of urban runoff quality were evaluated by the NURP program. The set is considerably smaller than previously published lists of potential management practices. Since the control approaches that were investigated were selected at the local level, the choices may be taken as an initial indication of local perceptions regarding practicality and feasibility from the standpoint of implementation.

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Conclusions

1. Control measures selected at the local level for detailed investigation reflected a strong preference for detention devices, street sweeping, and recharge devices. Interest was also shown in grass swales and wetlands.

   Six NURP projects monitored the performance of a total of 14 detention devices. Five separate projects conducted in-depth studies of the effectiveness of street sweeping on the control of urban runoff quality. A total of 17 separate study catchments were involved in this effort. Three NURP projects examined either the potential of recharge devices to reduce discharges of urban runoff to surface waters or the potential of the practice to contaminate groundwaters. A total of 12 separate sites were covered by this effort.

   Grass swales were studied by two NURP projects. Two swales in existing residential areas, and one experimental swale constructed to serve a commercial parking lot were studied.

   A number of NURP projects indicated interest in wetlands for improving urban runoff quality at early stages of the program. Only one allocated monitoring activity to this control measure, however.

   Various other management practices were identified as having local interest by individual NURP projects, but none of them was allocated the necessary resources to be pursued to a point which allowed an evaluation of their ability to control pollution from urban runoff. Management practices in this category included urban housekeeping (e.g., litter programs, catch basin cleaning, pet ordinances) and public information programs.

2. Detention basins are capable of providing very effective removal of pollutants in urban runoff. Both the design concept and the size of the basin in relation to the urban area served have a critical influence on performance capability.

   Wet basins (designs which maintain a permanent water pool) have the greatest performance capabilities. Observed pollutant reductions varied from excellent to very poor in the basins which were monitored. However, when basins are adequately sized, particulate removals in excess of 90 percent (TSS, lead) can be obtained. Pollutants with significant soluble fractions in urban runoff show lower reductions; on the order of 65 percent for total P and approximately 50 percent for BOD, COD, TKN, Copper, and Zinc. Results indicate that biological processes which are operative in the permanent pool produce significant reductions (50 percent or more) in soluble nutrients, nitrate and soluble phosphorus. These performance characteristics are indicated by both the NURP analysis results and conclusions reached by individual projects.

   Dry basins, (conventional stormwater management basins), which are designed to attenuate peak runoff rates and hence only very briefly detain portions of flow from the larger storms, are indicated by NURP data to be essentially ineffective for reducing pollutant loads.

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Dual-purpose basins (conventional dry basins with modified outlet structures which significantly extend detention time) are suggested by limited NURP data to provide effective reductions in urban runoff loads. Performance may approach that of wet ponds; however, the additional processes which reduce soluble nutrient forms do not appear to be operative in these basins. This design concept is particularly promising because it represents a cost effective approach to combining flood control and runoff quality control and because of the potential for converting existing conventional stormwater management ponds.

Approximate costs of wet pond designs are estimated to be in the order of $500 to $1500 per acre of urban area served, for on-site applications serving relatively small urban areas, and about $100 to $250 per acre of urban area for off-site applications serving relatively large urban areas. The costs reflect present value amounts which include both capital and operating costs. The difference is due to an economy of scale associated with large basin volumes. The range reflects differences in size required to produce particulate removals in the order of 50 percent or 90 percent. Annual costs are estimated at $60 to $175, and $10 to $25 respectively.

3. Recharge Devices are capable of providing very effective control of urban runoff pollutant discharges to surface waters. Although continued attention is warranted, present evidence does not indicate that significant groundwater contamination will result from this practice.

Both individual project results and NURP screening analyses indicate that adequately sized recharge devices are capable of providing high levels of reduction in direct discharges of urban runoff to surface waters. The level of performance will depend on both the size of the unit and the soil permeability.

Application will be restricted to areas where conditions are favorable. Soil type, depth to groundwater, land slopes, and proximity of water supply wells will all influence the appropriateness of this control technique.

Surface accumulations which result from the high efficiency of soils to retain pollutants, suggest further attention in applications where dual purpose recharge areas also serve as recreational fields or playground areas.

4. Street sweeping is generally ineffective as a technique for improving the quality of urban runoff.

Five NURP projects evaluated street sweeping as a management practice to control pollutants in urban runoff. Four of these projects concluded that street sweeping was not effective for this purpose. The fifth, which had pronounced wet and dry seasons, believed that sweeping just prior to the rainy season could produce some benefit in terms of reduced pollution in urban runoff.

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A large data base on the quality of urban runoff from street sweeping test sites was obtained. At 10 study sites selected for detailed analysis, a total of 381 storm events were monitored under control conditions, and an additional 277 events during periods when street sweeping operations were in effect. Analysis of these data indicated that no significant reductions in pollutant concentrations in urban runoff were produced by street sweeping.

There may be special cases in which street cleaning applied at restricted locations or times of year could provide improvements in urban runoff quality. Some examples that have been suggested, though not demonstrated by the NURP program, include periods following snow melt or leaf fall, or urban neighborhoods where the general level of cleanliness could be significantly improved.

5. Grass swales can provide moderate improvements in urban runoff quality. Design conditions are important. Additional study could significantly enhance the performance capabilities of swales.

Concentration reductions of about 50 percent for heavy metals, and 25 percent for COD, nitrate, and ammonia were observed in one of the swales studied. However the swale was ineffective in reducing concentrations of organic nitrogen, phosphorus, or bacterial species. Two other swales studied failed to demonstrate any quality improvements in the urban runoff passing through them.

Evaluations by the NURP projects involved concluded, however, that this was an attractive control technique whose performance could be improved substantially by application of appropriate design considerations. Additional study to develop such information was recommended.

Design considerations cited included slope, vegetation type and maintenance, control of flow velocity and residence time, and enhancement of infiltration. The latter factor could produce load reductions greater than those inferred from concentration changes and effect reductions in those pollutant species which are not attenuated by flow through the swale.

6. Wetlands are considered to be a promising technique for control of urban runoff quality. However, neither performance characteristics nor design characteristics in relation to performance were developed by NURP.

Although a number of projects indicated interest, only one assigned NURP monitoring activity to a wetland. This was a natural wetland, and flows passing though it were uncontrolled. Results suggest its potential to improve quality, but the investigation was not adequate to associate necessary design factors to performance capability. Additional attention to this control technique would be useful, and should include factors such as the need for maintenance harvesting to prevent constituent recycling.

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ISSUES

A number of issues with respect to managing and controlling urban runoff emerge from the conclusions summarized above. In some instances they represent the need for additional data/information or for further study. In others they point to the need for follow-up activity by EPA, State, or local officials to assemble and disseminate what is already known regarding water quality problems caused by urban runoff and solutions.

Sediments

The nature and scope of the potential long-term threat posed by toxic pollutant accumulation in the sediments of urban lakes and streams requires further study. A related issue is the safe and environmentally sound disposal of sediments collected in detention basins used to control urban runoff.

Priority Pollutants

NURP clearly demonstrated that many priority pollutants can be found in urban runoff and noted that a serious human health risk could exist when water supply intakes are in close proximity to urban stormwater discharges. However, questions related to the sources, fate, and transport mechanisms of priority pollutants borne by urban runoff and their frequencies of occurrence will require further study.

Acid Rain

The relationship between pH and heavy metal values in urban runoff has not been established and needs further study. Several NURP projects (mostly in the northeastern states) attributed high heavy metals concentrations in urban runoff to the effects of acid rain. Although it is quite plausible that acid rain increases the level of pollutants in urban runoff and may transform them to more toxic and more easily assimilated forms, further study is required to support this speculation.

Industrial Runoff

No truly industrial sites (as opposed to industrial parks) were included in any of the NURP projects. A very limited body of data suggests, however, that runoff from industrial sites may have significantly higher contaminant levels than runoff from other urban land use sites, and this issue should be investigated further.

Central Business Districts

Data on the characteristics of urban runoff from central business districts are quite limited as opposed to other land use categories investigated by NURP. The data do suggest, however, that some sites may produce pollutant concentrations in runoff that are significantly higher than those from other sites in a given urban area. When combined with their typically high degrees of imperviousness, the pollutant loads from central business districts can be

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quite high indeed. The opportunities for control in central business districts are quite limited, however, and the only practicable option in many cases may be to route this portion of a locality's urban runoff to a treatment plant via the sanitary sewers. More study is required before such a recommendation can be made, however, because this practice could either create a combined sewer overflow situation or aggrevate one which already exists.

Socio-Economic Effects

Although the NURP data in this area are quite limited, they strongly suggest that the runoff from disadvantaged neighborhoods contains dramatically higher levels of pollutants than does the runoff from more affluent parts of an urban area. Unique control opportunities may exist in such situations, but further study will be required before this issue can be dealt with in an adequate fashion.

Physical Effects

Several projects concluded that the physical impacts of urban runoff upon receiving waters have received too little attention and, in some cases, are more important determinants of beneficial use attainment than chemical pollutants. This contention requires much more detailed documentation.

Synergy

NURP did not evaluate the synergistic effects that might result from pollutant concentrations experienced in stormwater runoff, in association with pH and temperature ranges that occur in the receiving waters. This type of investigation might reveal that control of a specific parameter, such as pH, would adequately reduce an adverse synergistic effect caused by the presence of other pollutants in combination and be the most cost effective solution. Further investigations should include this issue.

Opportunities for Control

Based upon the results of NURP's evaluation of the performance of urban runoff controls, opportunities for significant control of urban runoff quality are much greater for newly developing areas. Institutional considerations and availability of space are the key factors. Guidance on this issue in a form useful to States and urban planning authorities should be prepared and issued.

Wet Weather Water Quality Standards

The NURP experience suggests the desirability of EPA supporting efforts to develop "wet weather" standards, criteria, or modifications to ambient criteria to reflect differences in impact due to the intermittent, short duration exposures characteristic of urban runoff and other nonpoint source discharges.

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Coliform Bacteria

The appropriateness of using coliform bacteria as indicator organisms for human health risk where the source is exclusively urban runoff warrants further investigation.

Wetlands

The use of wetlands as a control measure is of great interest in many areas, but the necessary information on design performance relationships required before cost effective applications can be considered has not been adequately documented. The environmental impacts of such use upon wetlands is a critical issue which, at present, has been addressed marginally, if at all.

Swales

The use of grass swales was suggested by two NURP projects to represent a very promising control opportunity. However, their performance is very dependent upon design features about which information is lacking. Further work to address this deficiency and appropriate maintenance practices appears warranted.

Illicit Connections

A number of the NURP projects identified what appeared to be illicit connections of sanitary discharges to stormwater sewer systems, resulting in high bacterial counts and dangers to public health. The costs and complications of locating and eliminating such connections may pose a substantial problem in urban areas, but the opportunities for dramatic improvement in the quality of urban stormwater discharges certainly exist where this can be accomplished. Although not emphasized in the NURP effort, other than to assure that the selected monitoring sites were free from sanitary sewage contamination, this BMP is clearly a desirable one to pursue.

Erosion Controls

NURP did not consider conventional erosion control measures because the information base concerning them was considered to be adequate. They are effective, and their use should be encouraged.

Combined Sewer Overflows

In order to address urban runoff from separate storm sewers, NURP avoided any sites where combined sewers existed. However, in view of their relative levels of contamination, priority should be given to control of combined sewer overflows.

Implementation Guidance

The NURP studies have greatly increased our knowledge of the characteristics of urban runoff, its effects upon designated uses, and of the performance efficiencies of selected control measures. They have also confirmed earlier

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impressions that some States and local communities have actually begun to develop and implement stormwater management programs incorporating water quality objectives. However, such management initiatives are, at present, scattered and localized. The experience gained from such efforts is both needed and sought after by many other States and localities. Documentation, evaluation, refinement and transfer of management and financing mechanisms/ arrangements, of simple and reliable problem assessment methodologies, and of implementation guidance which can be used by planners and officials at the State and local level are urgently needed as is a forum for the sharing of experiences by those already involved, both among themselves and with those who are about to address nonpoint source issues.

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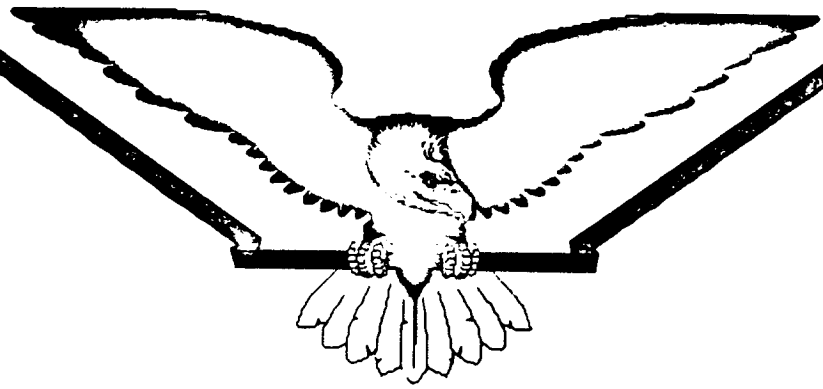

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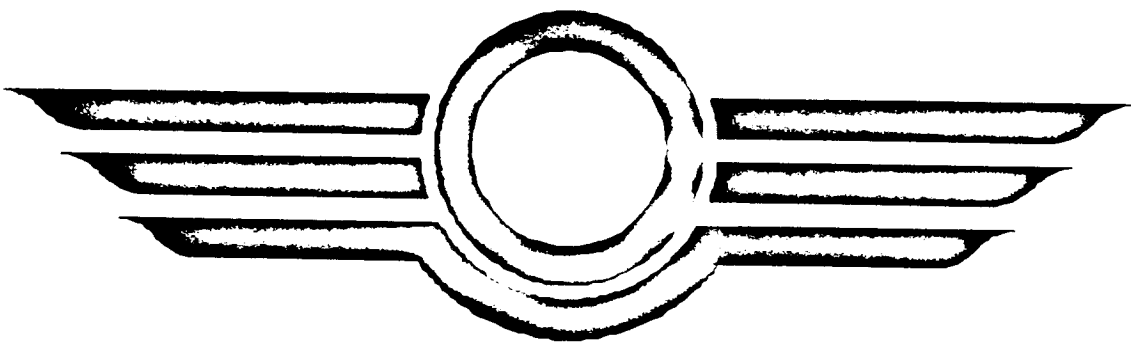

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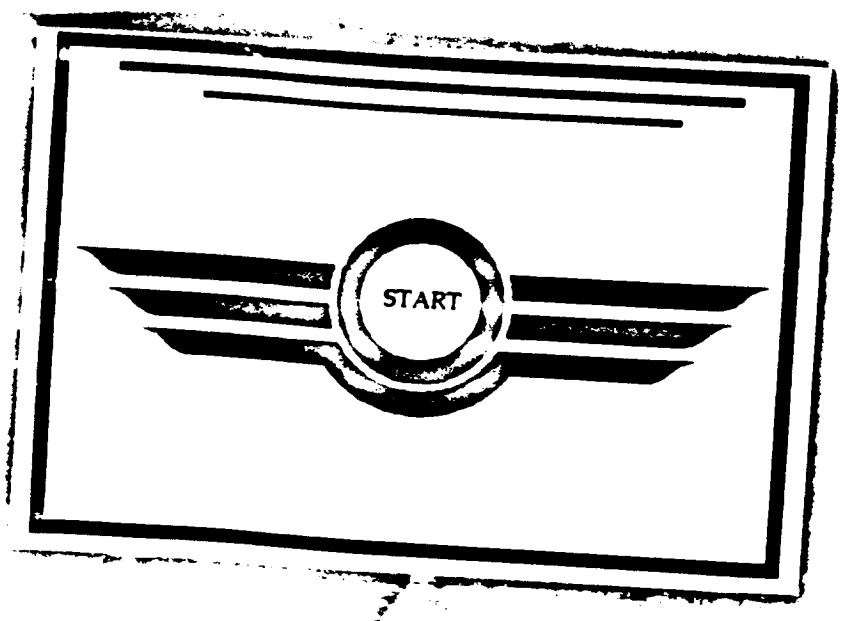

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE ADMINISTRATOR

VOL 12

Honorable Albert Gore
President of the Senate
Washington, D.C. 20515

Dear Mr. President:

As required by Section 305(b) of the Federal Water Pollution Control Act, I am transmitting to the Congress the 1992 National Water Quality Inventory Report. This biennial report is the ninth in a series of national water quality assessments first published by the U.S. Environmental Protection Agency (EPA) in 1975 and biennially since 1976.

While this report indicates that most of the Nation's waters are of good quality, it also indicates that the remaining waters are impaired to varying degrees. Of assessed waters, a majority are reported to be supporting the beneficial uses for which they have been designated by the States, but a significant number are not. States reported that these uses, such as drinking water supply, swimming, and the propagation of aquatic life were supported in 62 percent of assessed river miles, 56 percent of assessed lake acres, and 68 percent of assessed estuarine square miles. However, States report that they consider some of these waters threatened because they could become impaired if pollution control actions are not taken.

According to the States, the most commonly reported problems in impaired waters are from nonpoint sources (such as runoff from agricultural lands). Pollutants include nutrients, siltation, pathogens, and metals. Agriculture is the leading source of pollution in rivers and lakes, and ranks in the top three sources in estuaries.

We as a Nation have made important strides toward cleaning up America's waterways, yet 40 percent of our rivers, lakes, and estuaries are still not suitable for fishing and swimming. The Administration has a proposal for fundamental changes to the Clean Water Act that will address the last remaining sources of pollution at a reduced cost to the Nation. The proposed reform would cost $30 billion less per year than the current law. In addition, it would allow more flexibility in controlling pollution in ways that work best for each locality. We look forward to working with Congress to adopt the Administration's proposal.

Sincerely,

Carol M. Browner

Carol M. Browner

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE ADMINISTRATOR

VOL 12

Honorable Thomas S. Foley
Speaker of the House of
Representatives
Washington, D.C. 20515

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Sincerely,

Carol M. Browner

Carol M. Browner

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Acknowledgments

This report is based primarily on water quality assessments submitted to the U.S. Environmental Protection Agency by the States, Territories, American Indian Tribes, the District of Columbia, and Interstate Commissions of the United States. The EPA wishes to thank the authors of these assessments for the time and effort spent in preparing these reports and reviewing the draft of this national assessment. Additional thanks go to the water quality assessment coordinators from all ten EPA Regions who work with the States.

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Executive Summary

Introduction

The 1992 Report to Congress describes the geographic extent of water pollution across the country and identifies specific pollutants and sources of pollutants contaminating our waters. This national snapshot of water quality conditions summarizes information submitted by the States, the District of Columbia, Territories, Interstate Water Basin Commissions, and one American Indian Tribe in their 1992 water quality assessment reports (required under Clean Water Act Section 305(b)). The 1992 Section 305(b) reports contain assessments of each State's water quality during 1990 and 1991.

This report displays and summarizes data provided by the States to EPA. EPA has not determined the accuracy of these data. It is important to note that these State-reported data are intended to provide a snapshot of the quality of the waters they assessed and cannot be used to determine trends in our Nation's water resources. These limitations are due to major differences from year to year in assessment methods within and between States as well as differences in the waters assessed in each 2-year period. In addition, not all States follow EPA's guidance on procedures for determining whether waters are supporting the uses designated in their water quality standards. EPA and the States are taking many steps toward transforming the 305(b) process into one that provides comparable data with known accuracy. These steps include implementing the recommendations of the National 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality, as well as improving the Section 305(b) guidelines and implementing the Office of Water's Monitoring Strategy. These efforts will foster consistency and accuracy among the States and allow better sharing of data for watershed protection and across political boundaries.

Why Is It Important To Learn About Water Pollution?

The EPA encourages each citizen to become a steward of our precious natural resources. Complex environmental threats and diminishing funds for pollution control force us to jointly solve the pollution problems that foul our beaches and lakes or close our favorite fishing sites. We need to understand these problems and become a part of their solution. Once we understand these pollution problems and what is needed to combat them, we will be better able to prioritize our efforts, devise sound solutions, take appropriate action, monitor progress after solutions are implemented, and modify behavior that contributes to the problems.

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This document provides fundamental water quality information needed to resolve our persistent water pollution problems. This Report to Congress

- Defines key water quality concepts

- Discusses the leading pollution problems in rivers and streams, lakes, estuaries, coastal waters, wetlands, and ground water as reported to EPA by the States

- Briefly describes major State and Federal activities to control water pollution

- Offers several water quality protection actions for every citizen to adopt.

Measuring Water Quality

The States assess the quality of their waters by determining if their waters attain State water quality standards. Water quality standards consist of beneficial uses, numeric and narrative criteria for supporting each use, and an antidegradation statement:

- **Designated beneficial uses** are the desirable uses that water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support. Each designated use has a unique set of water quality requirements or criteria that must be met for the use to be realized. States may designate an individual waterbody for multiple beneficial uses.

- **Numeric water quality criteria** establish the minimum physical, chemical, and biological parameters required to support a beneficial use. Physical and chemical numeric criteria may set maximum concentrations of pollutants, acceptable ranges of physical parameters, and minimum concentrations of desirable parameters, such as dissolved oxygen. Numeric biological criteria describe the expected attainable community attributes and establish values based on measures such as species richness, presence or absence of indicator taxa, and distribution of classes of organisms.

- **Narrative water quality criteria** define, rather than quantify, conditions and attainable goals that must be maintained to support a designated use. Narrative biological criteria establish a positive statement about aquatic community characteristics expected to occur within a waterbody; for example, "Ambient water quality shall be sufficient to support life stages of all indigenous aquatic species." Narrative criteria may also describe conditions that are desired in a waterbody, such as, "Waters must be free of substances that are toxic to humans, aquatic life, and wildlife."

- **Antidegradation statements** protect existing designated uses and prevent high-quality waterbodies from deteriorating below the water quality necessary to maintain existing or anticipated designated beneficial uses.

The Clean Water Act provides primary authority to States to set their own standards but requires that all State beneficial uses and their criteria comply with the

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"fishable and swimmable" goals of the Act. At a minimum, State beneficial uses must support aquatic life and recreational use. In effect, States cannot designate "waste assimilation" as a beneficial use, as some States did prior to 1972.

The EPA recommends that States assess support of the following individual beneficial uses:

Aquatic Life Support

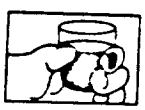
The waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Fish Consumption

The waterbody supports a population of fish free from contamination that could pose a human health risk to consumers.

Shellfish Harvesting

The waterbody supports a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.



Drinking Water Supply

The waterbody can supply safe drinking water with conventional treatment.

Primary Contact Recreation – Swimming

People can swim in the waterbody without risk of adverse human health effects (such as catching waterborne diseases from raw sewage contamination).

Secondary Contact Recreation

People can perform activities on the water (such as canoeing) without risk of adverse human health effects from occasional contact with the water.

Agriculture

The water quality is suitable for irrigating fields or watering livestock.

EPA recognizes five levels of use support (Table ES-1). If possible, the States determine the level of use support by comparing monitoring data with numeric criteria for each use designated for a particular waterbody. If monitoring data are not available, the State may determine the level of use support with qualitative information. Valid qualitative information includes land use data, fish and game surveys, and predictive model results. Monitored assessments are based on monitoring data. Evaluated assessments are based on qualitative information or monitored data more than 5 years old.

After the States determine the level of use support for each individual designated use in each waterbody, the States consolidate

Table ES-1: Levels of Use Support

Symbol	Use Support Level	Water Quality Condition	Definition
	Fully Supporting	Good	Water quality meets designated use criteria.
	Threatened	Good	Water quality supports designated uses now but may not in the future unless action is taken.
	Partially Supporting	Fair (Impaired)	Water quality fails to meet designated use criteria at times.
	Not Supporting	Poor (Impaired)	Water quality frequently fails to meet designated use criteria.
	Not Attainable	Poor	The State has performed a use-attainability study and documented that use support is not achievable due to natural conditions or human activity that cannot be reversed without imposing widespread economic and social impacts.

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NOTE

Overall use support is a general description of water quality conditions in a waterbody based on evaluation of individual use support. Overall use support determinations summarize multiple individual use determinations into a single measure of water quality conditions.

individual use support assessments to determine the level of overall use support for each waterbody.

- **Fully Supporting Overall Use** – All designated beneficial uses are fully supported.

- **Threatened Overall Use** – One or more designated beneficial uses are threatened and the remaining uses are fully supported.

- **Partially Supporting Overall Use** – One or more designated beneficial uses are partially supported and the remaining uses are fully supported.

- **Not Supporting Overall Use** – One or more designated beneficial uses are not supported.

- **Not Attainable** – The State has performed a use-attainability study and documented that use support of one or more designated beneficial uses is not achievable due to natural conditions or human activity that cannot be reversed without imposing widespread economic and social impacts.

- **Impaired Waters** – The sum of waterbodies partially supporting uses and not supporting uses.

The EPA then aggregates the State use support information into a national assessment of the Nation's water quality.

Water Quality Monitoring

Water quality monitoring consists of data collection and sample analysis performed according to quality control protocols. Monitoring also includes subsequent analysis of the body of data to support decision-making. Federal, Interstate, State, Territorial, Tribal, Regional, and local agencies, industry, and volunteer groups with approved quality assurance programs monitor a combination of chemical, physical, and biological water quality parameters throughout the country.

- Chemical data often measure concentrations of pollutants and other chemical conditions that influence aquatic life, such as pH (i.e., acidity) and dissolved oxygen concentrations. The chemical data may be measured in water samples, fish tissue samples, or sediment samples.

- Physical data include measurements of temperature, turbidity (i.e., light penetration through the water column), and solids in the water column.

- Biological data measure the health of aquatic communities. Biological data include counts of aquatic species that indicate healthy ecological conditions.

Monitoring agencies vary parameters, sampling frequency, and geographical site selection to meet program objectives and funding constraints. Sampling may occur at regular intervals (such as monthly, quarterly, or annually), irregular intervals, or during one-time intensive surveys. Sampling may be conducted at fixed sampling stations, randomly selected stations, stations near suspected water quality problems, or stations in pristine waters.

How Many of Our Waters Were Assessed for 1992?

National estimates of the total waters of our country provide the foundation for determining the percentage of waters assessed by the States and the portion impaired by pollution. In 1992, EPA calculated national estimates of total rivers and streams, lakes, estuaries, and coastal shoreline by summing State estimates of their total waters reported in their 1992 305(b) reports. Based on State-reported data, the estimate of total river and stream miles increased in 1992 in large part because the States included nonperennial streams, canals, and

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ditches that were previously excluded from estimates of total stream miles.

Current estimates indicate that the United States has

- More than 3.5 million miles of rivers and streams, which range in size from the Mississippi River to small streams that flow only when wet weather conditions exist (i.e., intermittent streams)
- Approximately 40 million acres of lakes, ponds, and reservoirs
- About 37,000 square miles of estuaries (excluding Alaska)
- More than 56,000 miles of ocean shoreline, including 36,000 miles in Alaska
- 5,382 miles of Great Lakes shoreline
- More than 277 million acres of wetlands such as marshes, swamps, bogs, and fens in the continental States including 170 million acres of wetlands in Alaska.

Due to factors such as funding limitations, most States assess a subset of their total water resources during each 2-year reporting cycle required under Clean Water Act Section 305(b). States are more capable of assessing all of their waters over a 5- to 10-year period. Figure ES-1 presents the percentage of total waters assessed by the States for the 1992 report. It should be noted that the percentage of perennial rivers and streams assessed is much greater than the percentage of total rivers and streams assessed.

Figure ES-1

Percent of Total Waters Assessed for the 1992 Report

Rivers and Streams
- 642,881 – 18% assessed
- Total miles: 3,551,247[a]

Lakes, Ponds, and Reservoirs
- 18,300,000 – 46% assessed
- Total acres: 39,920,000[b]

Estuaries
- 27,227 – 74% assessed
- Total square miles: 36,890[c]

Ocean Coastal Waters
- 3,398 – 6% assessed (including Alaska)
- Total miles: 56,121 miles, including Alaska's 36,000 miles of shoreline[d]

Great Lakes Shoreline
- 5,319 – 99% assessed
- Total miles: 5,382

Wetlands
- 10.5 million – 4% assessed (including Alaska)
- Total acres: 277 million acres, including Alaska's 170 million acres of wetlands

Based on 1992 State Section 305(b) reports.

NOTE: These figures were reported by the States. See explanation of changes in total water estimates on page ES-4.

[a] Does not include river miles in American Samoa and Guam, which did not report total river miles.
[b] Does not include lake acreages in American Samoa, Guam, Kentucky, and the Virgin Islands, which did not report total lake acreages.
[c] Does not include estuarine areas in Alaska, American Samoa, and Guam.
[d] Does not include shoreline miles in American Samoa and Guam.

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The summary information based on assessed waters may not represent overall conditions in the Nation's total waters because States often focus on monitoring and assessing major perennial rivers, estuaries, and public lakes with suspected pollution problems. Many States lack the resources to collect use support information for intermittent streams, small tributaries, and private ponds. EPA cannot predict the health of these unassessed waters.

Pollutants That Degrade Water Quality

Where possible, States identify the pollutants or processes that degrade water quality and indicators that document impacts of water quality degradation (see Table ES-2). Pollutants include sediment, nutrients, and chemical contaminants (such as dioxin and metals). Processes that degrade waters include habitat modification (such as destruction of streamside vegetation) and hydrologic modification (such as flow reduction). Indicators of water quality degradation include physical, chemical, and biological parameters. Examples of biological parameters include species diversity and abundance. Examples of physical and chemical parameters include pH, turbidity, and temperature. Following are descriptions of the effects of the pollutants and processes most commonly identified in rivers, lakes, estuaries, coastal waters, wetlands, and ground water.

Nutrients include nitrates found in sewage and fertilizers and phosphates found in detergents and fertilizers. In excess levels, nutrients overstimulate the growth of aquatic plants and algae. Excessive growth of these organisms, in turn, can clog navigable waters, use up dissolved oxygen as they decompose, and block light to deeper waters. This seriously affects the respiration of fish and aquatic invertebrates, leads to a decrease in animal and plant diversity, and affects our use of the water for fishing, swimming, and boating. In ground water, fertilizers and nitrates are among the principal contaminants that can lead to drinking water well closures.

Silt and other suspended solids wash off plowed fields, construction and logging sites, urban areas, strip-mined land, and eroded stream banks when it rains. As these sediments enter rivers, lakes, coastal waters, and wetlands, fish respiration is impaired, plant productivity and water depth are

Table ES-2. Top Causes of Water Quality Impairment

Rank	Rivers	Lakes	Estuaries
1	Siltation	Metals	Nutrients
2	Nutrients	Nutrients	Pathogens
3	Pathogens	Organic Enrichment/ Low DO	Organic Enrichment/ Low DO
4	Pesticides	Siltation	Siltation
5	Organic Enrichment/ Low DO	Priority Organic Chemicals	Suspended Solids

Based on 1992 State Section 305(b) reports.

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reduced, aquatic organisms and their habitats are smothered, and our aesthetic enjoyment of the water is reduced.

Pathogens (certain waterborne bacteria, viruses, and protozoans) can cause human illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. These organisms can enter waterways through a number of routes, including inadequately treated sewage, storm water drains, septic systems, runoff from livestock pens, and boats that dump sewage. Because it is impossible to test water for every type of disease-causing organism, States usually measure indicator bacteria such as fecal coliforms that suggest the water may be contaminated with untreated sewage and that other, more dangerous, organisms may be present.

Organic material may enter waterways in many different forms–as sewage, as leaves and grass clippings, or as runoff from livestock feedlots and pastures. When natural bacteria and protozoa in the water break down this organic material, they begin to use up the oxygen dissolved in the water. Many types of fish and bottom-dwelling animals cannot survive when levels of dissolved oxygen drop below 2 to 5 parts per million.

Metals (such as mercury, lead, and cadmium) and **toxic organic chemicals** (such as PCBs and dioxin) may originate in industrial discharges, runoff from city streets, mining activities, leachate from landfills, and a variety of other sources. These toxic chemicals, which are generally persistent in the environment, can cause death or reproductive failure in fish, shellfish, and wildlife. In addition, they can accumulate in animal and fish tissue, be absorbed in sediments, or find their way into drinking water supplies, posing long-term health risks to humans.

Pesticides and herbicides used on croplands, lawns, and in termite control can be washed into ground and surface waters by rainfall, snowmelt, and

Fish Kills

Fish kill reporting is a voluntary process; States are not required to report on how many fish kills occur, or what might have caused them. In many cases it is the public–fishermen and hunters, recreational boaters, or hikers–who first notice fish kills and report them to game wardens or other State officials. Many fish kills go undetected or unreported, and others may be difficult to investigate, especially if they occur in remote areas. This is because dead fish may be carried quickly downstream, or may be difficult to count because of turbid conditions. It is therefore likely that the statistics presented by the States underestimate the total number of fish kills that occurred nationwide between 1990 and 1992.

Despite these problems, fish kills are an important consideration in water quality assessments, and State reporting on the number and causes of kills is improving. In 1992, 43 States reported a total of 1,620 fish kill incidents. These States attributed 930 of the fish kills to pollution, 369 to unknown causes, and 586 to natural conditions, such as low flow and high temperatures. Pollutants most often cited as the cause of kills included biochemical oxygen-demanding substances, pesticides, manure and silage, oil and gas, chlorine, and ammonia. Leading sources of fish kills include agricultural activities, industrial discharges, municipal sewage treatment plant discharges, spills, and pesticide applications.

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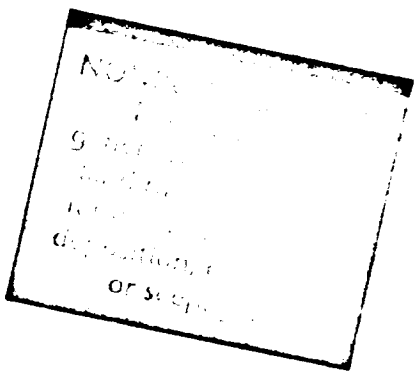

irrigation practices. These contaminants are generally very persistent in the environment and may accumulate in fish, shellfish, and wildlife to levels that pose a risk to human health and the environment. Pesticides are among the principal contaminants causing drinking water well closures in the southern and western regions of the country.

Habitat modification results from activities such as grazing, farming, channelization, dam construction, and dredging. Typical examples of the effects of hydrologic modification include loss of streamside vegetation, siltation, smothering of bottom-dwelling organisms, and increased water temperatures.

Other pollutants include salts, acidic contaminants, and oil and grease. Fresh waters may become unfit for aquatic life and some human uses when they become contaminated by salts. Sources of salinity include irrigation runoff, brine used in oil extraction, road deicing operations, and the intrusion of sea water into ground and surface waters in coastal areas. Acidity problems are of concern in areas with many abandoned mines (acid mine drainage) and areas susceptible to acid rain. Changes in acidity (measured as pH) can alter the toxicity of other chemicals in water and can render lakes and streams unfit for aquatic life.

Other pollutants of concern include crude oil and processed petroleum products spilled during extraction, processing, or transport or leaked from underground storage tanks; noxious aquatic plants, particularly introduced species that compete against native plants; and increased water temperatures resulting from industrial cooling processes or habitat modification.

Table ES-3. Pollution Source Categories Used in This Report

Category	Examples
Industrial	Pulp and paper mills, chemical manufacturers, steel plants, textile manufacturers, food processing plants
Municipal	Publicly owned sewage treatment plants that may receive indirect discharges from industrial facilities or businesses
Combined Sewers	Single facilities that treat both stormwater and sanitary sewage, which may become overloaded during storm events and discharge untreated wastes into surface waters.
Storm Sewers/ Urban Runoff	Runoff from impervious surfaces including streets, buildings, lawns, and other paved areas that enters a sewer, pipe, or ditch before discharge into surface waters
Agricultural	Crop production, pastures, rangeland, feedlots, other animal holding areas
Silvicultural	Forest management, tree harvesting, logging road construction
Construction	Land development, road construction
Resource Extraction	Mining, petroleum drilling, runoff from mine tailing sites
Land Disposal	Leachate or discharge from septic tanks, landfills, and hazardous waste sites
Hydrologic Modification	Channelization, dredging, dam construction, streambank modification

Sources of Water Pollution

Often we associate water pollution with images of oil spills or raw sewage and toxic chemicals spewing from pipes at industrial facilities and sewage treatment plants. Although point source discharges

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still produce some pollution, most are controlled with specific permit conditions that they usually meet. Currently, less visible nonpoint sources of pollution are more widespread and introduce vast quantities of pollutants into our surface and ground waters. Nonpoint sources deliver pollutants to waterbodies in a dispersed manner rather than from a discrete pipe or other conveyance. Nonpoint sources include atmospheric deposition, contaminated sediments, and land use activities that generate polluted runoff, such as construction, agriculture, logging, mining, and onsite sewage disposal.

In contrast, point sources discharge wastes into waterbodies from a discrete point that is easily identified. The most common point sources are industrial facilities, municipal treatment plants, and combined sewers. Although diffuse runoff is generally treated as a nonpoint source, runoff is a point source if it enters and is discharged from a conveyance such as those described in CWA Section 502(14) (such as pipes, ditches, and canals). Table ES-3 defines the point and nonpoint categories of pollution sources most frequently cited in this document. Table ES-4 lists the leading sources of impairment reported by States for their rivers, lakes, and estuaries.

Other sources cited less frequently include atmospheric deposition, in-place contaminants, and natural sources. Atmospheric deposition refers to contaminants entering waters from polluted air. In-place contaminants were generated by past activities, such as discontinued industrial discharges, logging, or one-time spills. In-place contaminants often reside in sediments but continue to release pollutants back into the water column. Natural sources refer to an assortment of water quality problems:

- Natural deposits of salts, gypsum, nutrients, and metals in soils that leach into surface and ground waters
- Warm weather and dry conditions that raise water temperatures, depress dissolved oxygen concentrations, and dry up shallow waterbodies
- Low-flow conditions and tannic acids from decaying leaves that lower pH and dissolved oxygen concentrations in swamps draining into streams.

With so many potential sources of pollution, it is difficult and expensive for States to identify specific sources responsible for water quality impairments. Many States lack funding for monitoring to identify all but the most apparent sources degrading waterbodies. State management priorities may focus monitoring

> *"The term 'point source' means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture."*
>
> Clean Water Act Section 502(14)

Rank	Rivers	Lakes	Estuaries
1	Agriculture	Agriculture	Municipal Point Sources
2	Municipal Point Sources	Urban Runoff/ Storm Sewers	Urban Runoff/ Storm Sewers
3	Urban Runoff/ Storm Sewers	Hydrologic/Habitat Modification	Agriculture
4	Resource Extraction	Municipal Point Sources	Industrial Point Sources
5	Industrial Point Sources	Onsite Wastewater Disposal	Resource Extraction

Based on 1992 State Section 305(b) reports.

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Total rivers = 3.5 million miles
Total assessed = 642,881 miles

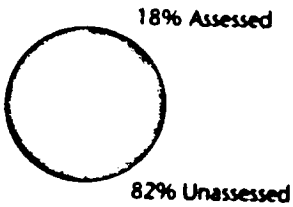
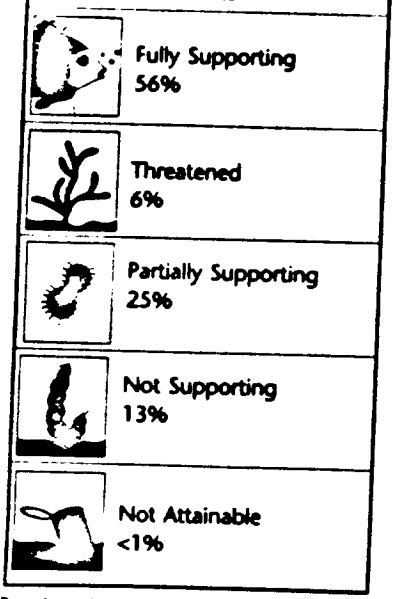


Figure ES-2

Levels of Overall Use Support – Rivers and Streams



Based on data contained in Appendix A, Table A-1.

budgets on other water quality issues, such as identification of contaminated fish populations that pose a human health risk. Management priorities may also direct monitoring efforts on larger waterbodies and overlook sources impairing smaller waterbodies. As a result, the States do not associate every impacted waterbody with a source of impairment in their 305(b) reports, and the summary information presented in this report applies exclusively to a subset of the Nation's impaired waters.

Rivers and Streams

Pollutants discharged upstream often become the problem of someone who lives downstream (or of the aquatic life that exists *instream*), and all of the activities that take place in a watershed can have a water quality impact elsewhere in the watershed. The term watershed simply refers to a geographic area in which water, sediments, and dissolved materials (contaminants) drain to a common outlet such as a point on a larger river, lake, ground water aquifer, or ocean. It is therefore important to remember that rivers and streams are connected–by hydrology, ecology, geology, and social and economic considerations–to the lakes, wetlands, and coastal and ground waters we discuss later in this document.

Do Our Rivers and Streams Support Uses?

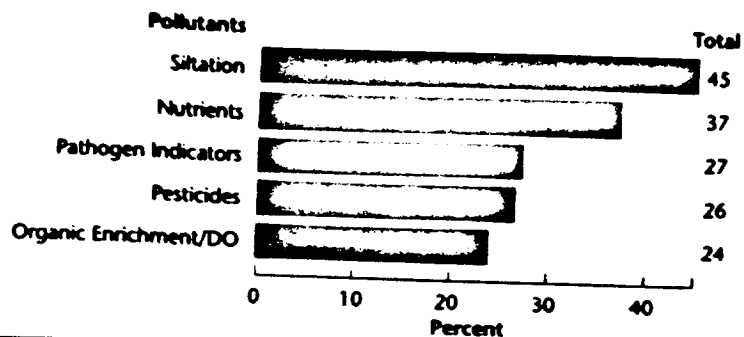
For the 1992 Report, 54 States, Territories, Tribes, Commissions, and the District of Columbia (hereafter referred to as "States") assessed 642,881 miles (18%) of the Nation's total 3.5 million miles of rivers and streams (see Appendix A, Table A-1, for individual State information).

The States assessed about 4,000 fewer river miles in 1992 than in

Figure ES-3

Percent of Assessed River Miles Impaired by Pollutants

(222,370 assessed river miles impaired)



Based on data contained in Appendix A, Table A-3.

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1990. EPA expected the percentage and amount of waters assessed to decline in 1992 because EPA advised the States to no longer include waters in the assessed categories for which the State lacked specific information. The percentage of waters assessed dropped because the baseline estimate of total waters increased.

Conditions in unassessed rivers cannot be estimated with summary information based on assessed waters because unassessed rivers include an unknown combination of pristine and impaired rivers. Therefore, the following discussion applies exclusively to assessed waters and cannot be extrapolated to describe conditions in the Nation's rivers as a whole. EPA is working with the States to expand assessment coverage of the Nation's waters and expects future assessment information to cover a greater portion of the Nation's rivers and streams (see Chapter 12).

Of the Nation's 642,881 assessed river miles, the States found that 56% fully support their designated uses, and an additional 6% support uses but are threatened and may become impaired if pollution control actions are not taken. The States reported that 25% of the assessed river miles partially support uses, and 13% of the assessed river miles do not support designated uses. Only 125 miles (less than one-tenth of 1%) of the assessed waters could not attain designated uses (see Figure ES-2).

What Is Polluting Our Rivers and Streams?

The States reported that siltation and nutrients impair more miles of rivers and streams than any other pollutants, affecting 45% and 37% of impaired stream miles in the States reporting causes, respectively (see Appendix A, Table A-3, for individual State information). Other leading causes of impairment include indicators of pathogens, affecting 27%; pesticides, affecting 26%; and organic enrichment and resultant low levels of dissolved oxygen, affecting 24% of impaired stream miles (see Figure ES-3).

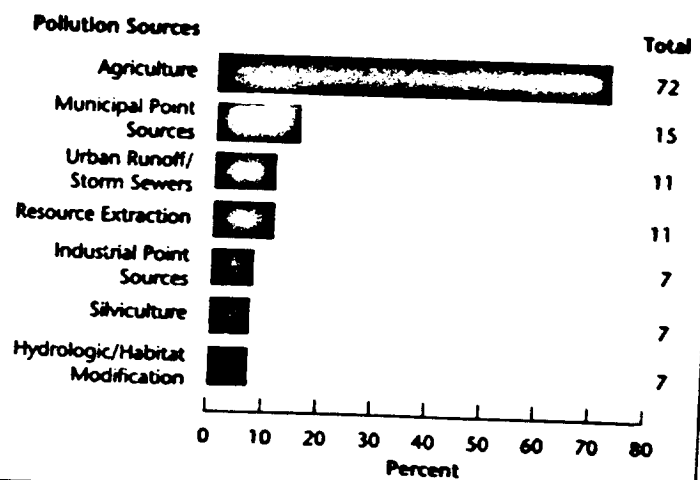
Where Does This Pollution Come From?

Forty-eight States identified sources contributing to the impairment of 221,877 miles of their rivers and streams not fully supporting designated uses (see Appendix A, Table A-4, for individual State information). These States reported that agricultural runoff is the leading source of pollutants in rivers and streams (see Figure ES-4). Forty-five States identified almost 160,000 river miles impaired by agricultural sources, including nonirrigated crop production, irrigated crop production, rangeland, and animal holding

Figure ES-4

Percent of Assessed River Miles Impaired by Sources of Pollution

(221,877 assessed river miles impaired)



Based on data contained in Appendix A, Table A-4.

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areas. These States found that agricultural activities contribute to the impairment of 72% of the impaired stream miles in the 48 States reporting sources. The States identified other sources of impairment less frequently, such as municipal point sources, affecting 15%, urban runoff and storm sewers, affecting 11%, and resource extraction, affecting 11% of the impaired waters.

Although this summary provides the best picture of national impacts from sources available to EPA at this time, it has limitations. The information provided applies to only a small portion of our Nation's total rivers and streams because the States cannot assess all their waters in a 2-year period and they cannot specify the source of pollution impairing each waterbody assessed. In addition, national summary information can obscure sources with regional or State significance. For example, Oregon reports that silviculture (forestry activity) contributes to the impairment of 46% of their rivers and streams that do not fully support designated uses. Nationally, silviculture impacts only 7% of the impaired rivers and streams. Therefore, it is important to refer to the individual State data presented in Appendix A for a more specific description of sources impairing rivers and streams.

Lakes, Ponds, and Reservoirs

Lakes are sensitive to pollution inputs because lakes flush out their contents relatively slowly. Even under natural conditions, lakes undergo eutrophication, an aging process that slowly fills in the lake with sediment and organic matter (see sidebar on p. ES-12). The eutrophication process alters basic lake characteristics such as depth, biological productivity, oxygen levels, and water clarity. The eutrophication process is commonly defined by a series of trophic states as described in the sidebar.

Trophic States

Oligotrophic	Clear waters with little organic matter or sediment and minimum biological activity.
Mesotrophic	Waters with more nutrients and, therefore, more biological productivity.
Eutrophic	Waters extremely rich in nutrients, with high biological productivity. Some species may be choked out.
Hypereutrophic	Murky, highly productive waters, closest to the wetlands status. Many clearwater species cannot survive.
Dystrophic	Low in nutrients, highly colored with dissolved humic organic matter. (Not necessarily a part of the natural trophic progression.)

The Eutrophication Process

Eutrophication is a natural process, but human activities can accelerate eutrophication by increasing the rate at which nutrients and organic substances enter lakes from their surrounding watersheds. Agricultural runoff, urban runoff, leaking septic systems, sewage discharges, eroded streambanks, and similar sources can enhance the flow of nutrients and organic substances into lakes. These substances can overstimulate the growth of algae and aquatic plants, creating conditions that interfere with the recreational use of lakes and the health and diversity of indigenous fish, plant, and animal populations. Enhanced eutrophication from nutrient enrichment due to human activities is one of the leading problems facing our Nation's lakes and reservoirs.

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Do Our Lakes and Reservoirs Support Uses?

Forty-nine States assessed overall use support in more than 18 million lake acres representing 46% of the approximately 40 million total acres of lakes, reservoirs, and ponds in the Nation (see Appendix B, Table B-1, for individual State information). For 1992, the States assessed about 180,000 fewer lake acres than in 1990. Overall, 43% of the assessed lake acres fully support designated uses such as swimming, fishing, and drinking water supply (see Figure ES-5). An additional 13% were identified as threatened and could soon become impaired if pollution control actions are not taken. The States reported that 35% of assessed lake acres partially support designated uses, 9% do not support uses, and less than 1% cannot attain uses.

What Is Polluting Our Lakes, Reservoirs, and Ponds?

Forty-seven States reported causes of impairment in their lakes (Appendix B, Table B-3, contains individual State data). Overall, these States reported that metals and nutrients are the most common causes of nonsupport in assessed lakes, affecting 47% and 40% of impaired lake acres, respectively (see Figure ES-6). However, impairments due to metals were concentrated in several States with large numbers of lakes (primarily Minnesota), while nutrient problems were widely reported by 41 States. Other leading causes of lake impairment were organic enrichment, affecting 24% of impaired lake acres; siltation, affecting 22%; and priority organics, affecting 20% of impaired lake acres.

Total lakes = 39,920,000 acres
Total assessed = 18,300,000 acres

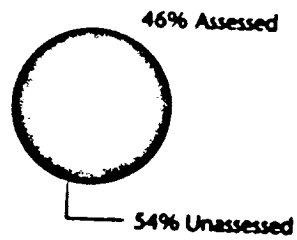
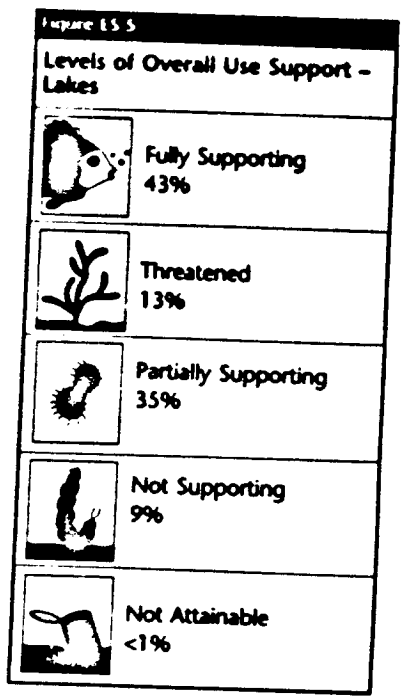


Figure ES-5

Levels of Overall Use Support – Lakes

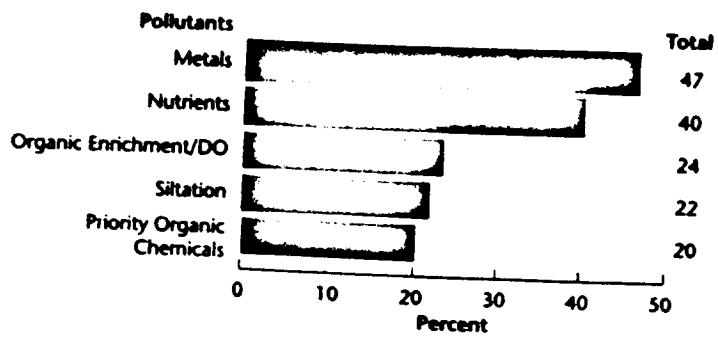


Based on data contained in Appendix B, Table B-1.

Figure ES-6

Percent of Assessed Lake Acres Impaired by Pollutants

(7,958,064 assessed lake acres impaired)



Based on data contained in Appendix B, Table B-3.

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Forty-one States also assessed trophic status, which is associated with nutrient enrichment, in 11,477 of their lakes. Nutrient enrichment tends to increase the proportion of lakes in the eutrophic and hyper-eutrophic categories. These States reported that 17% of the lakes they assessed for trophic status were oligotrophic, 35% were mesotrophic, 32% were eutrophic, 7.5% were hypereutrophic, and 8.5% were dystrophic. This information may not be representative of national lake conditions because States often assess lakes in response to a problem or public complaint or because of their easy accessibility. It is likely that more remote lakes – which are probably less impaired – are underrepresented in these assessments.

Acid Effects on Lakes

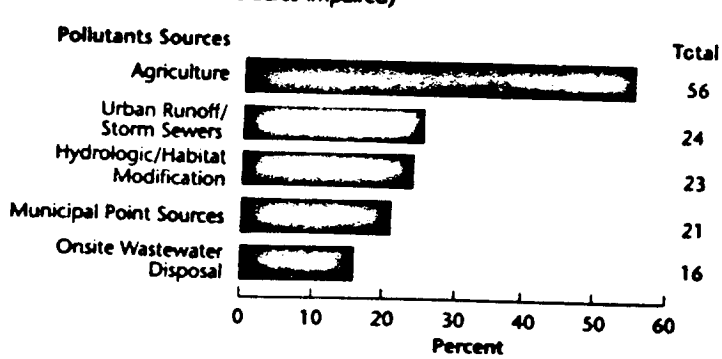
Increases in lake acidity can radically alter the community of fish and plant species in lakes and can increase the solubility of toxic substances and magnify their adverse effects. Twenty-four States reported the results of lake acidification assessments. These States assessed pH (a measure of acidity) at more than 6,800 lakes and detected a threat of acidic conditions in 1,038 lakes (15% of the assessed lakes). Most of the States that assessed acidic conditions are located in the Northeast, upper Midwest, and the South.

Only 11 States identified sources of acidic conditions. States in the Northeast attributed most of their acid lake conditions to acid deposition from acidic rain, fog, or dry deposition in conjunction with natural conditions that limit a lake's capacity to neutralize acids. Only two States, Tennessee and Alabama, reported that acid mine drainage resulted in acidic lake conditions.

Figure ES-7

Percent of Assessed Lake Acres Impaired by Sources of Pollution

(5,543,987 assessed lake acres impaired)



Based on data contained in Appendix B, Table B-4.

Where Does This Pollution Come From?

Forty-five States identified individual sources degrading some of their 5.5 million impaired lake acres (Appendix B, Table B-4, contains individual State data). These States reported that agriculture impairs more lake acres than any other source. Thirty-eight States found that agriculture contributes to the impairment of 3 million lake acres, or 56% of the impaired lake acres in the 45 States reporting sources of pollution in lakes (see Figure ES-7).

The States also reported that urban runoff and storm sewers contribute to impairments in 24% of their impaired lake acres, hydrologic modifications and habitat modifications affect 23%, municipal point sources affect 21%, and onsite wastewater disposal (such as septic systems) affect 16% of the impaired lake acres.

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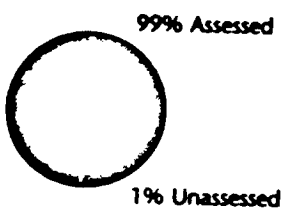
The Great Lakes

The Great Lakes contain one-fifth of the world's fresh surface water and are stressed by a wide range of pollution sources associated with the large urban centers located on their shores. Many of the pollutants that reach the Great Lakes remain in the system indefinitely because the Great Lakes are a relatively closed water system.

Do the Great Lakes Support Uses?

The States assessed 99% of the Great Lakes shoreline miles in 1992. Less than 3% of the assessed shoreline miles fully support uses due to conditions that generate fish consumption advisories issued by the Great Lakes States and the Province of Ontario for the nearshore waters of the Great Lakes (see Figure ES-8). Thirty percent of assessed shoreline miles partially support uses, and the remaining 67% do not support uses. These figures do not address water quality conditions in the deeper, cleaner, central waters of the Lakes.

Total Great Lakes = 5,382 miles
Total assessed = 5,319 miles

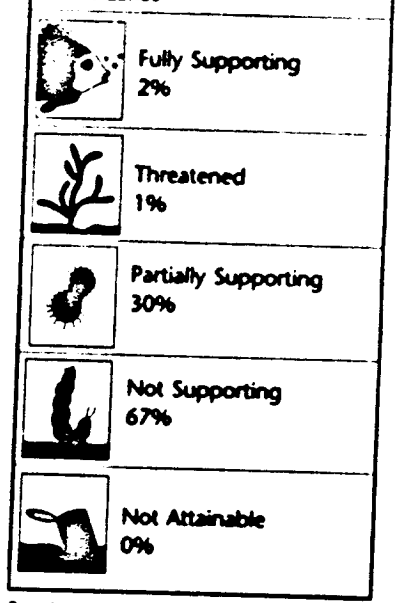


What Is Polluting the Great Lakes?

Most of the Great Lakes shoreline is polluted by toxic organic chemicals–primarily PCBs and DDT–that are often found in fish tissue samples. The Great Lakes States reported that toxic organic chemicals impact 99% of the impaired Great Lakes shoreline miles. Other leading causes of impairment include metals, affecting 11%, organic enrichment and low dissolved oxygen, affecting 7%; nutrients, affecting 5%; and siltation, affecting 3% (see Figure ES-9).

Figure ES-8

Levels of Overall Use Support – Great Lakes

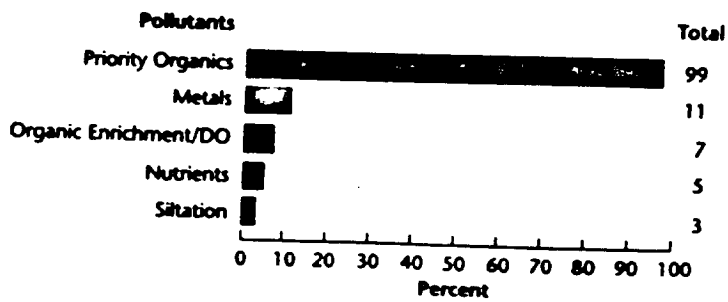


Based on data contained in Appendix F, Table F-1.

Figure ES-9

Percent of Assessed Great Lakes Shore Miles Impaired by Pollutants

(5,171 assessed Great Lakes shore miles impaired)



Based on data contained in Appendix F, Table F-3.

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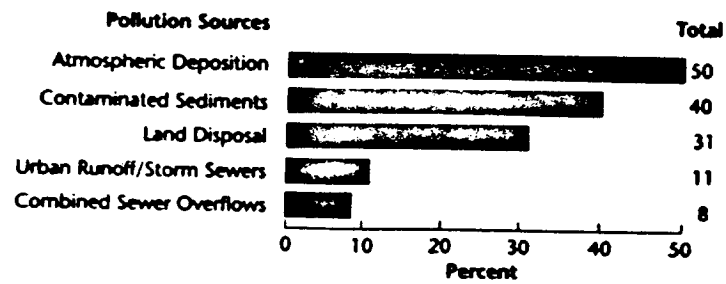
Where Does This Pollution Come From?

Although information on sources of pollution in the Great Lakes is sketchy, the reported information suggests that atmospheric deposition and contaminated sediments are the leading sources impairing Great Lakes waters. Sediment contamination is a major problem in nearshore waters and harbors. Other sources cited by the States include landfills, urban runoff, and combined sewer overflows (see Figure ES-10).

Figure ES-10

Percent of Assessed Great Lakes Shore Miles Impaired by Sources of Pollution

(1,884 assessed Great Lakes shore miles impaired)



Based on data contained in Appendix F, Table F-4.

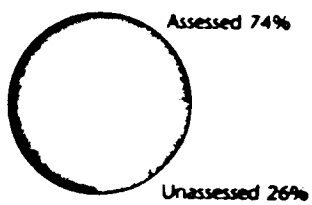
Estuaries

Estuaries are areas partially surrounded by land where rivers meet the sea. They are characterized by varying degrees of salinity, complex water movements affected by ocean tides and river currents, and high turbidity levels. They are also highly productive ecosystems with a range of habitats for many different species of plants, shellfish, fish, and animals.

Many species permanently inhabit the estuarine ecosystem; others, such as shrimp, use the nutrient-rich estuarine waters as nurseries before traveling to the sea.

Estuaries are stressed by the particularly wide range of activities located within their watersheds. They receive pollutants carried by rivers from agricultural lands and cities; they often support marinas, harbors, and commercial fishing fleets; and their surrounding lands are highly prized for development. These stresses pose a continuing threat to the survival of these bountiful waters.

Total estuaries = 36,890 square miles
Total assessed = 27,227 square miles



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Do Our Estuaries Support Uses?

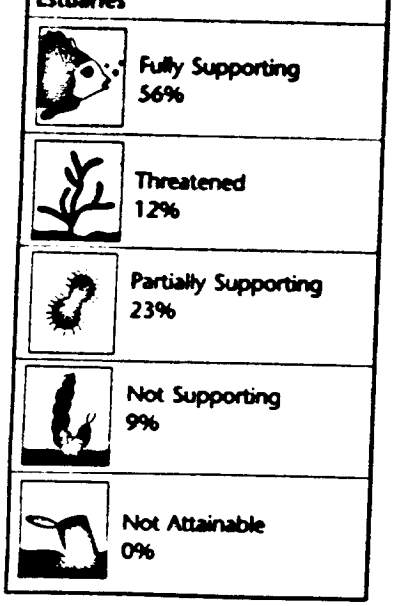
Twenty-five coastal States assessed roughly three-quarters of the Nation's total estuarine waters in 1992. Of these, 56% were found to fully support designated uses. An additional 12% are fully supporting uses but are threatened and could become impaired if pollution control actions are not taken. Twenty-three percent of assessed estuarine square miles partially support uses, and the remaining 9% do not support uses (see Figure ES-11).

What Is Polluting Our Estuaries?

States report that the most common causes of nonsupport of designated uses in our Nation's estuaries are nutrients, affecting 55% of the 8,572 impaired square miles; followed by pathogens, affecting 42%; organic enrichment and resulting low levels of dissolved oxygen, affecting 34%; and siltation, affecting 12% (see Figure ES-12). Pathogen contamination is responsible for the closure of shellfishing beds in many areas of the country.

Figure ES-11

Levels of Overall Use Support – Estuaries

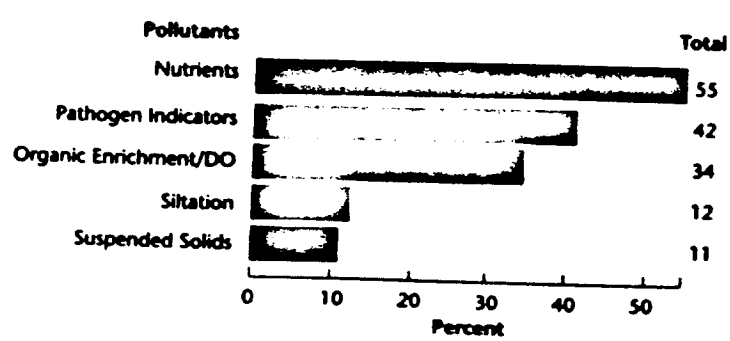


Based on data contained in Appendix C, Table C-1.

Figure ES-12

Percent of Assessed Estuary Square Miles Impaired by Pollutants

(8,572 assessed estuarine square miles impaired)



Based on data contained in Appendix C, Table C-3.

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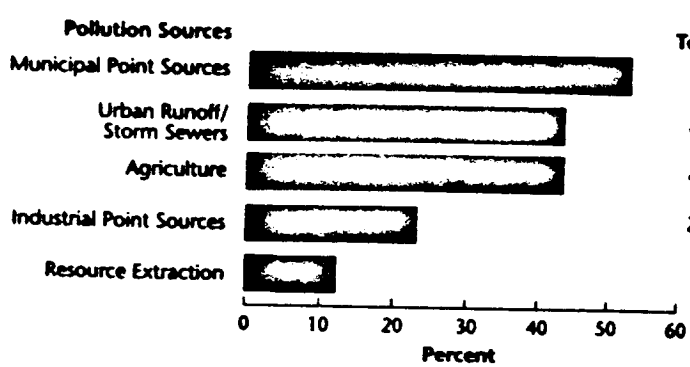
Where Does This Pollution Come From?

States report that municipal sewage treatment plants, urban runoff/storm sewers, and agriculture are the leading sources of pollution in their estuarine waters, affecting 53%, 43%, and 43% of impaired estuarine square miles, respectively (see Figure ES-13). Other leading sources cited by the States include industrial point sources, affecting 23%, and resource extraction, affecting 12%. Point sources continue to have a significant impact on estuarine water quality because concentrated population centers and industrial operations are located adjacent to major estuarine systems. In contrast, rivers and lakes are more dispersed in rural and urban areas throughout the country and tend to support more diverse land uses that generate nonpoint source pollution.

Figure ES-13

Percent of Assessed Estuary Square Miles Impaired by Sources of Pollution
(8,303 assessed estuarine square miles impaired)



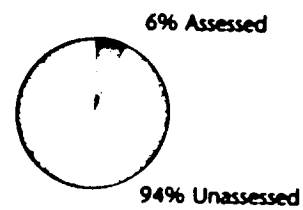
Based on data contained in Appendix C, Table C-4.

Ocean Coastal Waters

We know less about the condition of our ocean coastal waters than we do about our estuarine or inland waters. In part, this may be because we tend to think that only oil spills or similar disastrous events could possibly affect a resource as vast as an ocean.

In fact, we are seeing evidence that our ocean waters – particularly the waters near our coasts – suffer from the same pollution problems that affect our inland waters. Beach debris cleanups are cataloging tons of trash carried into the oceans by rivers, washed in from city storm sewers, thrown in by beach visitors, or dumped overboard by boaters. Beaches are closed to swimming every summer due to pathogens from inadequately treated wastes. Marine mammals are suffering from pollution-related stresses. Fragile coral reefs in Florida and Hawaii show signs of pollution impacts. Coastal development is increasing at a rapid rate. Clearly we can no longer assume that the oceans can take care of themselves.

Total ocean shore = 56,121 miles
Total assessed = 3,398 miles



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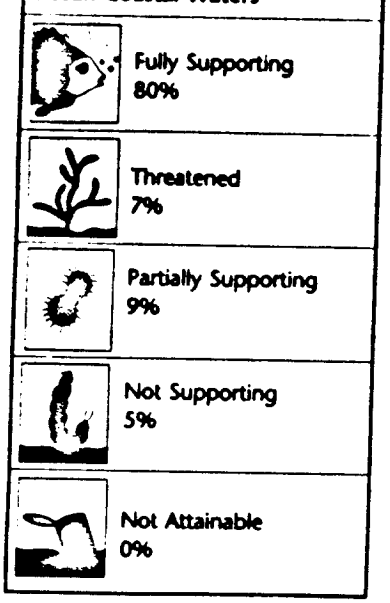
Do Ocean Shores Support Uses?

Twelve of the 29 coastal States assessed only 6% of the Nation's estimated 56,121 miles of ocean coastline. Of these, 80% were found to fully support their designated uses, and 7% are supporting uses but are threatened and likely to become impaired if pollution control actions are not taken. Nine percent of assessed ocean shore miles partially support designated uses, and 5% do not support uses (see Figure ES-14). These figures do not necessarily represent water quality conditions in the Nation's ocean coastal waters as a whole because they apply to only 6% of the Nation's coastline miles. Data on pollutants and sources of pollution are too sparse to be included in this report.

Figure ES-14

Levels of Overall Use Support – Ocean Coastal Waters



Based on data contained in Appendix C, Table C-5.

Wetlands

Wetlands are areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Often in the past, wetlands were considered wastelands–the source of mosquitoes, flies, and unpleasant odors–to be filled or drained and put to "better use." When European settlers first arrived in America, over 200 million acres of wetlands existed in the coterminous States. Today, half of our Nation's wetlands have been destroyed by filling, draining, polluting, channelizing, grazing, clearing, and other modifications resulting from human activity.

Wetlands are now recognized as some of the most unique and important natural areas on earth. They vary in type according to differences in local and regional hydrology, vegetation, water chemistry, soils, topography, and climate. Coastal wetlands include estuarine marshes; mangrove swamps found in Puerto Rico, Hawaii, and Florida; and Great Lakes coastal wetlands. Inland wetlands, which may be adjacent to a waterbody or isolated,

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Total wetlands = 277 million acres
Total assessed = 10,516,754 acres

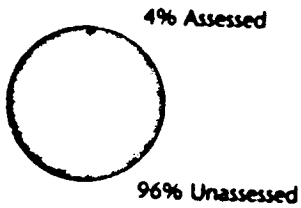
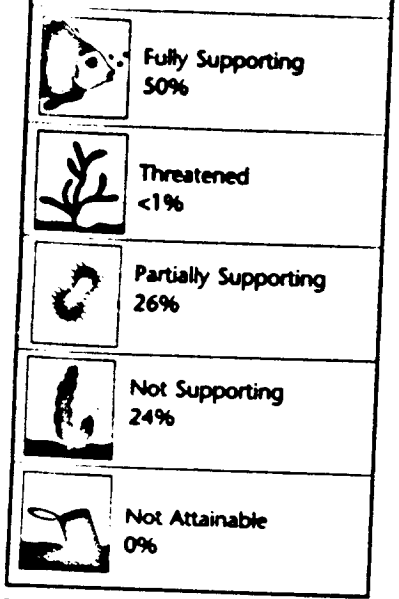


Figure ES-15

Levels of Overall Use Support – Wetlands



Based on data contained in Appendix D, Table D-2.

NOTE: The information on designated use support represents data from only eight States so national trends should not be drawn from these data.

include marshes and wet meadows, bottomland hardwood forests, Great Plains praine potholes, cypress-gum swamps, and southwestern playa lakes.

Wetlands provide food and shelter to countless animal species including many fishes, birds, reptiles, and mammals. A high percentage of federally listed threatened or endangered animals and plants depend directly or indirectly on wetlands for their survival. Wetlands also provide spawning habitat and nursery grounds for an estimated 71% of commercially valuable fish and shellfish consumed in this country. In addition, they also serve as feeding areas along migration routes for waterfowl and other wildlife.

Wetlands soil and vegetation help in flood control by acting as natural sponges that attenuate flooding water. Wetlands plants also help control erosion in two ways: their roots bind the soil and their leaves slow the movement of water. Wetlands help purify water by processing nutrients and other pollutants and filtering suspended materials. They also help regulate water quantity by absorbing water in wet seasons and releasing it through seeps, springs, and open outlets during dry seasons.

In addition, wetlands are widely enjoyed by hikers, birdwatchers, hunters, fishermen, photographers, and boaters and play an important role in our Nation's natural and cultural heritage. Millions of people spend nearly $10 billion each year observing and photographing wetlands-dependent wildlife.

Do Our Wetlands Support Uses?

In 1992, most States could not assess use support in wetlands because they were still developing wetlands water quality standards. As a result, only eight States (California, Colorado, Hawaii, Iowa, Kansas, Nevada, North Carolina, and Oklahoma) reported use support for 10.5 million acres of their wetlands. These States assessed use support in approximately 4% of the Nation's 277 million acres of wetlands. North Carolina assessed 98% of the assessed wetlands; therefore, the summary information on use support describes conditions primarily in North Carolina's wetlands rather than the Nation's wetlands as a whole (see Figure ES-15).

These States reported that 50% of the assessed wetlands fully support designated uses, less than 1% are threatened, 26% partially support uses, and 24% do not support designated uses (Appendix D, Table D-2, contains individual State data). However, this information does not accurately reflect water quality conditions in the Nation's wetlands due to the skewed distribution of the assessed wetlands. Despite limitations in the data, the summary information suggests that water quality problems exist in our remaining wetlands.

What is Polluting Our Wetlands?

Of the eight States reporting overall use support in wetlands, only three States (Iowa, Kansas, and Nevada) quantified the wetlands acreage degraded by specific

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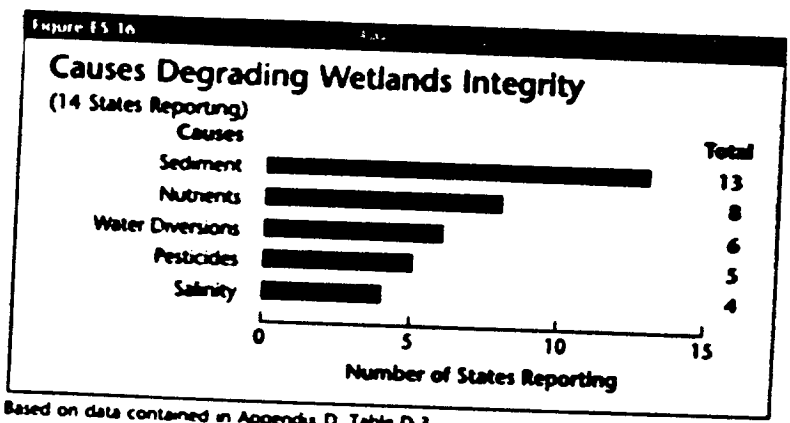
pollutants or processes causing wetlands impairment. Although the data submitted by these States are not representative of national conditions in wetlands, these States did report that metals impair over 60,000 acres of wetlands, salinity and chlorides impair over 42,000 acres of wetlands, and siltation impairs almost 29,000 acres of wetlands. Fourteen States did not quantify the acreage affected but did identify pollutants and processes that degrade some unknown quantity of their wetlands. Most of these States cited sediment and nutrients as pollutants of concern in wetlands (Figure ES-16). Fewer States reported that water diversions, pesticides, salinity, heavy metals, ponding, weeds, low dissolved oxygen, and pH impact their wetlands.

Where Does This Pollution Come From?

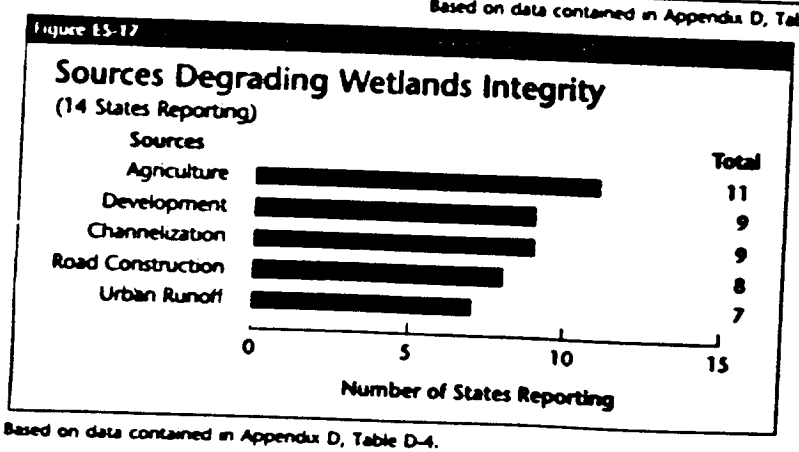
Iowa, Kansas, and Nevada also reported that agriculture impairs 76,000 acres of wetlands, hydrologic habitat modification impairs 48,000 acres, and municipal point sources impair over 11,000 acres of wetlands. Fourteen States did not quantify the acreage affected but did identify sources of pollutants that degrade some unknown quantity of wetlands. Most of these States reported that agriculture, development, channelization, and road construction degrade wetlands integrity (see Figure ES-17). These States also reported that urban runoff, resource extraction, landfills, natural conditions, industrial runoff, onsite systems, irrigation, recreation, point sources, and silviculture impact wetlands.

Figure ES-16



Based on data contained in Appendix D, Table D-3.

Figure ES-17



Based on data contained in Appendix D, Table D-4.

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Wetlands Loss: A Continuing Problem

Despite what we have learned about the value of our wetlands, these national treasures continue to be threatened by a variety of human activities. A U.S. Fish and Wildlife Service study of wetlands loss found that 2.6 million acres of wetlands were lost over the 9-year study period from the mid-1970s to the mid-1980s, or 290,000 acres a year. This is an improvement from the 1950s to the 1970s when wetlands were lost at a rate of 458,000 acres per year. Serious consequences have resulted nationwide from the loss and degradation of wetlands, including species decline and extinction, water quality decline, and increased incidences of flooding.

In 1992, 27 States reported on sources of current wetlands losses. These include agriculture, commercial development, residential development, highway construction, impoundments, resource extraction, industry, and dredge disposal (see Appendix D, Table D-1, for individual State information).

Ground Water

Ninety-five percent of all fresh water available on earth (exclusive of icecaps) is ground water. Ground water–water found in natural underground rock formations called aquifers–is a vital natural resource with many uses. The extent of the Nation's ground water resources is enormous. At least 60% of the land area in the conterminous United States overlies aquifers. Usable ground water exists in every State.

Aquifers can range in size from thin surficial formations that yield small quantities of ground water to large systems such as the High Plains aquifer that underlies eight western States and provides water to millions. Although most of the Nation's ground water is considered to be of good quality, an increasing number of pollution events have threatened the integrity of the resource.

Ground Water Use

Nationally, 53% of the population relies to some extent on ground water as a source of drinking water. This percentage is even higher in rural areas where most

Comprehensive State Ground Water Protection Programs

A Comprehensive State Ground Water Protection Program (CSGWPP) is a prevention-first approach that will enable better coordination of Federal, State, Tribal, and local ground-water-related programs. This will allow for better allocation of resources to the highest priority activities. Once the EPA endorses a CSGWPP, the Agency will seek to provide more consistent deference to State priorities.

A CSGWPP is composed of six "strategic activities," which include

- Establishing a prevention-oriented goal
- Establishing priorities, based on the characterization of the resource and identification of sources of contamination
- Defining roles, responsibilities, resources, and coordinating mechanisms
- Implementing all necessary efforts to accomplish the State's ground water protection goal
- Coordinating information collection and management to measure progress and reevaluate priorities
- Improving public education and participation.

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residents rely on potable or treatable ground water as an economical source of drinking water. Eighty-one percent of community water systems are dependent on ground water. Seventy-four percent of community water systems are small ground water systems serving 3,300 people or less. Ninety-five percent of the approximately 200,000 noncommunity water systems (serving schools, parks, etc.) are ground water systems.

Irrigation accounts for approximately 64% of national ground water withdrawals. Public drinking water supplies account for approximately 19% of the Nation's total ground water withdrawals. Domestic, commercial, livestock, industrial, mining, and thermoelectric withdrawals together account for approximately 17% of national ground water withdrawals.

Ground Water Quality

Although the 1992 Section 305(b) State Water Quality Reports indicate that, overall, the Nation's ground water quality is good to excellent, many local areas have experienced significant ground water contamination. Although the sources and types of ground water contamination vary depending upon the region of the country, those most frequently reported by States include:

- **Leaking underground storage tanks.** About 400,000 of an estimated 5 to 6 million underground storage tanks in the United States are thought to be leaking. About 30% of all tanks store petroleum or hazardous materials.

- **Septic tanks.** Approximately 23 million domestic septic systems are in operation in the United States. About half a million new systems are installed each year.

- **Municipal landfills.** Of the quarter million solid waste disposal facilities in the United States, about 6,000 are municipal solid waste facilities. Approximately 25% of these municipal facilities have ground water monitoring capabilities.

- **Agricultural activities.** Seventy-seven percent of the 1.1 billion pounds of pesticides produced annually in the United States is applied to land in agricultural production, which often overlies aquifers.

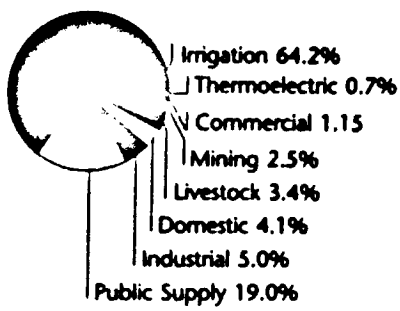
- **Abandoned hazardous waste sites.** Approximately 33,000 sites have been identified as abandoned hazardous waste sites, of which 42% involve ground water contamination.

The most common contaminants associated with these sources include nitrates, metals, volatile organic compounds (VOCs), and pesticides.

EPA has been working with States to develop a set of ground water quality indicators. These indicators will allow the characterization of trends in ground water quality over space and time. Examples of preliminary indicators include the number of maximum contaminant level violations in public water systems, detections of VOCs in ground water, and the extent of leachable agricultural pesticide use. EPA will

IRRIGATION
accounted for more than 64% of ground water use

National Ground Water Withdrawls by Water Use Category



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continue to work with the States to refine these ground water quality indicators.

Additional ground water monitoring initiatives have been undertaken in numerous States. These initiatives are aimed at characterizing the overall quality of ground water resources and typically include the establishment of ambient monitoring networks, regional monitoring networks that focus on sensitive aquifers, or site-specific monitoring efforts that focus on known or suspected contamination sources.

Water Quality Protection Programs

The EPA works in partnership with State and local governments to improve and protect water quality. Since the 1990 Report to Congress, EPA and many States have moved toward a more geographically oriented approach to water quality management. They share a growing consensus that the Nation's remaining water quality problems can be solved most effectively at the basin or watershed level.

In 1991, EPA highlighted the Watershed Protection Approach (WPA), a framework for focusing and integrating water quality monitoring and management activities in a watershed of concern. The WPA is not a new government program, but rather a means of pulling together the resources and expertise of existing programs at all levels, from Federal to State and local levels.

The EPA, other Federal agencies, State pollution control agencies, and local governments are applying the WPA to existing monitoring and assessment programs as well as water quality protection programs (see sidebar). A number of laws provide the authority to develop and implement pollution control programs. The primary statute providing for water quality protection in the Nation's rivers, lakes, wetlands, estuaries, and coastal waters is the Federal Water Pollution Control Act of 1972, commonly known as the Clean Water Act (CWA).

The Watershed Protection Approach (WPA)

Several key features characterize the WPA:

- The WPA encourages managers to examine all the factors contributing to water quality problems in a watershed and apply a coordinated, holistic approach to resolving the problems.
- The WPA advocates restoring and protecting ecological integrity in addition to protecting human health and meeting water quality standards.
- The WPA fosters a high level of interprogram coordination.

A State that is using the WPA

- Targets those watersheds where pollution poses the greatest risk to human health, ecological resources, or desirable uses of the water
- Involves all parties with a stake in the watershed in the analysis of problems and the implementation of solutions
- Draws on the full range of methods and tools available, integrating them into a coordinated, multiorganizational attack on the problems.

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The Clean Water Act

The Clean Water Act of 1972 and its amendments are the driving force behind many of the water quality improvements we have witnessed in recent years. Key provisions of the Clean Water Act provide the following pollution control programs.

Water quality standards and criteria – States adopt EPA-approved standards for their waters that define water quality goals for individual waterbodies. Standards consist of designated beneficial uses to be made of the water, criteria to protect those uses, and antidegradation provisions to protect existing water quality (see page ES-2).

Effluent guidelines – The EPA develops nationally consistent guidelines limiting pollutants in discharges from industrial facilities and municipal sewage treatment plants. These guidelines are then used in permits issued to dischargers under the National Pollutant Discharge Elimination System (NPDES) program. Additional controls may be required if receiving waters are still affected by water quality problems after permit limits are met.

Total Maximum Daily Loads– The development of Total Maximum Daily Loads, or TMDLs, establishes the link between water quality standards and point/nonpoint source pollution control actions such as permits or Best Management Practices (BMPs). A TMDL calculates allowable loadings from the contributing point and nonpoint sources to a given waterbody and provides the quantitative basis for pollution reduction necessary to meet water quality standards. States develop and implement TMDLs for high-priority impaired or threatened waterbodies.

Permits and enforcement – All industrial and municipal facilities that discharge wastewater must have an NPDES permit and are responsible for monitoring and reporting levels of pollutants in their discharges. EPA issues these permits or can delegate that permitting authority to qualifying States. The States and EPA inspect facilities to determine if their discharges comply with permit limits. If dischargers are not in compliance, enforcement action is taken.

In 1990, EPA promulgated permit application requirements for municipal sewers that carry storm water separately from other wastes and serve populations of 100,000 or more and for storm water discharges associated with some industrial activities. The EPA is developing regulations to establish a comprehensive program to regulate storm sewers, including requirements for State storm water management programs.

Grants – The EPA provides States with financial assistance to help support many of their pollution control programs. These programs include the State Revolving Fund program

NOTE

Under the Watershed Protection Approach (WPA), a "watershed" is a hydrogeologic area defined for addressing water quality problems. For example, a WPA watershed may be a river basin, a county-sized watershed, or a small drinking water supply watershed.

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for construction and upgrading of municipal sewage treatment plants; water quality monitoring, permitting, and enforcement; and developing and implementing nonpoint source pollution controls, combined sewer and storm water controls, ground water strategies, lake assessment, protection, and restoration activities, estuary and near coastal management programs, and wetlands protection activities.

Nonpoint source control – The EPA provides program guidance, technical support, and funding to help the States control nonpoint source pollution. The States are responsible for analyzing the extent and severity of their nonpoint source pollution problems and developing and implementing needed water quality management actions.

Control of combined sewer overflows – Under the National Combined Sewer Overflow Control Strategy of 1989, States develop and implement measures to reduce pollution discharges from combined storm and sanitary sewers. The EPA works with the States to implement the national strategy.

The CWA also established pollution control and prevention programs for specific waterbody categories, such as the Clean Lakes Program, discussed in more detail on the next page. Other statutes that also guide the development of water quality protection programs include

The Safe Drinking Water Act, under which States establish standards for drinking water quality, monitor wells and local water supply systems, implement drinking water protection programs, and implement Underground Injection Control (UIC) programs.

The Resource Conservation and Recovery Act establishes State and EPA programs for ground water and surface water protection and cleanup and emphasizes prevention of releases through management standards in addition to other waste management activities.

The Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Program), which provides EPA with the authority to clean up contaminated waters during remediation at contaminated sites.

The Pollution Prevention Act of 1990 requires EPA to promote pollutant source reduction rather than focus on controlling pollutants after they enter the environment.

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The Clean Lakes Program

EPA's Clean Lakes Program provides Federal funds to help States carry out diagnostic studies of lake problems, determine necessary protection and restoration measures, implement those measures, and monitor the long-term impacts and effectiveness of those measures. The Clean Lakes Program provides grants for four types of cooperative agreements:

Lake Water Quality Assessments strengthen State lake management programs and improve water quality information.

Phase I Diagnostic/Feasibility Studies investigate the causes of water quality decline in a publicly owned lake and determine the most feasible procedures for controlling pollutants and restoring the lake.

Phase II Projects implement the restoration and pollution control methods identified in a Phase I study.

Phase III Postrestoration Monitoring Projects sponsor long-term monitoring to verify the longevity and effectiveness of restoration and control measures implemented during a Phase II project.

Managing lake quality often requires a combination of in-lake restoration measures and pollution controls, including watershed management measures:

Restoration measures are implemented to reduce existing pollution problems. Examples of in-lake restoration measures include harvesting aquatic weeds, dredging sediment, and adding chemicals to precipitate nutrients out of the water column. Restoration measures focus on restoring uses of a lake and may not address the source of the pollution.

Pollution control measures deal with the sources of pollutants degrading lake water quality or threatening to impair lake water quality. Control measures include planning activities, regulatory actions, and implementation of BMPs to reduce nonpoint sources of pollutants.

During the 1980s, most States implemented chemical and mechanical in-lake restoration measures to control aquatic weeds and algae. In their 1992 Section 305(b) reports, the States report a shift toward watershed planning techniques and nonpoint source controls to reduce pollutant loads responsible for aquatic weed growth and algal blooms. Watershed management plans simultaneously address multiple sources of pollutants, such as runoff from urbanized areas, agricultural activities, and failing septic systems along the lake shore. Although the States reported that they still use in-lake treatments (Figure ES-18), the States recognize that source controls are needed in addition to in-lake treatments to restore lake water quality.

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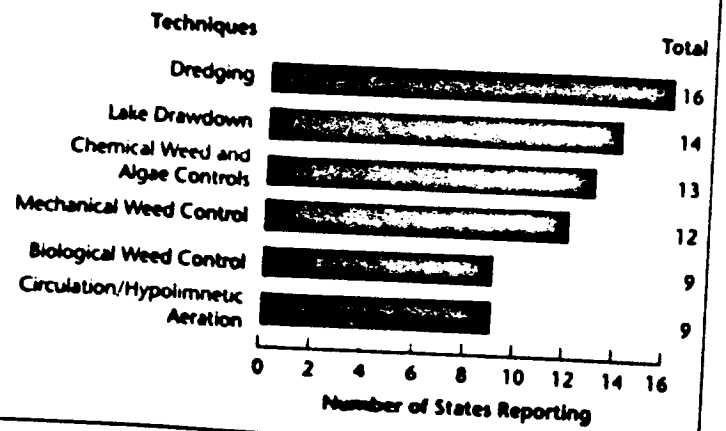
Figure ES-18

In-Lake Treatment Techniques Implemented by the States

(22 States Reporting)

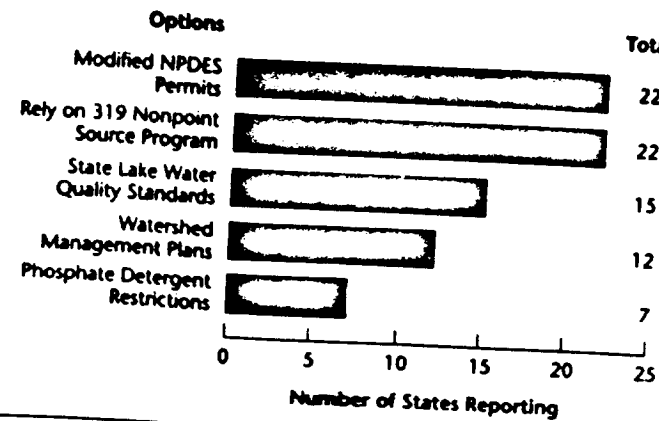


Based on 1992 State Section 305(b) reports.

Figure ES-19

Management Options for Lake Restoration and Pollution Control

(35 States Reporting)



Based on 1992 State Section 305(b) reports.

The States reported that they most frequently rely on their NPDES permit programs and their Section 319 nonpoint source (NPS) management programs to control pollutants entering lakes (Figure ES-19). Through the State NPDES permit programs, States often impose stricter nutrient limits for effluents discharged into lakes than into rivers and streams. Seven States reported that phosphorus detergent restrictions enhanced sewage treatment plant compliance with NPDES nutrient limits. Twenty-two States reported that they use their Section 319 NPS programs to implement BMPs in watersheds surrounding impaired or threatened lakes.

Successful lake programs require strong commitment from local citizens and cooperation from natural resource agencies at the local, State, and Federal levels. Forty-nine States, Puerto Rico, and 18 American Indian Tribes have established cooperative frameworks for managing lakes under the Clean Lakes Program.

The National Estuary Program

Section 320 of the Clean Water Act (as amended by the Water Quality Act of 1987) established the National Estuary Program (NEP) to protect and restore water quality and living resources in estuaries. The NEP adopts a geographic or watershed approach by planning and implementing pollution abatement activities for the estuary and its surrounding land area as a whole.

Through the NEP, States nominate estuaries of national significance that are threatened or impaired by pollution, development,

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or overuse. EPA evaluates the nominations and selects those that show evidence of a committed citizenry, political support, a range of government involvement (State, Federal, regional, and local), and available scientific and technical expertise to tackle the problem. The EPA convenes management conferences with representatives from all interested groups (e.g., industry, agriculture, conservation organizations, and State agencies) to more fully characterize the problems and seek solutions.

The NEP is also a national demonstration program. There are more than 150 estuaries in the United States and only a small fraction can be targeted for action through the NEP. It is therefore important that the lessons learned through the NEP be communicated to estuarine water quality managers throughout the country. As of June 1993, 21 estuaries are included in the NEP (see Figure ES-20).

Protecting Wetlands

Section 404 of the CWA remains the primary Federal vehicle for protecting wetlands. Section 404 regulates the discharge of dredged or fill material into waters of the United States, including wetlands. EPA continues to promote other mechanisms to protect wetlands including

- Incorporating wetlands considerations into traditional water programs and other EPA programs
- Working with other Federal agencies
- Helping to build State and local government programs to protect wetlands
- Improving wetlands science
- Promoting outreach and education
- Developing voluntary partnerships with landowners
- Coordinating international wetlands protection.

Figure ES-20

Locations of National Estuary Program Sites

Source: U.S. EPA National Estuary Program.

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More information on wetlands can be obtained from the EPA Wetlands Hotline at 1-800-832-7828.

In addition, EPA has awarded wetlands grants since 1990 to support the development of State and Tribal wetlands protection programs. States and Tribes have used these grants to develop water quality standards, monitor trends in wetlands loss, coordinate State and local planning agencies, and disseminate educational materials on wetlands.

Overall, States reported that they are making considerable progress in protecting the quantity and quality of their wetlands through regulatory and nonregulatory approaches. States were asked to report on several key areas, including the application of Section 401 certification authority to protect wetlands, their progress in developing water quality standards for wetlands, and efforts to incorporate wetlands considerations into other programs (see Appendix D, Table D-5). In addition, 18 States and one Territory reported on efforts to inventory the physical acreage of their wetlands.

According to State-reported information, no State is currently operating a statewide wetlands monitoring program. However, five States did describe water quality and habitat monitoring efforts for some portion of their wetlands.

EPA recognizes that the development of biological monitoring and assessment methods for wetlands is a critical need for State wetlands managers so that they can begin to monitor their wetlands. To this end, EPA is developing assessment protocols for freshwater emergent wetlands as part of its 5-year research plan. However, more research on other wetlands systems is needed on both the Federal and State levels.

State monitoring programs are critical for determining whether wetlands are meeting their designated and existing uses as well as for prioritizing restoration once impairment is identified. Wetlands monitoring information is also important for making Section 401 certification decisions, determining mitigation success for Section 404, and supporting other management decisions.

Protecting the Great Lakes

The Great Lakes are cooperatively managed by the United States and Canada under the Great Lakes Water Quality Agreement of 1978 (as amended in 1987). The International Joint Commission, established by the 1909 Boundary Waters Treaty, is responsible for identifying actions to protect the Great Lakes. Representatives from State and Federal agencies and universities work together on the Commission's two boards to identify problem areas, plan programs to reduce pollution, and publish findings and issue papers.

Since 1973, 43 Areas of Concern have been identified in the Great Lakes basin where environmental quality is substantially degraded. Most Areas of Concern are harbors, bays, and river mouths. Remedial Action Plans are being developed for each Area of Concern. These plans identify impaired uses and examine management options to restore the areas.

In 1989, the EPA launched the Great Lakes Initiative to provide a framework for Federal assistance in pursuing the goal of whole-system restoration based on an ecosystem

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perspective. The Initiative emphasizes areas in which EPA can provide State governments and other stakeholders with technical support. The Initiative envisions EPA making the following technical contributions:

- Develop guidance for identifying toxic hot spots
- Develop guidance for tracking the relative contributions of toxic and acidic pollutants from surface water and atmospheric sources
- Develop guidance for determining the relative roles of point and nonpoint source contributions to conventional and toxic pollutant burdens
- Suggest innovative approaches for the protection of critical habitat areas
- Support the development of special wildlife standards.

To help implement the goals of the Great Lakes Initiative, EPA Region 5 and the EPA Great Lakes National Program Office coordinate a Steering Committee, Technical Workgroup, and Public Participation Group. The States have played an active role in the development of draft criteria and policies.

By late 1992, EPA had reviewed a draft of the Great Lakes Initiative Guidance. When issued in final form, this major guidance document will assist in updating the Great Lakes Strategy, which provides the framework for implementing the Great Lakes Water Quality Agreement. Specific policies under the Great Lakes Initiative will help integrate the development of Remedial Action Plans for designated Areas of Concern with the more holistic goals of Lakewide Management Plans and pollution prevention strategies for the Great Lakes as a whole.

The Chesapeake Bay Program

In 1975, the Chesapeake Bay became the Nation's first estuary targeted for protection and restoration when Congress directed EPA to study the causes of environmental declines in the Bay. Section 117(a) of the 1987 CWA amendments required that the EPA Administrator continue the Chesapeake Bay Program to

- Collect and distribute information about the Bay's environmental quality
- Coordinate Federal and State efforts to improve the Bay's water quality
- Determine impacts from environmental changes such as inputs of nutrients, chlorine, oxygen demanding substances, toxic pollutants, and acid precipitation.

A system of committees, subcommittees, work groups, and task forces have evolved under the Chesapeake Executive Council, which consists of the Governors of Maryland, Virginia, and Pennsylvania, the Administrator of EPA, the Mayor of the District of Columbia, and the Chairman of the Chesapeake Bay Commission. The Council coordinates program implementation, establishes policy directions,

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and provides oversite for the restoration and protection of the Bay and its living resources. On August 6, 1991, the Chesapeake Executive Council adopted four action steps, building on the 1987 Chesapeake Bay Agreement to reduce nitrogen and phosphorus loads entering the Bay by 40%. The four action steps commit the Council to

- Reevaluating and accelerating the nutrient reduction program
- Adopting pollution prevention
- Restoring and enhancing living resources and their habitats, such as submerged aquatic vegetation beds
- Broadening participation in the Bay Program.

The Chesapeake Bay Program has implemented programs to reduce impacts from nutrients, oxygen-demanding substances, and pathogens. To date, three elements of the Chesapeake Bay Program's point source control strategy are responsible for reductions in nutrient loadings:

- Ugrading wastewater treatment plants
- Improving compliance with discharge and pretreatment permits
- Pollution prevention actions such as prohibiting the sale of detergents containing phosphorus.

As a result of these measures, annual discharges of phosphorus into the Bay dropped by 40% (4.7 million pounds) between 1985 and 1991.

The Chesapeake Bay Program's nonpoint source program emphasizes controls for runoff generated by agricultural activities, paved surfaces, and construction in urban areas. The program includes nutrient management for applying animal wastes and fertilizers to cropland in amounts calculated to meet crop requirements without contaminating ground and surface waters.

The Chesapeake Bay Program developed a model to estimate nutrient load reductions from nonpoint sources because it is not possible to monitor every nonpoint source in the Bay's watershed. The model estimates that implementation of nonpoint source controls has resulted in a 12% and 8% reduction in controllable nonpoint source nitrogen and phosphorus, respectively.

Overall, water quality monitoring data confirm significant progress in reducing phosphorus loads into Chesapeake Bay. Total phosphorus concentrations in the Bay decreased by 16% between 1984 and 1992. However, total nitrogen concentrations have remained stable in the mainstem of the Bay and increased in some tributanes, indicating a need for additional progress in reducing nitrogen loadings.

The Gulf of Mexico Program

In 1988, the Gulf of Mexico Program (GMP) was established with EPA as the lead Federal agency to develop and help implement a strategy to protect, restore, and maintain the health and productivity of the Gulf. The GMP is a grass roots program that serves as a catalyst to promote sharing of information, pooling of resources,

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and coordination of efforts to restore and reclaim wetlands and wildlife habitat, clean up existing pollution, and prevent future contamination and destruction of the Gulf. The GMP mobilizes State, Federal, and local government; business and industry; academia; and the community at large through public awareness and information dissemination programs, forum discussions, citizen committees, and technology applications.

A Policy Review Board and a newly formed Management Committee determine the scope and focus of GMP activities. The program also receives input from a Technical Advisory Committee and a Citizen's Advisory Committee. The GMP Office and 10 Issue Committees coordinate the collection, integration, and reporting of pertinent data and information. The Issue Committees are responsible for documenting environmental problems and management goals, available resources, and potential solutions for a broad range of issues, including habitat degradation, public health, freshwater inflow, marine debris, shoreline erosion, nutrients, toxic pollutants, and living aquatic resources. The Issue Committees publish their findings in Action Agendas. Two additional committees provide operational support and information transfer activities for the entire GMP.

On December 10, 1992, the Governors of Alabama, Florida, Louisiana, Mississippi, and Texas; EPA; the Chair of the Citizen's Advisory Committee; and representatives of 10 other Federal agencies signed the Gulf of Mexico Program Partnership for Action agreement for protecting, restoring, and enhancing the Gulf of Mexico and adjacent lands. The agreement commits the signatory agencies to pledge their efforts, over the next 5 years, to obtain the knowledge and resources to

- Significantly reduce the rate of loss of coastal wetlands
- Achieve an increase in Gulf Coast seagrass beds
- Enhance the sustainability of Gulf commercial and recreational fisheries
- Protect human health and food supply by reducing input of nutrients, toxic substances, and pathogens to the Gulf
- Increase Gulf shellfish beds available for safe harvesting by 10%
- Ensure that all Gulf beaches are safe for swimming and recreational uses
- Reduce by at least 10% the amount of trash on beaches
- Improve and expand coastal habitats that support migratory birds, fish, and other living resources
- Expand public education/outreach tailored for each Gulf Coast county or parish.

During 1992, the GMP also launched Take-Action Projects in each of the five Gulf States to demonstrate that program strategies and methods could achieve rapid results. The Take-Action Projects primarily address inadequate sewage treatment, pollution prevention, and habitat protection and restoration. Several projects aim to demonstrate

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the effectiveness of innovative sewage treatment technologies to control pathogenic contamination of shellfish harvesting areas. Other projects aim to restore wetlands, sea grass beds, and oyster reefs. The Take-Action Projects are designed to have Gulf-wide application.

Ground Water Protection Programs

Protection of ground water resources is addressed under the Clean Water Act, the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Toxic Substances Control Act, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Pollution Prevention Act. The Comprehensive State Ground Water Protection Programs (CSGWPP) are an approach to ground water protection that embraces all the above-mentioned ground water protection activities, with emphasis placed on preventing contamination. A CSGWPP is also intended to act as a catalyst for fundamental changes in the development and implementation of ground water protection programs at the Federal, State, and local levels.

Several principal or important ground water protection programs control pollutant sources: solid and hazardous waste treatment, storage, and disposal and underground storage tanks are regulated under RCRA; subsurface injection of fluids is regulated under SDWA; abandoned waste is regulated under CERCLA; and pesticides are controlled under FIFRA. These programs enable States to regulate and monitor pollutant sources more effectively.

Funds allotted under Sections 319(h) and (i) and 518 of the Clean Water Act are intended to assist States in implementing EPA-approved nonpoint source management programs and ground water protection activities. In addition, a number of States have developed nonpoint source control programs that focus on contamination resulting from agriculture and septic tanks.

The Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act control the use and disposal of commercial chemical products thereby minimizing the risks to public health and the environment. EPA's Pesticides and Ground Water Strategy emphasizes prevention and protection of the Nation's ground water resources and provides a flexible framework for tailoring programs to the needs of each State. In addition, EPA has established a Restricted Use classification for pesticides, which is intended to reduce both the risks of point source causes of ground water contamination and nonpoint source causes of contamination.

The Pollution Prevention Act of 1990 was enacted by Congress to promote pollution prevention and environmental protection goals. The Act allows for grants to be allotted to fund research projects involving education, demonstration, and training in sustainable agriculture and other agricultural practices that emphasize ground water protection and reducing the excessive use of nutrients and pesticides.

A number of mechanisms have been developed to manage the

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ever-growing volume of information on the Nation's ground water resources. These include the development of a standard format for reporting ground water data called the Minimum Set of Data Elements (MSDE) for Ground Water Quality. The MSDE is intended to improve access to ground water data and to increase information sharing capabilities by standardizing the elements used in ground water databases. Additional mechanisms include the development of a geographic information system (GIS) to integrate ground water data that have been collected under different programs, the development and management of two databases concerning pesticides and ground water, and inclusion of ground water data in a modernized STORET (EPA's water database).

What You Can Do

Federal and State programs have helped clean up many waters and slow the degradation of others. But government alone cannot solve the entire problem, and water quality concerns persist. Nonpoint source pollution, in particular, is everybody's problem, and everybody needs to solve it.

Examine your everyday activities and think about how you are contributing to the pollution problem. Here are some suggestions on how you can make a difference.

Be Informed

You should learn about water quality issues that affect the communities in which you live and work. Become familiar with your local water resources. Where does your drinking water come from? What activities in your area might affect the water you drink or the rivers, lakes, beaches, or wetlands you use for recreation?

Learn about procedures for disposing of harmful household wastes so they do not end up in sewage treatment plants that cannot handle them or in landfills not designed to receive hazardous materials.

Be Responsible

In your yard, determine whether additional nutrients are needed before you apply fertilizers, and look for alternatives where fertilizers might run off into surface waters. Consider selecting plants and grasses that have low maintenance requirements. Water your lawn conservatively. Preserve existing trees and plant new trees and shrubs to help prevent erosion and promote infiltration of water into the soil. Restore bare patches in your lawn to prevent erosion. If you own or manage land through which a stream flows, you may wish to consult your local county extension office about methods of restoring stream banks in your area by planting buffer strips of native vegetation.

Around your house, keep litter, pet waste, leaves, and grass clippings out of gutters and storm drains. Use the minimum amount of water needed when you wash your car. Never dispose of any household, automotive, or gardening wastes in a storm drain. Keep your septic tank in good working order.

Within your home, fix any dripping faucets or leaky pipes and install water-saving devices in shower heads and toilets. Always follow

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directions on labels for use and disposal of household chemicals. Take used motor oil, paints, and other hazardous household materials to proper disposal sites such as approved service stations or designated landfills.

Be Involved

As a citizen and a voter there is much you can do at the community level to help preserve and protect our Nation's water resources. Look around. Is soil erosion being controlled at construction sites? Is the community sewage plant being operated efficiently and correctly? Is the community trash dump in or along a stream? Is road deicing salt being stored properly?

Become involved in your community election processes. Listen and respond to candidates' views on water quality and environmental issues. Many communities have recycling programs; find out about them, learn how to recycle, and volunteer to help out if you can. One of the most important things you can do is find out how your community protects water quality, and speak out if you see problems.

Volunteer Monitoring: You Can Become Part of the Solution

In many areas of the country, citizens are becoming personally involved in monitoring the quality of our Nation's water. As a volunteer monitor, you might be involved in taking ongoing water quality measurements, tracking the progress of protection and restoration projects, or reporting special events, such as fish kills and storm damage.

Volunteer monitoring can be of great benefit to State and local governments. Some States stretch their monitoring budgets by using data collected by volunteers, particularly in remote areas that otherwise might not be monitored at all. Because you are familiar with the water resources in your own neighborhood, you are also more likely to spot unusual occurrences such as fish kills.

The benefits to you of becoming a volunteer are also great. You will learn about your local water resources and have the opportunity to become personally involved in a nationwide campaign to protect a vital, and mutually shared, resource. If you would like to find out more about organizing or joining volunteer monitoring programs in your State, contact your State department of environmental quality, or write to

Alice Maylo
U.S. EPA
Volunteer Monitoring (4503F)
401 M St. SW
Washington, DC 20460
(202) 260-7018

For further information on water quality in your State, write to your State department of environmental quality (see Chapter 8). Additional water quality information may be obtained from the following Regional offices of the U.S. EPA:

Diane Switzer
EPA Region 1 (EMS-LEX)
60 Westview Street
Lexington, MA 02173
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Fish Consumption Advisories

States issue fish consumption advisones to protect the public from ingesting harmful quantities of toxic pollutants in contaminated fish and shellfish. Fish may accumulate dangerous quantities of pollutants in their tissues by ingesting many smaller organisms, each contaminated with a small quantity of pollutant. This process is called bioaccumulation or biomagnification. Pollutants also enter fish and shellfish tissues through the gills or skin.

Fish consumption advisories recommend that the public limit the quantity and frequency of fish consumption from specific waterbodies. The States tailor individual advisories to minimize health risks based on contaminant data collected in their fish tissue sampling programs. Advisories may completely ban fish consumption in severely polluted waters or limit fish consumption to several meals per month or year in cases of less severe contamination. Advisories may target a subpopulation at risk (such as children, pregnant women, and nursing mothers), specific fish species, or larger fish that may have accumulated high concentrations of a pollutant over a longer lifetime than a smaller, younger fish.

The EPA fish consumption advisory database tracks advisories issued by each State. For 1993, the database listed 1,279 fish consumption advisories in effect in 47 States. Fish consumption advisories are unevenly distributed among the States because the States use their own criteria to determine if fish tissue concentrations of toxics pose a health risk that justifies an advisory. States also vary the amount of fish tissue monitoring they conduct and the number of pollutants analyzed. States that conduct more monitoring and use strict criteria will issue more advisories than States that conduct less monitoring and use weaker criteria. For example, 66% of the advisories active in 1993 were issued by the States surrounding the Great Lakes, which support

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extensive fish sampling programs and follow strict criteria for issuing advisories.

Most of the fish consumption advisories are due to mercury, polychlorinated biphenyls (PCBs), chlordane, dioxins, and DDT (with its byproducts). The States report that the leading sources of these pollutants are industrial discharges and polluted wet weather runoff from agricultural lands, urban areas, and storm sewers.

Many coastal States report restrictions on shellfish harvesting in estuarine waters. Shellfish—particularly oysters, clams, and mussels—are filter-feeders that extract their food from water. Waterborne bacteria and viruses may also accumulate on their gills and mantles and in their digestive systems. Shellfish contaminated by these microorganisms are a serious human health concern, particularly if consumed raw.

States currently sample water from shellfish harvesting areas to measure indicator bacteria, such as total coliform and fecal coliform bacteria. These bacteria serve as indicators of the presence of potentially pathogenic microorganisms associated with untreated or undertreated sewage. States restrict shellfish harvesting to areas that maintain these bacteria at concentrations in sea water below established health limits.

In 1992, 18 States reported that shellfish harvesting restrictions were in effect for more than 3,455 square miles of estuarine and coastal waters during the 1990-1992 reporting period. Nine States reported that urban runoff and storm sewers, municipal wastewater treatment facilities, marinas, and industrial discharges restricted shellfish harvesting.

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Part I

Introduction

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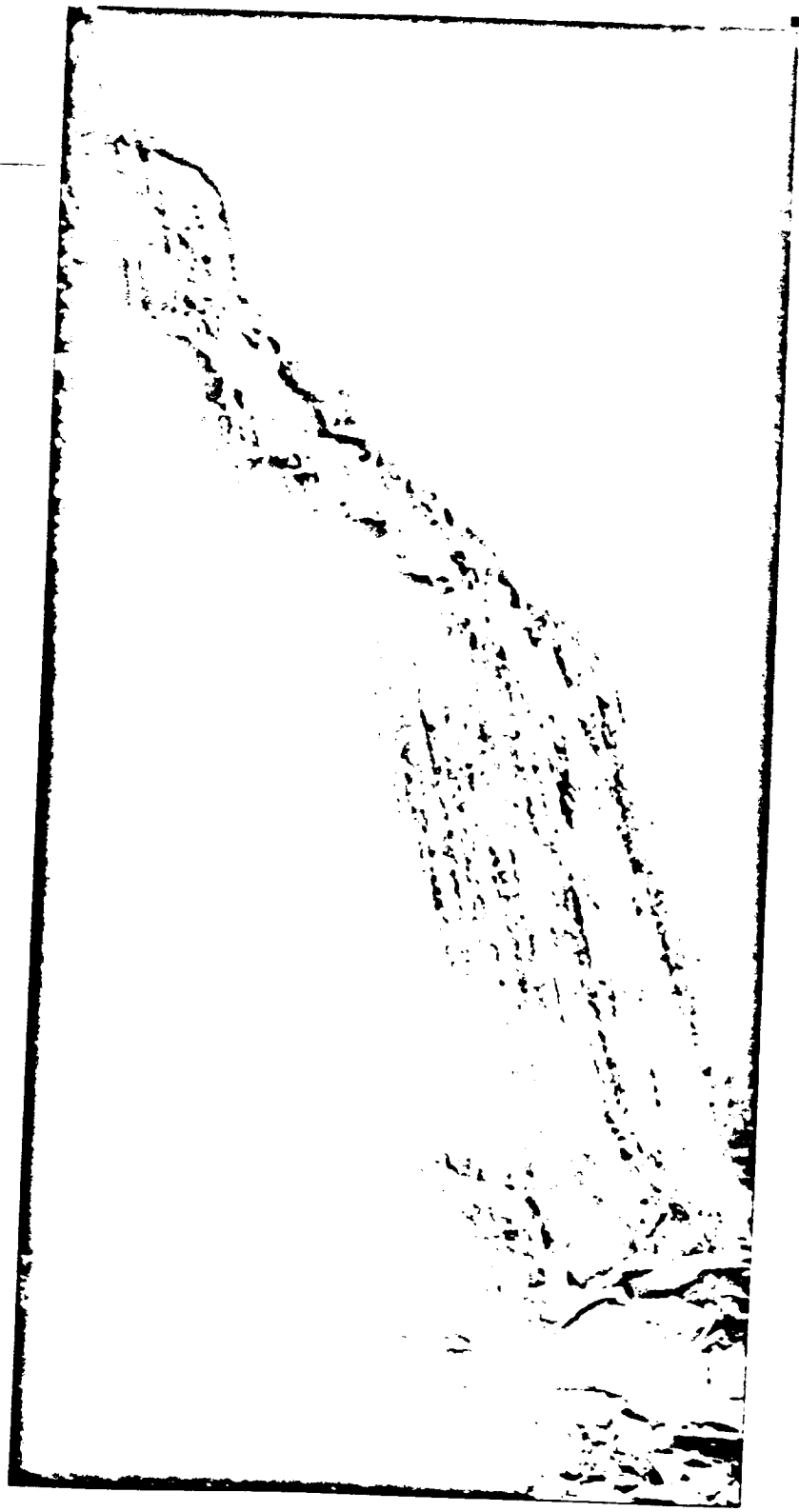

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Introduction

This document describes the overall quality of our Nation's assessed surface and ground waters during 1990 and 1991. The contents discuss the geographic extent of water pollution across the country and identify specific pollutants and sources of pollutants contaminating our waters. This document also highlights programs initiated by State and local governments, the U.S. Environmental Protection Agency (EPA), and other Federal agencies to improve water quality.

To prepare this document, EPA summarized information submitted by States, Territories, Interstate Water Basin Commissions, the District of Columbia, and the Gila River Indian Community in their 1992 water quality assessment reports (the "305(b) reports" required under Clean Water Act Section 305(b)). Individual State summaries are provided in Chapter 8.

This report displays and summarizes data provided by the States to EPA. EPA has not determined the accuracy of these data. It is important to note that these State-reported data are intended to provide a snapshot of the quality of the waters they assessed and cannot be used to determine trends in our Nation's water resources. These limitations are due to major differences from year to year in assessment methods within and between States as well as differences in the waters assessed in each 2-year period. In addition, not all States follow EPA's guidance on procedures for determining whether waters are supporting the uses designated in their water quality standards. EPA and the States are taking many steps toward transforming the 305(b) process into one that provides comparable data with known accuracy. These steps include implementing the recommendations of the National 305(b) Consistency Workgroup and the Intergovernmental Task Force for Monitoring Water Quality, as well as improving the Section 305(b) guidelines and stipulating adherence to those guidelines in proposed State Section 106 grant guidelines. These efforts will foster consistency and accuracy among the States and allow better sharing of data across political boundaries for watershed protection.

The Clean Water Act

The Clean Water Act (CWA) still guides Federal and State water pollution control programs 20 years after it was enacted by Congress. In 1972, the CWA launched a national objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Act set two goals to achieve this objective:

- Eliminate the discharge of pollutants into navigable waters by 1985, and

The Clean Water Act of 1972

. . . it is the national goal that, wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water, be achieved by July 1, 1983 . . .

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■ Achieve an interim water quality level that protects and propagates fish, shellfish, and wildlife and supports recreation in and on the water, where attainable.

As it became evident that the Nation could not eliminate pollutant discharges by 1985, Congress amended the CWA to stress achieving the interim water quality levels, which came to be known as "the fishable and swimmable goals of the Act."

The EPA measures national progress in achieving the CWA interim water quality levels by summarizing attainment of State water quality standards. Water quality standards consist of designated beneficial uses, numeric and narrative criteria sufficient to protect each use, and an antidegradation statement:

■ **Designated beneficial uses** are the desirable uses that water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support. Each designated use has a unique set of water quality requirements or criteria that must be met for the use to be realized. States may designate an individual waterbody for multiple beneficial uses.

■ **Numeric water quality criteria** establish the minimum physical, chemical, and biological parameters required to support a beneficial use. Physical and chemical numeric criteria may set maximum concentrations of pollutants, acceptable ranges of physical parameters, and minimum concentrations of desirable parameters, such as dissolved oxygen. Numeric biological criteria describe the expected attainable community attributes and establish values based on measures such as species richness, presence or absence of indicator taxa, and distribution of classes of organisms.

■ **Narrative water quality criteria** define, rather than quantify, conditions and attainable goals that must be maintained to support a designated use. Narrative biological criteria establish a positive statement about aquatic community characteristics expected to occur within a waterbody. For example, "Aquatic life shall be as it naturally occurs," or "Ambient water quality shall be sufficient to support life stages of all indigenous aquatic species." Narrative criteria may also describe conditions that are desired in a waterbody, such as, "Waters must be free of substances that are toxic to humans, aquatic life, and wildlife."

■ **Antidegradation statements** protect existing designated uses and prevent high-quality waterbodies from deteriorating below the water quality necessary to maintain existing or anticipated designated beneficial uses.

The CWA allows States to set their own standards but requires that all State beneficial uses and their criteria comply with the goals of the Act. At a minimum, State beneficial uses must provide for "the protection and propagation of fish, shellfish, and wildlife" and provide for "recreation in and on the water" (i.e., the fishable and swimmable goals of the Act), where attainable. The Act prohibits States from designating waste transport or waste assimilation as a beneficial use, as some States did prior to 1972.

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Assessment Methodology

Section 305(b) of the CWA requires that the States biennially assess their water quality for attainment of the fishable and swimmable goals of the Act and report the results to EPA. The States measure attainment of the CWA goals by determining how well their waters support their designated beneficial uses. EPA encourages States to assess support of the following individual beneficial uses:

Aquatic Life Support

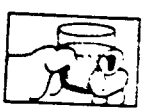
The waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Fish Consumption

The waterbody supports a population of fish free from contamination that could pose a human health risk to consumers.

Shellfish Harvesting

The waterbody supports a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.



Drinking Water Supply

The waterbody can supply safe drinking water with conventional treatment.

Primary Contact Recreation – Swimming

People can swim in the waterbody without risk of adverse human health effects (such as catching waterborne diseases from raw sewage contamination).

Secondary Contact Recreation

People can perform activities on the water (such as canoeing) without risk of adverse human health effects from occasional contact with the water.

Agriculture

The water quality is suitable for irrigating fields or watering livestock.

The States assign one of five levels of use support categories to each of their waterbodies (Table 1-1). If possible, the States determine the level of use support by comparing monitoring data with numeric criteria for each use designated for a particular waterbody. If monitoring data are not available, the State may determine the level of use support with qualitative information. Valid qualitative information

Table 1-1: Levels of Use Support

Symbol	Use Support Level	Water Quality Condition	Definition
	Fully Supporting	Good	Water quality meets designated use criteria.
	Threatened	Good	Water quality supports beneficial uses now but may not in the future unless action is taken.
	Partially Supporting	Fair (Impaired)	Water quality fails to meet designated use criteria at times.
	Not Supporting	Poor (Impaired)	Water quality frequently fails to meet designated use criteria.
	Not Attainable	Poor	The State has performed a use-attainability study and documented that use support is not achievable due to a natural condition or human activity that cannot be reversed without imposing widespread economic and social impacts.

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includes land use data, fish and game surveys, and predictive model results. Monitored assessments are based on monitoring data. Evaluated assessments are based on qualitative information or monitored information more than 5 years old.

Overall Use Support

For waterbodies with more than one designated use, the States consolidate the individual use support information into a single overall use support determination:

- **Fully Supporting Overall Use** – All designated beneficial uses are fully supported.
- **Threatened Overall Use** – One or more designated beneficial uses are threatened and the remaining uses are fully supported.
- **Partially Supporting Overall Use** – One or more designated beneficial uses are partially supported and the remaining uses are fully supported.
- **Not Supporting Overall Use** – One or more designated beneficial uses are not supported.
- **Not Attainable** – The State has performed a use-attainability study and documented that use support of one or more designated beneficial uses is not achievable due to natural conditions or human activity that cannot be reversed without imposing widespread economic and social impacts.
- **Impaired Waters** – The sum of waterbodies partially supporting uses and not supporting uses.

Total Assessed Waters

Most States do not assess all of their waterbodies during the 2-year reporting cycle required under Section 305(b). Thus, the assessed waters reported in Figure 1-1 are a subset of the Nation's total waters. In addition, the summary information based on assessed waters may not represent overall conditions in

SAMPLE

Little River

Little River is designated for aquatic life use and primary contact recreation. The State examines dissolved oxygen data and notes that 15% of the samples contained dissolved oxygen concentrations below the aquatic life use criterion of 5 parts per million (ppm). Bacterial indicators did not exceed the contact recreation criterion. Therefore, the waterbody partially supports aquatic life use and fully supports contact recreation use. The waterbody partially supports overall uses based on monitored data.

SAMPLE

Turkey Lake

Turkey Lake is also designated for aquatic life use and primary contact recreation. However, the State has never sampled chemical and physical parameters, such as dissolved oxygen, in the lake. The State did perform a biological survey of the lake and noted the presence of desirable fish species and insect larvae. The survey also revealed a probable source of sewage contamination upstream. The lake appears to fully support aquatic life use but may only partially support contact recreation use due to sewage contamination. The waterbody partially supports overall uses based on evaluated information (the suspected source of sewage contamination).

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the Nation's total waters because States often focus on assessing major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many States lack the resources to collect use support information for intermittent streams, small tributaries, and private ponds. This report does not predict the health of these unassessed waters, which include an unknown ratio of pristine waters and waters impaired by point sources and nonpoint sources.

Causes and Sources of Impairment

Where possible, States identify the pollutants causing water quality impairments and the sources of pollutants degrading their waterbodies. Causes of impairment are pollutants or processes that violate numeric or narrative use support criteria. Causes of impairment include chemical contaminants (such as polychlorinated biphenyls [PCBs], dioxin, and metals), physical parameters (such as temperature), and biological parameters (such as aquatic weeds).

Sources of impairment generate the pollutants that violate use support criteria. Point sources discharge pollutants directly into surface waters from a conveyance. Point sources include industrial facilities, municipal sewage treatment plants, and combined sewer overflows. Nonpoint sources deliver pollutants to surface waters from diffuse origins. Nonpoint sources include urban runoff, agricultural runoff, and atmospheric deposition of contaminants in air pollution.

Figure 1-1

Percentage of Total Waters Assessed for the 1992 Report

Rivers and Streams
642,881 – 18% assessed
Total miles: 3,551,247[a]

Lakes, Ponds, and Reservoirs
18,300,000 – 46% assessed
Total acres: 39,920,000[b]

Estuaries
27,227 – 74% assessed
Total square miles: 36,890[c]

Ocean Coastal Waters
3,398 – 6% assessed (including Alaska)
Total miles: 56,121 miles, including Alaska's 36,000 miles of shoreline[d]

Great Lakes Shoreline
5,319 – 99% assessed
Total miles: 5,382

Wetlands
10.5 million – 4% assessed (including Alaska)
Total acres: 277 million acres, including Alaska's 170 million acres of wetlands

Source: 1992 State 305(b) reports.

NOTE: These figures were reported by the States. See explanation of changes in total water estimates on page 8.

[a] Does not include river miles in American Samoa and Guam, which did not report total river miles.
[b] Does not include lake acreages in American Samoa, Guam, Kentucky, and the Virgin Islands, which did not report total lake acreages.
[c] Does not include estuarine area in Alaska, American Samoa, and Guam.
[d] Does not include shoreline miles in American Samoa and Guam.

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NOTE

Several States assess a portion of their watersheds each year as part of a rotating basin planning program. These States assess all of their waters in a 5-year period. The 2-year 305(b) snapshot does not give these States full credit for their wide assessment coverage. States that will assess all of their waters over a longer time period include North Carolina, Ohio, South Carolina, and Wisconsin.

Habitat alterations, such as hydromodification, dredging, and streambank destabilization, can also degrade water quality.

Throughout this document, EPA rates the significance of causes and sources of pollution by the percentage of waters impaired by each individual cause or source (obtained from the States 305(b) reports). Note that the cause and source rankings do not describe the condition of all waters in the United States because the States identify the causes and sources degrading a subset of their impaired waters, which are a small subset of assessed waters, which are a subset of the Nation's total waters. For example, the States identified sources degrading some of the 241,407 impaired river miles, which represent 38% of the assessed river miles and only 7% of the Nation's total stream miles.

Changes in Reporting Methodology

Individual Use Support and the CWA Goals

During previous 305(b) report cycles, States reported overall use support status and CWA fishable and swimmable goal attainment for their waters. CWA goal attainment was reported separately from overall use support status. For example, in the past a State would report

- The number of river miles fully supporting, threatened, partially supporting, and not supporting designated uses
- The number of river miles attaining the fishable goal of the Act
- The number of river miles attaining the swimmable goal of the Act.

For the 1992 report cycle, the 305(b) Consistency Workgroup (composed of State and EPA Regional 305(b) coordinators as well as EPA Headquarters staff) recommended that States report individual use support status instead of CWA goal status. The Workgroup suggested that data on individual use support, such as fish consumption use and aquatic life use support, would distinguish which components of the fishable and swimmable goals of the Act are impaired. In the past, it was unclear whether waters did not attain the fishable goals of the Act because the water quality failed to support a healthy community of fish or because the fish were contaminated and unfit for human consumption, or both. Individual use support information identifies specific water quality problems contributing to lack of full attainment of the fishable and swimmable goals of the Act.

Total Waters

National estimates of total waters provide the foundation for determining the percentage of our waters assessed by the States. In 1992, EPA provided the States with national estimates of total waters derived from the EPA Reach File, a database containing traces of waterbodies adapted from 1:100,000 scale maps prepared by the U.S. Geological Survey. The States modified these total water estimates where necessary. Previously, EPA had used estimates of total rivers and stream miles and lake acres reported in *America's Clean Water: The States' Nonpoint Source*

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Assessment, prepared by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) in 1985. Based on the new Federal/State estimates of total waters, the estimate of total river and stream miles increased in 1992 because most States included intermittent streams, canals, and ditches in total water estimates for the first time. As a result, the percentage of river and stream miles assessed appears much lower than in past Reports to Congress (Table 1-2).

The estimate of total Great Lakes shoreline grew in 1992 because Wisconsin's Coastal Zone Management Division updated its measurements of Wisconsin's shoreline mileage. Wisconsin's estimate of total Great Lakes shoreline grew from 650 miles (reported in 1990) to 840 miles in 1992.

The States assessed nearly the same area of lakes and estuarine waters in 1992 and 1990, but the States assessed fewer ocean shoreline miles in 1992. EPA did not change its method for calculating total estuarine and ocean coastal waters; both the 1990 and 1992 estimates are based on State estimates of their total estuarine and ocean coastal waters. However, the national estimates of total estuarine and ocean coastal waters increased in 1992 because more States reported the information. In particular, the estimate of total ocean coastal waters more than doubled with the addition of 36,000 shoreline miles in Alaska.

Interpreting Toxic Pollutant Data

In the guidelines for preparing the 1992 State Section 305(b) reports, EPA recommended that the States implement stricter assessment methods for determining aquatic life use support with toxicant data. According to the new assessment method, one or more violations of toxic pollutant criteria in a 3-year period indicate that a waterbody does not support aquatic life use. In previous assessment cycles, States might have classified waterbodies with one toxic criteria violation as partially supporting aquatic life use. The new assessment method increases the proportion of waters not supporting designated uses even if no actual change in water quality occurred between 1990 and 1992.

Table 1-2. Comparison of Waters Assessed in 1990 and 1992

Waterbody Type	Year	Estimate of Total Waters	Assessed Waters	Percent Assessed
Rivers and Streams	1992	3,551,247 mi[a]	642,881 mi	18
	1990	1,800,000 mi	647,066 mi	36
Lakes, Ponds, and Reservoirs	1992	39,920,000 ac[b]	18,300,000 ac	46
	1990	39,400,000 ac	18,488,636 ac	44
Estuaries	1992	36,890 mi²[c]	27,227 mi²	74
	1990	35,624 mi²[c]	26,693 mi²	75
Ocean Shoreline	1992	56,121 mi[d]	3,398 mi	6
	1990	19,200 mi[e]	4,230 mi	22
Great Lakes Shoreline	1992	5,382 mi	5,319 mi	99
	1990	5,169 mi	4,857 mi	94

Sources: *National Water Quality Inventory: 1990 Report to Congress* and the 1992 State Section 305(b) reports.

[a] Does not include river miles in American Samoa and Guam, which did not report total river miles.

[b] Does not include lake acreages in American Samoa, Guam, Kentucky, and the Virgin Islands, which did not report total lake acreages. Includes estimate of Alaska's total lake acreage reported in the 1986 Report to Congress.

[c] Does not include estuarine area in Alaska, American Samoa, and Guam.

[d] Does not include shoreline miles in American Samoa and Guam.

[e] Does not include shoreline miles in Alaska.

NOTE: These figures were reported by the States. See explanation of changes in total water estimates on page 8.

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The Waterbody System:

A Database of Water Quality Assessments

EPA designed the Waterbody System (WBS) as a State and national database for storing and analyzing water quality assessment information. The WBS tracks use support information for water units called waterbodies. States, Territories, American Indian Tribes, and River Basin Commissions define their own waterbodies to best serve their management needs. An individual waterbody may consist of a short stretch of stream, an individual lake, or the rivers and streams of an entire watershed. Usually, waterbody boundaries correspond to significant hydrologic or ecologic features, such as watershed boundaries. The WBS recognizes rivers, lakes, estuaries, tidal wetlands, freshwater wetlands, Great Lakes shorelines, and coastal shorelines as different types of waterbodies.

The WBS provides a convenient way for a State to track a wide range of assessment information for its designated waterbodies. Data fields track information on designated use support including aquatic life support, human health risks related to fish and shellfish consumption, and recreational use support. The WBS provides data fields to document causes and sources of pollution impairing full attainment of State water quality standards in each designated waterbody.

Once a State enters the data, it can use the WBS to generate a variety of summary reports and lists that simplify preparation of its 305(b) water quality assessment reports. EPA can then use all WBS data to prepare the National Water Quality Inventory Report to Congress. Summary data from each 305(b) Report and the WBS are found in the Appendices of this report. Other WBS uses include information management for the Section 314 Clean Lakes Program, the Section 319 Nonpoint Source Management Program, and the new nonpoint source management initiatives under the Coastal Zone Act Reauthorization Amendments.

EPA originally designed the WBS to facilitate analyses of water quality information. The future design for the WBS is to include geographic analyses and visualization as pictured on the next page. The WBS and related software tools can be used on a variety of computer platforms, including personal computers, the EPA National

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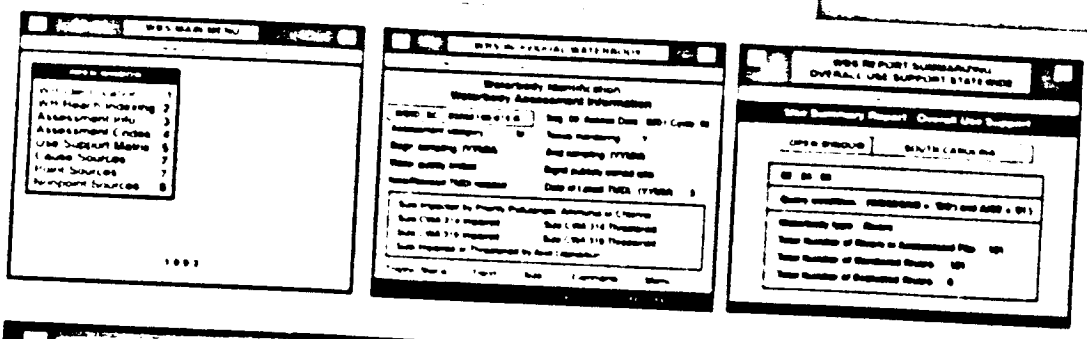
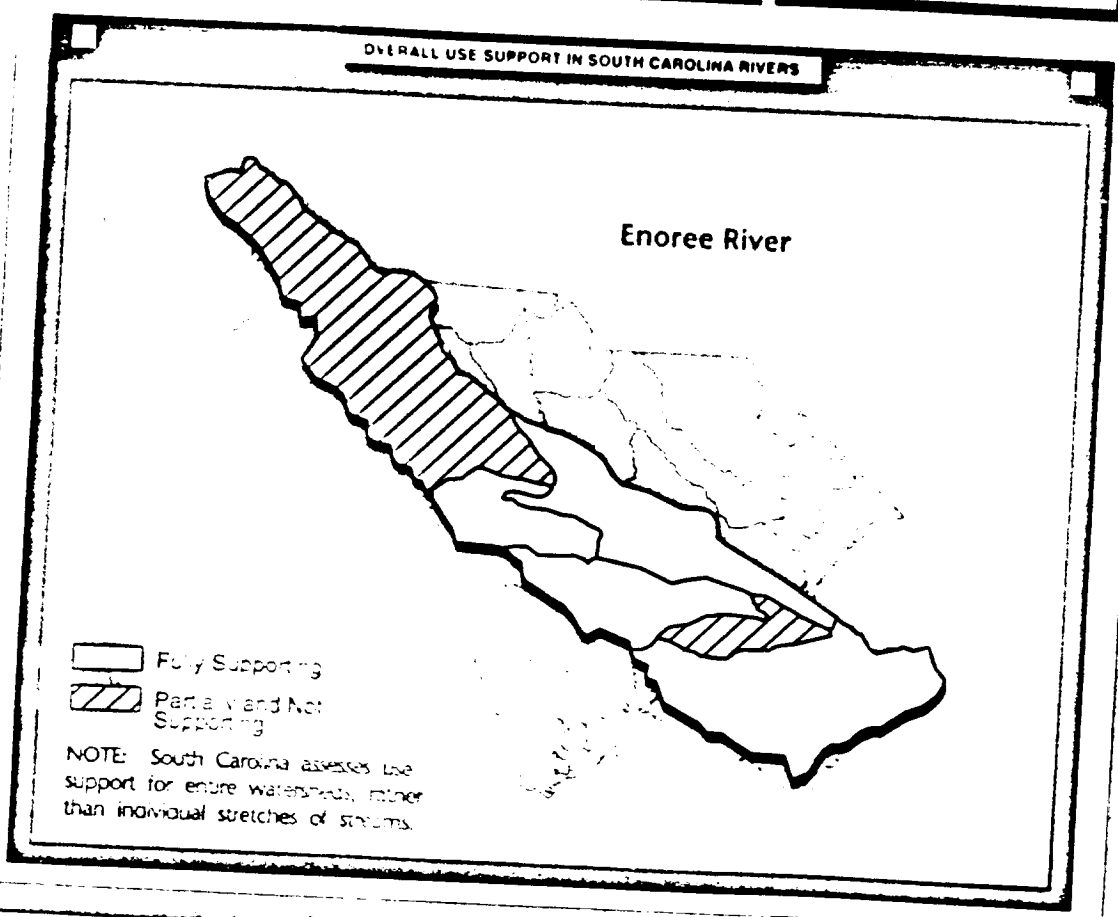
WBS: Design for the Future

Prototype example shown: South Carolina





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Computing Center mainframe computer, and Geographic Information System workstation environments. WBS data through the 1992 cycle are available on the EPA mainframe and from the States through the 305(b) coordinators (see Chapter 8). Those accessing the data on the mainframe must have an account and be authorized STORET users. As EPA moves to encourage geographic targeting approaches, access to databases with spatial location elements becomes critical. EPA's Watershed Protection Initiative (see Chapter 10) and the total maximum daily load (TMDL) process provide additional uses for spatially oriented water quality information stored in the WBS.

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Part II

Water Quality Assessments

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Rivers and Streams

Fifty-three States, Territories, Jurisdictions, and Interstate River Commissions, the District of Columbia, and one American Indian Tribe (hereafter collectively referred to as States) rated the water quality in 642,881 miles of streams and rivers in their 1992 Section 305(b) reports. In the years 1990-1992, these States assessed 18% of the total 3,551,247 river and stream miles reported by these States (Figure 2-1). The States assessed about 4,000 fewer river miles than they assessed for 1990. EPA expected the States to assess fewer waters in 1992 because EPA issued stricter guidance for defining assessed waters in 1992. The percentage of rivers assessed in 1992 appears much smaller than the percentage assessed in 1990 because the Nation shifted its baseline to the more inclusive total waters estimates described in Chapter 1 (page 8).

Fifty States reported overall use support for rivers and streams. Overall use support is the standard measure of water quality required by the Clean Water Act. States determine overall use support by summarizing how well each waterbody supports each designated use, such as drinking water supply use,

NOTE

It appears that the States assessed a smaller percentage of the Nation's rivers in 1992 than in 1990 due to an increase in the estimate of total waters in the United States. For the first time, most States used a nationally consistent method for counting their waters. By this method, States included intermittent streams, canals, and ditches in estimates of total stream miles in 1992. As a result, the national estimate of total stream miles almost doubled from 1.8 million miles in 1990 to more than 3.5 million miles in 1992.

Figure 2-1

Based on data contained in Appendix A, Table A-1.

River Miles Assessed by the States

1992 ■ 642,881 miles = 18% assessed
■ Total miles: 3,551,247

1990 ■ 647,066 miles = 36% assessed
■ Total miles: 1,800,000

1988 ■ 519,413 = 29% assessed
■ Total miles: 1,800,000

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THREATENED RIVERS may not support uses in the near future if we fail to control potential sources of pollution.

recreational use, or aquatic life use (see Chapter 1 for a complete discussion of use support). Another five States reported individual use support for rivers and streams but did not summarize overall use support. In such cases, EPA assumed that the status of aquatic life support use represented overall use support.

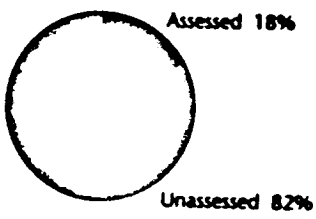
Overall Use Support

Fifty-six percent of the 642,881 river miles assessed fully support overall designated uses (Figure 2-2). The percentage of river miles fully supporting overall designated uses fell slightly in 1992 due to changes in the total river miles assessed, the number of States reporting use support, and the assessment methods employed by each State.

An additional 6% of the assessed river miles fully support overall uses but are threatened by potential sources of pollution. These rivers may not support uses in the near future if we fail to control potential sources of pollution. Twenty-five percent of the assessed river miles partially support designated uses. One or more uses may be temporarily restricted in these rivers. For example, a stream may fully support recreational use in dry weather but not support recreational use following a severe thunderstorm because heavy rainfall might overload a combined sewer system with a slug of runoff. The resulting discharge of undertreated sewage would restrict the public's use of the river for swimming until

Total rivers = 3.5 million miles
Total assessed = 642,881 miles

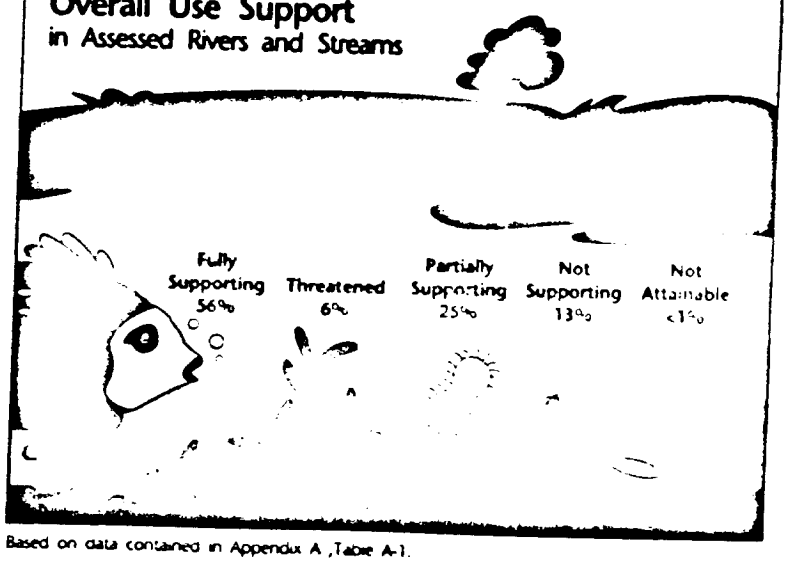
■ 18% assessed
■ 82% unassessed



Of the assessed miles:
- 36% were monitored
- 60% were evaluated
- 4% were not specified

Figure 2-2

Overall Use Support
in Assessed Rivers and Streams



Based on data contained in Appendix A, Table A-1.

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Rivers and Streams

Fifty-three States, Territories, Jurisdictions, and Interstate River Commissions, the District of Columbia, and one American Indian Tribe (hereafter collectively referred to as States) rated the water quality in 642,881 miles of streams and rivers in their 1992 Section 305(b) reports. In the years 1990-1992, these States assessed 18% of the total 3,551,247 river and stream miles reported by these States (Figure 2-1). The States assessed about 4,000 fewer river miles than they assessed for 1990. EPA expected the States to assess fewer waters in 1992 because EPA issued stricter guidance for defining assessed waters in 1992. The percentage of rivers assessed in 1992 appears much smaller than the percentage assessed in 1990 because the Nation shifted its baseline to the more inclusive total waters estimates described in Chapter 1 (page 8).

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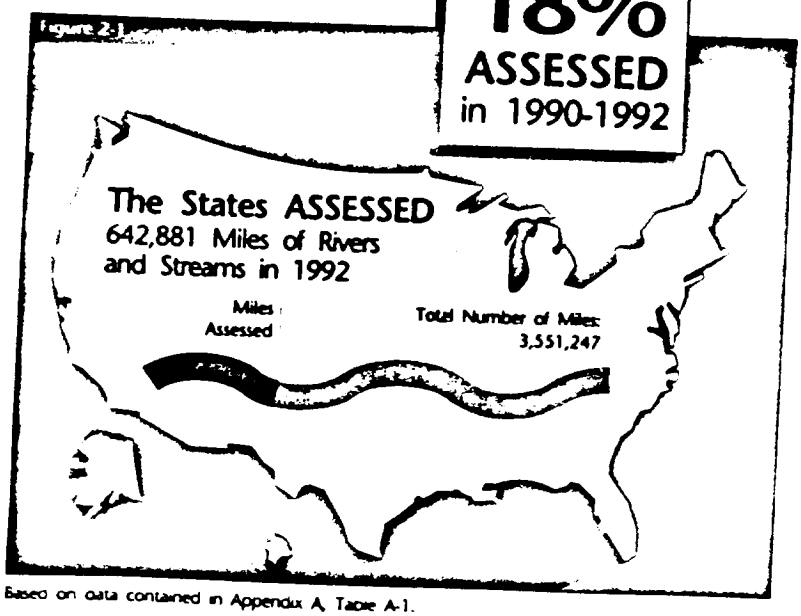
Figure 2-1



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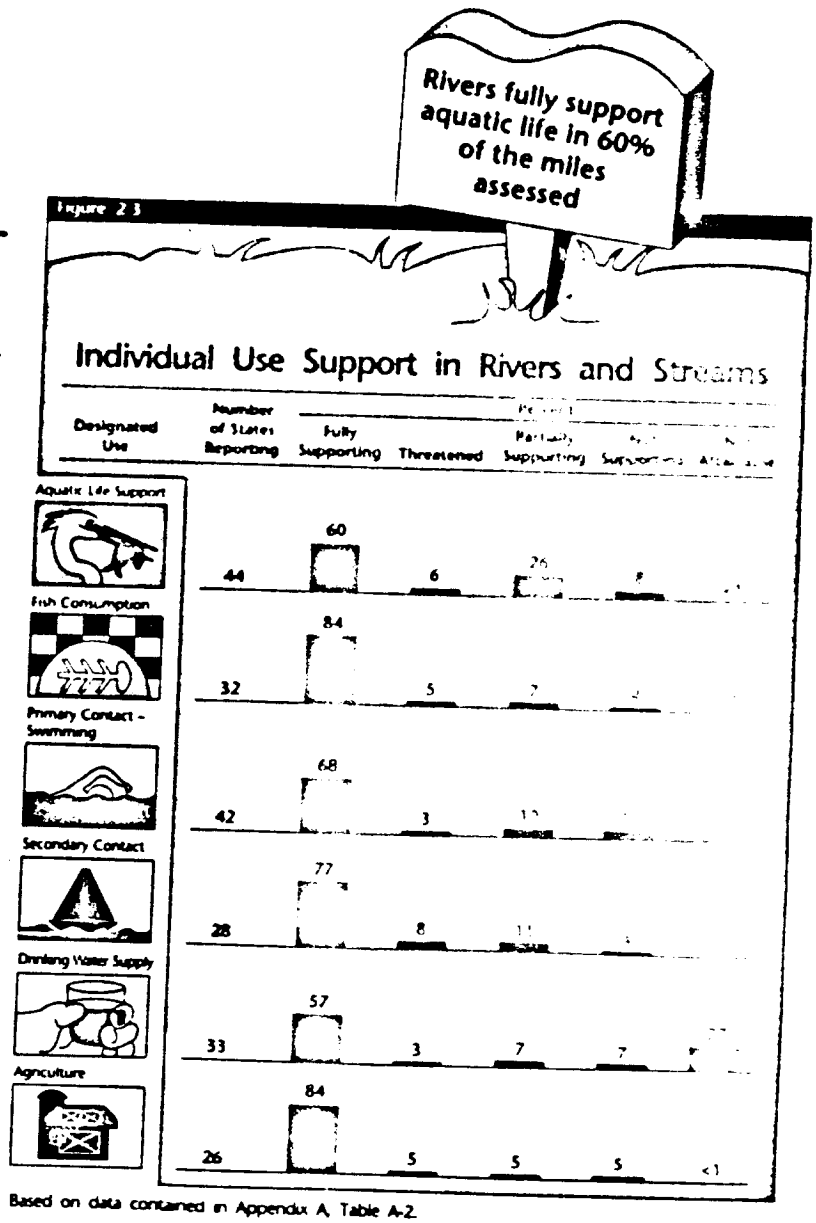
the flow of runoff into the treatment plant subsided.

Thirteen percent of the assessed river miles do not support overall designated uses and less than 1% cannot attain designated uses due to excessive degradation or natural conditions such as low flow.

Individual Use Support

The States assessed support of six individual designated uses in rivers: aquatic life support, fish consumption, primary contact recreation–swimming, secondary contact recreation, public drinking water supply, and agricultural supply (see Chapter 1, page 3, for a description of each individual use). The States reported the status of aquatic life support and swimming use support most frequently (Figure 2-3). Fifteen States failed to report individual use support (see Appendix A, Table A-2, for individual State information).

Rivers fully support aquatic life in 60% of the 547,871 miles assessed. Aquatic life support accounts for most of the river miles partially supporting their designated uses. Of the 221,352 river miles assessed for drinking water supply use, 27% cannot attain drinking water use standards. Natural physical characteristics, such as hardness and color, as well as degradation from human activities may prevent rivers from attaining drinking water standards.



Based on data contained in Appendix A, Table A-2.

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Causes of Impairment

Forty-nine States identified the number of stream miles affected by individual causes of nonsupport. Causes of nonsupport are pollutants or pollutant processes that impair waterbodies, such as sediment, metals, acidity, and hydromodification. The total number of river miles affected by a particular pollutant is subdivided into whether the cause is a major or moderate/minor contributor to impairment. A major contributor is solely responsible for the impairment or predominates over other causes. A moderate contributor is one of multiple causes responsible for less than full support, of which none predominate.

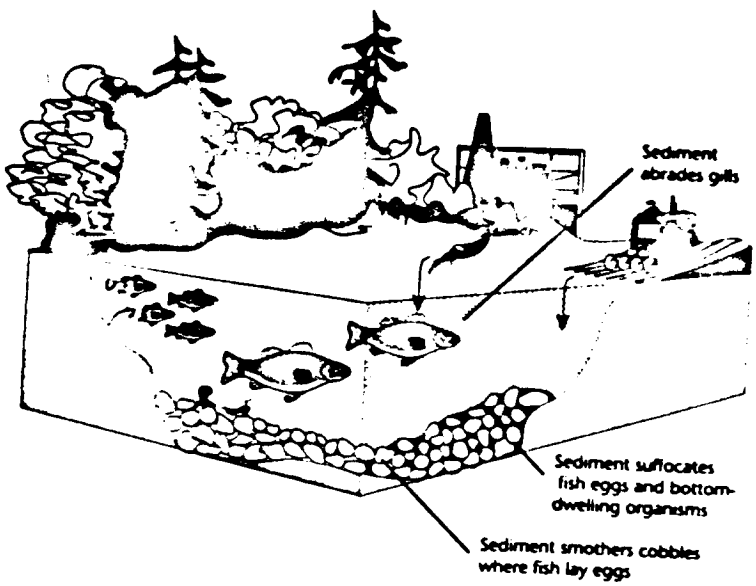
Any given stream mile can be affected by multiple causes of impairment. Therefore, States count each stream mile under each cause category contributing to its impairment. As a result, States count a single mile of river affected by multiple causes of impairment under several cause categories. The values reported are the total number of river miles affected by a particular cause of impairment according to whether the cause is a major or moderate/minor contributor to impairment.

States report that siltation is the most prevalent cause of impairment in assessed rivers and streams (Figure 2-4). Siltation affects 45% of the 222,370 impaired stream miles in the States reporting causes of pollution (Figure 2-5). Nutrients, the second most commonly reported cause, affect 37% of the impaired river miles and most often consist of nitrogen and phosphorus compounds typically found in agricultural fertilizers, phosphate detergents, and municipal sewage treatment plant discharges.

Pathogen contamination affects 27% of the impaired stream miles. Pathogens impair drinking water supply uses and contact recreation uses and commonly enter waters in inadequately treated sewage or runoff from pastures, feedlots, and urban areas.

Figure 2-4

The Effects of Siltation in Rivers and Streams



Siltation is the leading pollution problem in the Nation's rivers and streams. Over the long term, unchecked siltation can alter habitat with profound effects on aquatic life. In the short term, silt can kill fish directly, destroy spawning beds, and increase water turbidity resulting in depressed photosynthetic rates.

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Forty-two States specified the degree of impact (i.e., major or moderate/minor) of the causes affecting rivers and streams. These States reported that all causes have more moderate and minor impacts than major impacts.

Sources of Impairment

Forty-eight States reported sources of some impairments in their rivers and streams. Because it is so difficult to detect and differentiate sources of pollution, most States identify sources for a subset of their impaired rivers, which are a portion of their assessed rivers, which are, in turn, a fraction of the Nation's total river miles. As a result, the ranking of sources shown in Figure 2-6 applies to only 6% of the Nation's total river miles.

As with causes of impairment, multiple sources may affect an individual river mile. Therefore, States count a single river mile under each source category contributing to its impairment. As a result, States count a single mile of river affected by multiple sources of impairment under several source categories. The values reported are the total number of river miles affected by a particular source of impairment according to whether the source is a major or moderate/minor contributor to impairment.

The States report that agriculture is the most extensive source of pollution in the Nation's assessed rivers. The general category of agriculture, which includes irrigated crop production, nonirrigated crop

SILTATION
is the leading c
of impairm
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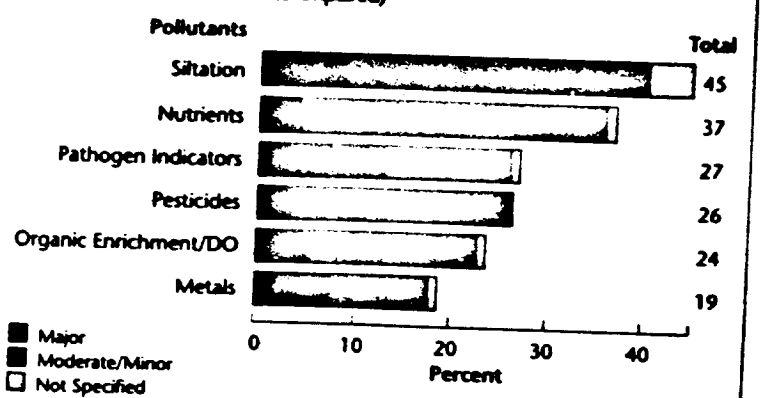
affecting 45
impaired river m

Figure 2-5

Percent of ASSESSED River Miles Impaired by Pollutants

(222,370 assessed river miles impaired)



Total rivers = 3.5 million miles
Total assessed = 642,881 miles

■ 18% assessed
■ 82% unassessed

Based on data contained in Appendix A, Table A-3.

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AGRICULTURE is the leading source of impairment to the Nation's rivers, affecting 72% of the impaired river miles.

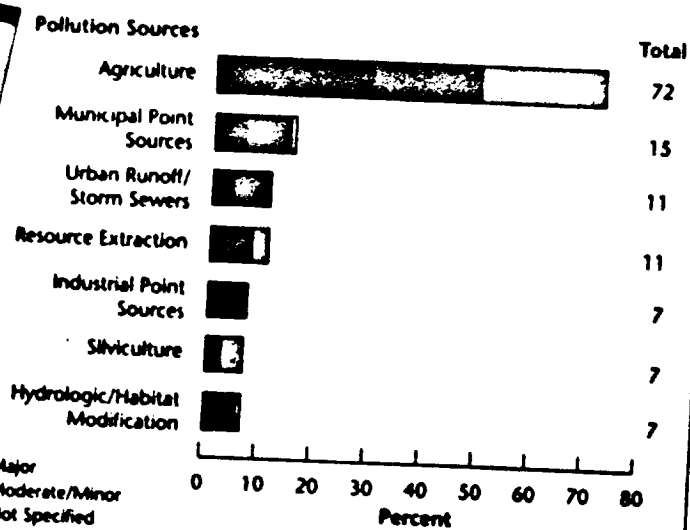
Total rivers = 3.5 million miles
Total assessed = 642,881 miles

■ 18% assessed
■ 82% unassessed

Figure 2-6

Percent of ASSESSED River Miles Impaired by Sources of Pollution

(221,877 assessed river miles impaired)



Based on data contained in Appendix A ,Table A-4.

NOTE

It is relatively easy to collect a water sample and identify pollutants causing impairments, such as fecal coliform bacteria indicating pathogen contamination. However, detecting and ranking sources of pollutants can require monitoring pollutant movement from numerous potential sources, such as failing septic systems, agricultural fields, urban runoff, municipal sewage treatment plants, and local waterfowl populations.

production, rangeland, and feed lots, affects 72% of the 221,877 impaired river miles in the States reporting sources of river impairments. Reporting of agricultural impacts is widespread (Figure 2-7). Agricultural sources are responsible for many pollutants such as sediment, nutrients, pesticides, pathogens, and organic enrichment.

Other specific sources of pollution that impair rivers include municipal point sources (15%), urban runoff and storm sewers (11%), resource extraction (11%), industrial point sources (7%), silviculture (7%), and hydrologic and habitat alterations (7%).

The States also report that "other" sources impair significant stretches of our rivers and streams. "Other" sources include natural sources, such as low-flow conditions, leaf litter, and glacial debris that may increase turbidity, acidity, and water temperature in the absence of human activity. For example, Oregon reported that 4,232 river miles were impaired by natural glacial debris elevating turbidity.

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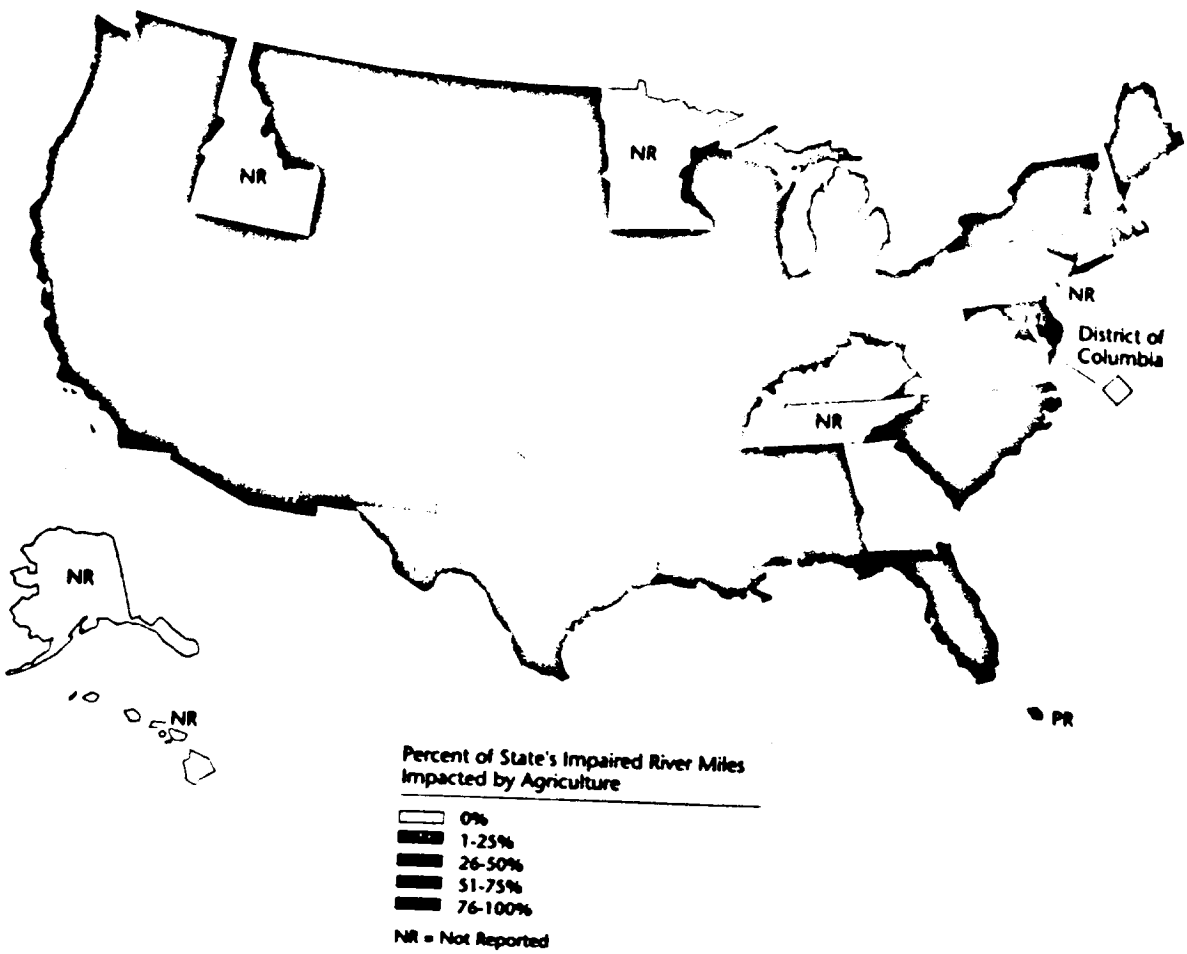
Figure 2-7

Distribution of Agricultural Impacts on Rivers and Streams



Based on data contained in Appendix A, Table A-4.

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Nutrient Loads in Four Major River Basins*

Nutrient enrichment is one of the most pervasive water quality problems in the Nation's rivers and streams. Excessive inputs of nutrients (such as nitrogen and phosphorus) can overstimulate aquatic plant growth and algal productivity, which, in turn, destabilizes dissolved oxygen concentrations and pH (acidity) in stream ecosystems. The unstable conditions may force fish and other aquatic organisms to seek healthier habitat.

The U.S. Geological Survey (USGS) assessed total phosphorus and total nitrogen loads in four river basins under the National Water Quality Assessment (NAWQA) Program. The USGS designed the NAWQA Program to describe status and trends in the Nation's water resources and to improve understanding of the natural and human factors that affect the quality of water resources. The NAWQA program assessed point and nonpoint source nutrient loads in the Kentucky River Basin, the Upper Illinois River Basin, the Lower

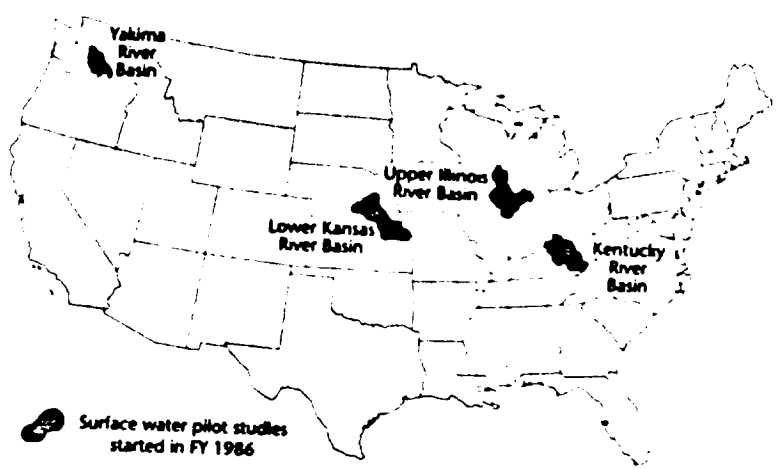

Figure 1. U.S. Geological Survey National Water Quality Assessment Program.

*The information contained in this highlight was extracted from *Preliminary Estimates of Phosphorus and Nitrogen Loads from Point and Nonpoint Sources in Four Major River Basins in the United States*, by J.V. Davis and W.G. Wilber of the U.S. Geological Survey.

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Kansas River Basin, and the Yakima River Basin in Washington (Figure 1).

The USGS estimated the mean daily instream loads of total phosphorus and total nitrogen at USGS's most downstream long-term monitoring site in each river basin. The USGS used all available water quality data to develop equations relating instream flow to nutrient loads and applied the equations to daily streamflow records to estimate mean annual nutrient loads in each basin. The annual loads were divided by 365 days to estimate the mean daily instream load of nutrients entering each basin. The USGS also divided the mean daily nutrient loads by the drainage area of each basin to estimate the yield of nutrients coming off an acre of land in each basin.

The USGS calculated mean daily loads from point sources (such as sewage treatment plants and industrial dischargers) with effluent flow rate data and nutrient concentration data contained in EPA's Permit Compliance System Database and other databases managed by wastewater treatment plant operators. The USGS estimated nonpoint source nutrient loads by subtracting the total point source load in a basin from the total instream basin load at the most downstream monitoring station. The resulting estimate of nonpoint source nutrient load is conservative because it does not take into account nutrient losses due to physical, biological, and chemical processes.

Of the four basins studied, the Upper Illinois River basin had the highest estimates of instream nutrient loads and yields (Figure 2). The Upper Illinois River basin also has the largest percentage of land devoted to cultivated row crops (75%), the highest nitrogen and phosphorus fertilizer application rates, and the largest wastewater effluent loadings of nitrogen and phosphorus due to the large population in the basin (about 7.6 million people).

In contrast, nitrogen and phosphorus loads were smallest in the Yakima River basin, which has a small population and land use dominated by forests, grazing lands,

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orchards, and crops that tend to be more permanent and result in less erosion.

Nonpoint sources generated most of the nutrient loads in the Lower Kansas River basin, the Kentucky River basin, and the Yakima River basin (Figure 2). Point sources played a greater role in generating nutrients in the Upper Illinois River basin than in the other basins because the Upper Illinois River basin's large population generates more sewage than do populations in the other basins. Point sources accounted for 57% of the mean annual load of total phosphorus exported from the Upper Illinois River basin compared to 39% in the Lower Kansas River basin, 27% in the Yakima River basin, and 20% in the Kentucky River basin.

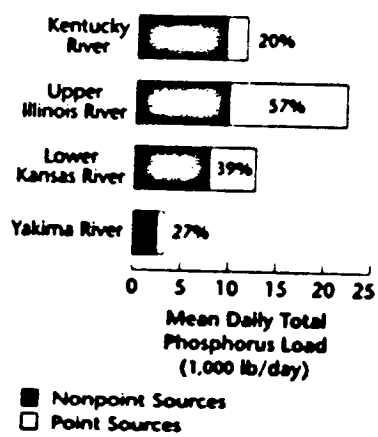

Figure 2. Mean daily total phosphorus loads.

In general, point source effluent monitoring and ambient monitoring programs still lack integration, which limits our ability to determine the relative magnitude of point versus nonpoint sources of contamination. For example, relatively few wastewater treatment facilities routinely monitor their effluent for nutrients, metals, and other constituents of interest in ambient water assessments. Estimates of point and nonpoint sources of contamination would be improved by the following:

- Sampling the same pollutants and constituents in point source discharges and ambient waterbodies
- Increasing the frequency of effluent monitoring at many locations and using flow-weighted composite samples for selected constituents
- Developing and using a quality assurance plan for effluent flow-rate estimation.

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Lakes, Reservoirs, and Ponds

Overall Use Support

Forty-seven States and Territories, the District of Columbia, and one American Indian Tribe (hereafter referred to as States) assessed overall use support in more than 18 million acres of lakes, reservoirs, and ponds (see Appendix B, Table B-1, for individual State data). As shown in Figure 3-1, these States assessed almost half of the Nation's 40 million acres of lake waters (excluding the Great Lakes, discussed in Chapter 11). The States based 63% of their lake assessments on monitored data, 22% of their lake assessments on evaluated information, and 14% were not specified.

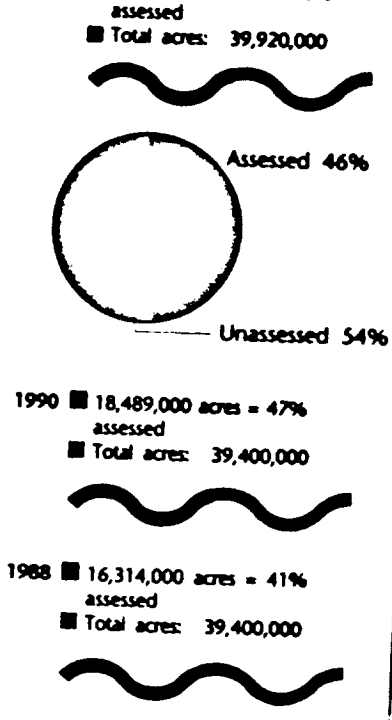
Forty-three percent of the assessed lake acres fully support designated beneficial uses (Figure 3-2). Another 13% of the assessed lake acres fully support uses but are threatened by potential sources of pollutants. Thirty-five percent of the assessed lake acres partially support designated uses, and 9% of the assessed lake acres do not support designated uses.

THE STATES ASSESSED more than 18 million acres of lakes in 1992.

46% ASSESSED in 1990-1992

Figure 3-1

Lake, Reservoir, and Pond Acres Assessed by the States



Based on data contained in Appendix B, Table B-1.

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43% OF ASSESSED lake acres fully supporting designated uses and 1% currently supporting uses but are threatened.

Lake data should not be compared among States, which devote varying resources to monitoring water quality chemistry, biological integrity, and toxic pollutants in fish tissues. These inconsistencies, rather than actual differences in water quality, often account for the wide range in use support reported by individual States.

Individual Use Support

The States reported individual use support for the first time in their 1992 Section 305(b) reports (Appendix B, Table B-2, contains individual State data). Forty States described the status of aquatic life use support in their lakes. The criteria for supporting aquatic life use are often more strict than the criteria for supporting other uses because aquatic organisms are sensitive to numerous water quality parameters. The States reported that 60% of the assessed lake acres fully support aquatic life and 9% are threatened (Figure 3-3). Aquatic life support use is impaired (i.e., partially supporting or not supporting designated uses) in the remaining 31% of the assessed lake acres.

Fish consumption use was also highly impaired, primarily by elevated contaminant concentrations in fish tissues that trigger States to issue fish consumption advisories. Fish consumption advisories recommend that the public restrict ingestion of contaminated fish to minimize human exposure to elevated toxic pollutants in fish tissues. Water pollution also impairs

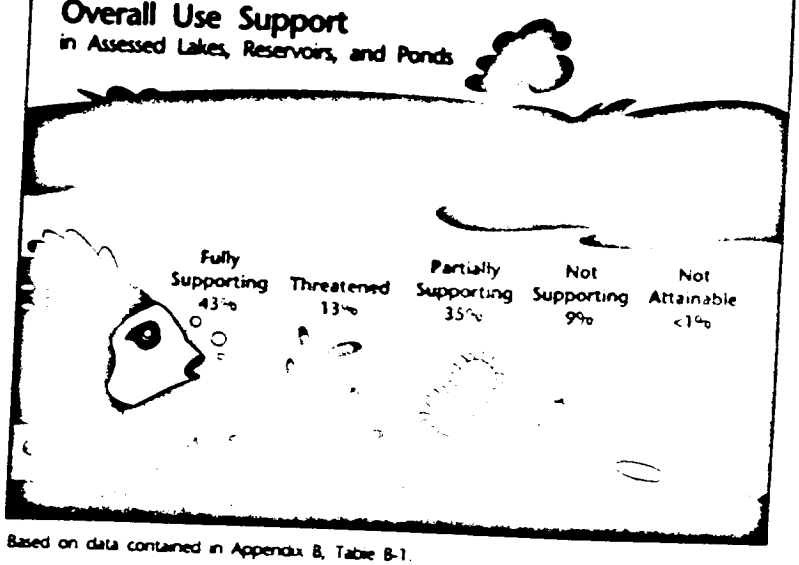
Figure 3-2

Overall Use Support
in Assessed Lakes, Reservoirs, and Ponds

Total lakes = 39,920,000 acres
Total assessed = 18,300,000 acres

- 46% assessed
- 54% unassessed

Of the assessed acres:
- 63% were monitored
- 22% were evaluated
- 14% were not specified



Based on data contained in Appendix B, Table B-1.

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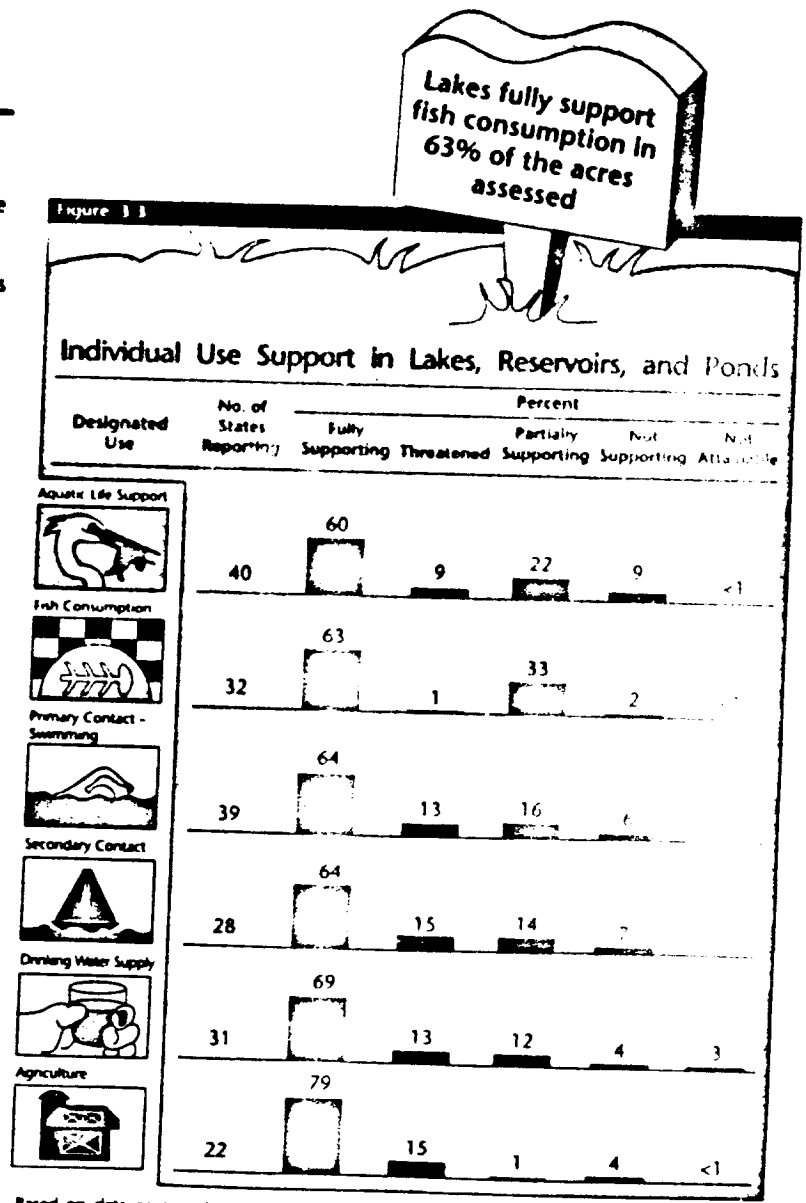
fish consumption use by degrading the habitat of desirable sport fish species.

Causes of Impairment

Forty-seven States reported the number of lake acres impaired by individual causes of nonsupport (see Appendix B, Table B-3, for individual State data). Causes of nonsupport are pollutants and processes that impair water quality, such as metals, nutrients, or sediment. Multiple pollutants may impair an individual lake acre. Therefore, States may count an individual lake acre under several cause categories although the lake acre was counted only once as an impaired waterbody. The causes are designated as either major or moderate/minor contributors to waterbody impairments.

The relative extent of each cause is determined by dividing the acreage impaired by each cause category by the total impaired acres in the States reporting causes of nonsupport. In 1992, these States reported that 7,958,064 lake acres were impaired, which represents 43% of the assessed lake acres and 20% of the 40 million total lake acres in the Nation.

The information reported by the States indicates that metals, nutrients, organic enrichment/dissolved oxygen depletion, siltation, and priority organic chemicals are the five leading causes of lake impairment (Figure 3-4). Although metals impaired the most lake acres overall, the effect of metals is concentrated in one State: Minnesota



Based on data contained in Appendix B, Table B-2.

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reported more than 50% of all the acres impaired by metals. The information on metals contamination may also be exaggerated by contaminated samples. The Workshop on Aquatic Life Criteria for Metals, held by EPA in January 1993, found that most metals data have not been collected using clean sampling and analysis techniques. Consequently, metal values may be unreliable due to various types of contamination.

More States reported problems from nutrients than any other single pollutant (Figure 3-5). Forty-one States reported that nutrients impair more than 3 million lake acres. Nutrients cause nuisance overgrowth of algae as well as noxious aquatic plants, which leads to oxygen depletion via plant respiration and microbial decomposition of plant matter (Figure 3-6).

Thirty States reported that siltation impairs their lakes, ponds, and reservoirs. Siltation can smother aquatic organisms and their habitats, damage gills in fish and other aquatic organisms, and gradually fill in reservoirs. As reservoirs fill, they support fewer recreational activities and cannot function as reliable sources of drinking water.

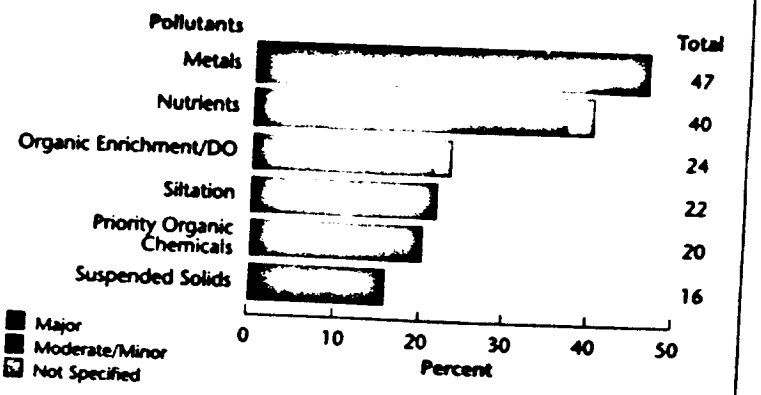
Priority organic chemicals (such as polychlorinated biphenyls–PCBs) increased in relative importance during the 1992 reporting cycle. In 1990, priority organics ranked eighth in the number of lake acres impaired. In 1992, priority organics ranked fifth, with Minnesota reporting 82% of the lake acreage impacted by priority organics.

Total lakes = 39,920,000 acres
Total assessed = 18,300,000 acres

- 46% assessed
- 54% unassessed

Figure 3-4

Percent of ASSESSED Lake Acres Impaired by Pollutants
(7,958,064 assessed lake acres impaired)



Based on data contained in Appendix B, Table B-3.

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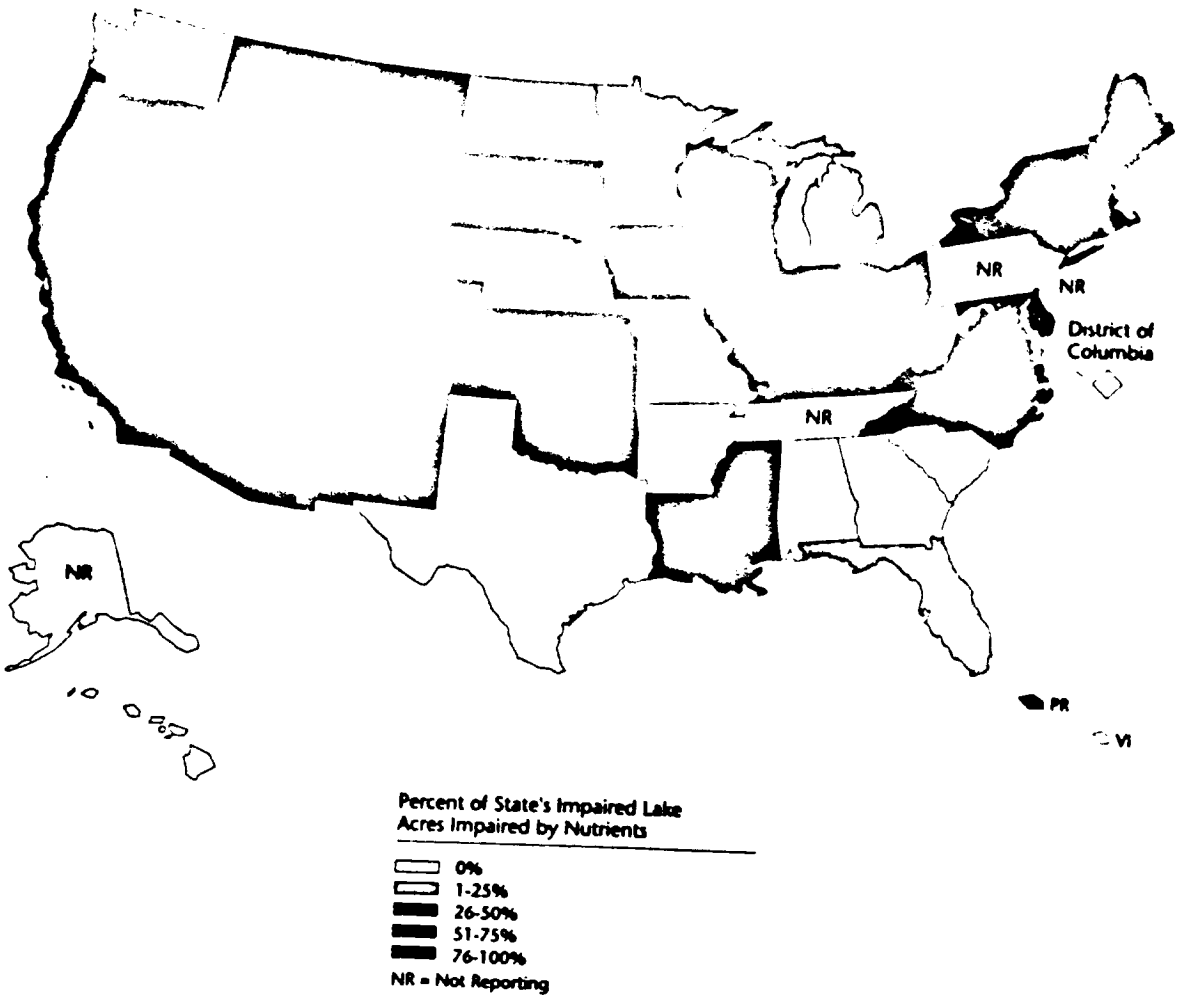
Figure 3-5

Distribution of Lake Acres Impaired by Nutrients



Source: 1992 State Section 305(b) reports.

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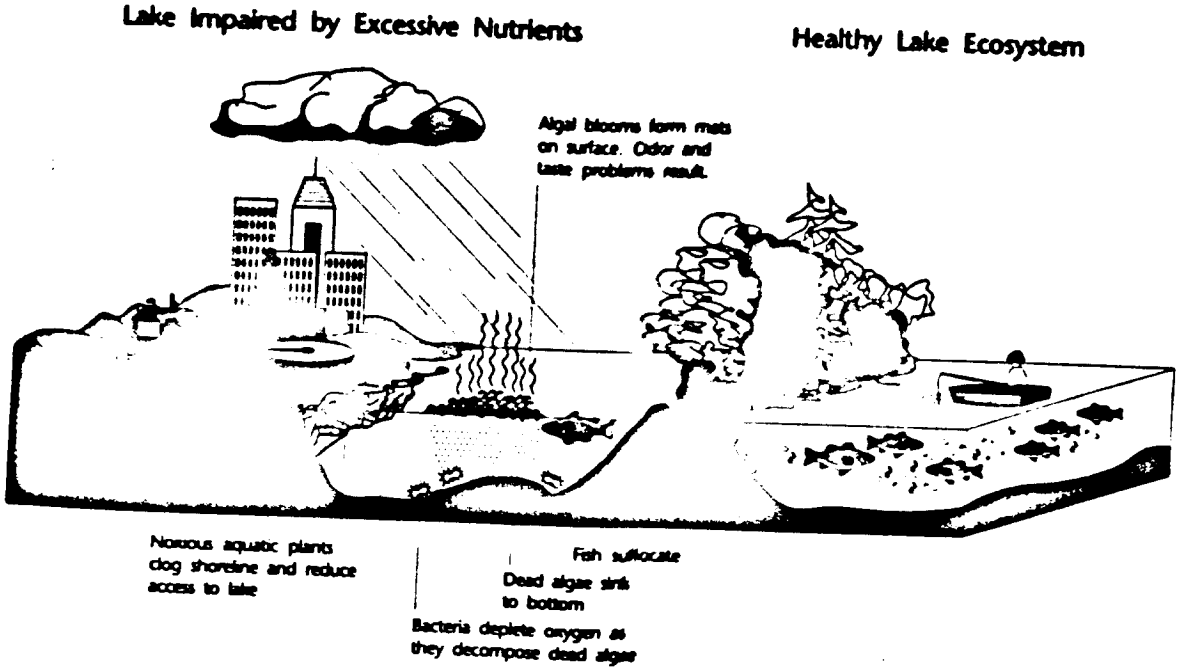
Sources of Impairment

Forty-five States reported the number of lake acres impaired by individual sources of pollutants (see Appendix B, Table B-4). Multiple sources may impair an individual lake acre. In these cases, States count the impaired acre under each source category contributing to its impairment. Therefore, States may count an individual lake acre under several source categories. The sources are designated as either major or moderate/minor contributors to waterbody impairments.

As with causes, the source categories are ranked by the percentage of impaired waters attributed to each source category. The States reported sources of lake impairment for 5,543,987 impaired lake acres, which represents 30% of the lake acres assessed and 14% of the 40 million total lake acres in the United States.

Figure 3.6



Nutrients cause nuisance overgrowth of algal as well as noxious aquatic plants, which leads to oxygen depletion via plant respiration and microbial decomposition of plant matter. If not properly managed and controlled, sources such as agriculture, industrial activities, municipal sewage, and atmospheric deposition can contribute to excessive nutrients in lakes.

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The State data portray agriculture as the most extensive specific source of pollution in the Nation's lakes, followed by urban runoff and storm sewers, hydrologic and habitat modification, municipal point sources, and onsite wastewater disposal (Figure 3-7). Hydrologic modification includes dredging activities and drawdown at reservoirs. Habitat modification includes activities that destroy shoreline vegetation that buffers the aquatic system from disturbances on shore. The States also reported that "other" sources, including natural sources, impair lakes, reservoirs, and ponds. Natural sources include drought conditions and natural turbidity, which may impair swimming use at a reservoir.

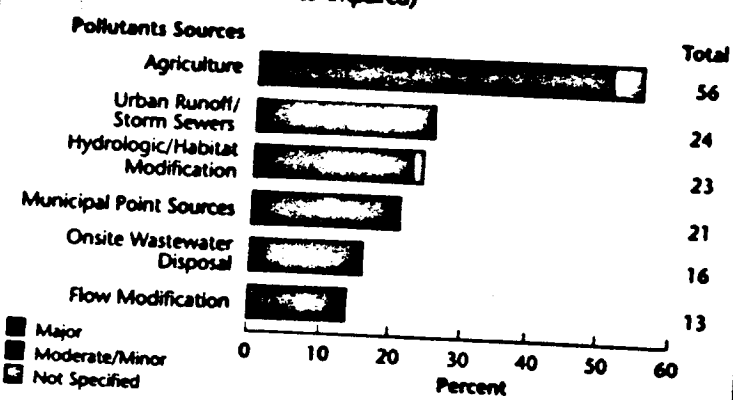
The summary information on sources of impairment in lakes should be interpreted with care. Individual States with large lake acreages can influence source rankings. For example, Florida alone reported 49% (almost half) of all the lake acres impaired by urban runoff and storm sewers and 68% of the lake acres impaired by onsite wastewater disposal. As a result, the source ratings can fluctuate dramatically depending on which States report sources of impairment.

AGRICULTURE is the leading source of impairment in lakes, affecting [illegible] of impaired la[illegible] acres.

Figure 3-7

Percent of ASSESSED Lake Acres Impaired by Sources of Pollution

(5,543,987 assessed lake acres impaired)



Total lakes = 39,920,000 acres
Total assessed = 18,300,000 acres

46% assessed
54% unassessed

Based on data contained in Appendix B, Table B-4.

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HIGHLIGHT HIGHLIGHT HIGHLIGHT

EMAP – Surface Waters: Northeast Lakes Pilot

The EPA Office of Research and Development (ORD) initiated the Environmental Monitoring and Assessment Program (EMAP) to evaluate the quantity and quality of our Nation's ecological resources. EMAP consists of seven integrated units, each dedicated to evaluating an individual ecological resource area such as forests or surface waters (lakes and streams). To address EMAP's broad goals, ORD coordinates planning and implementation with numerous EPA program offices, EPA Regions, and States, as well as other Federal agencies, including the U.S. Fish and Wildlife Service , the U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration.

In 1991, ORD began piloting the EMAP-Surface Waters program with a study of northeastern lakes. The EMAP-Surface Water team selected indicators of biological integrity, trophic condition, and fishability to describe the condition of the Nation's lakes. The first year of the pilot study focused on collecting data on trophic status from northeastern lakes with a surface area between 1 and 2,000 hectares (or approximately 2.5 to 5,000 acres). The pilot study also estimated the number of lakes in the northeastern United States using updated versions of the EPA Office of Water's River Reach File (which produced the estimates of total waters used in this report).

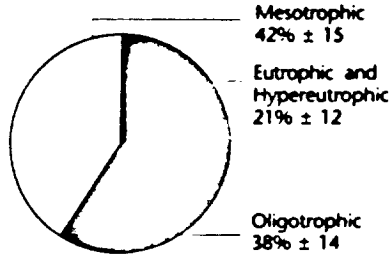

Figure 1. Lake Trophic State – 1991 EMAP data for the Northeastern United States.

Lake Water Quantity

The EPA Office of Water, using Version 3.0 of the EPA River Reach File (RF3), summarizes digitized traces of waters from the USGS 1:100,000 scale map series to estimate the number of lakes and total lake acreage in each State. RF3 was used by EMAP-Surface Waters to select a stratified, random sample of lakes across the northeastern States. This statistical sampling approach will allow EMAP, along with the States and others, to submit corrections to update the RF3 estimates of stream miles, lakes, and lake acreage.

Lake Water Quality

During the first year of the lake pilot study, EMAP-Surface Waters sampled and analyzed chlorophyll *a* and total phosphorus concentrations in northeastern lakes (New England, New York, and New Jersey). Chlorophyll *a* (a surrogate measure of algal biomass) and total phosphorus concentrations indicate the degree of nutrient enrichment in lakes. After screening over 300 lakes, EMAP teams visited 74 lakes to measure various lake quality parameters. EMAP-Surface Waters then applied criteria developed by the North American Lake Management Society

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to chlorophyll *a* and total phosphorus data to classify lakes according to trophic category. Based on the distribution of sampled lakes, EMAP-Surface Waters estimated the total number of lakes (including confidence limits) in each trophic category in the Northeast (Figure 1).

To demonstrate how the EMAP approach might be used to evaluate spatial patterns in lake quality, the data were statistically aggregated into three ecoregions (Figure 2): the Adirondacks, the New England Uplands, and the Coastal/Lowland/Plateau regions. During this first year's pilot, the sample sizes within each of these regions were quite small (all <30 lakes sampled) but the statistical design still provides an estimate of lake trophic condition and a measure of the uncertainty in the estimate (Figure 3). In future years, the sample size will be larger and greater confidence can be placed in the estimates.

The results of the EMAP-Surface Waters program complement the State programs described elsewhere in this report. The EMAP-Surface Waters program applies a consistent lake definition, sampling protocols, and assessment methods across an entire region. EMAP-Surface Waters looks at all lakes rather than a subset of impacted lakes or other high-priority lakes. With data from EMAP and from the assessments of high- priority waterbodies conducted by the States, we will have a much clearer picture of water resource conditions upon which to base management decisions. In future years, EMAP-Surface Waters will report on biological integrity in lakes and will address the condition of river and stream resources.

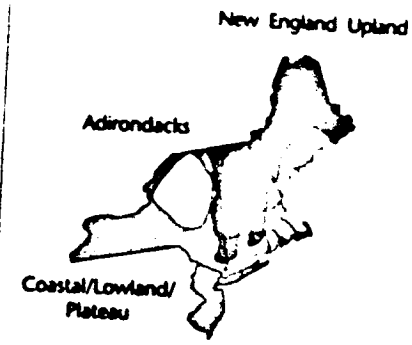

Figure 2. Three ecological regions on which statistical summaries can be based for routine reporting.

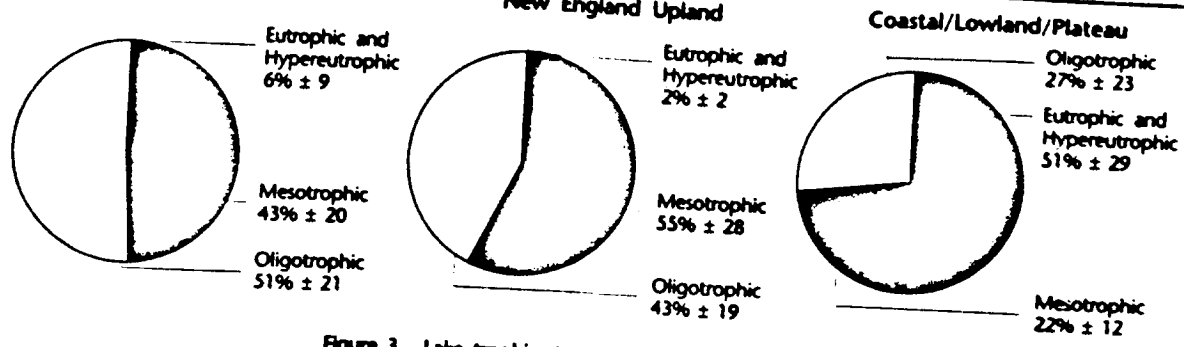

Figure 3. Lake trophic states for northeast subregions.

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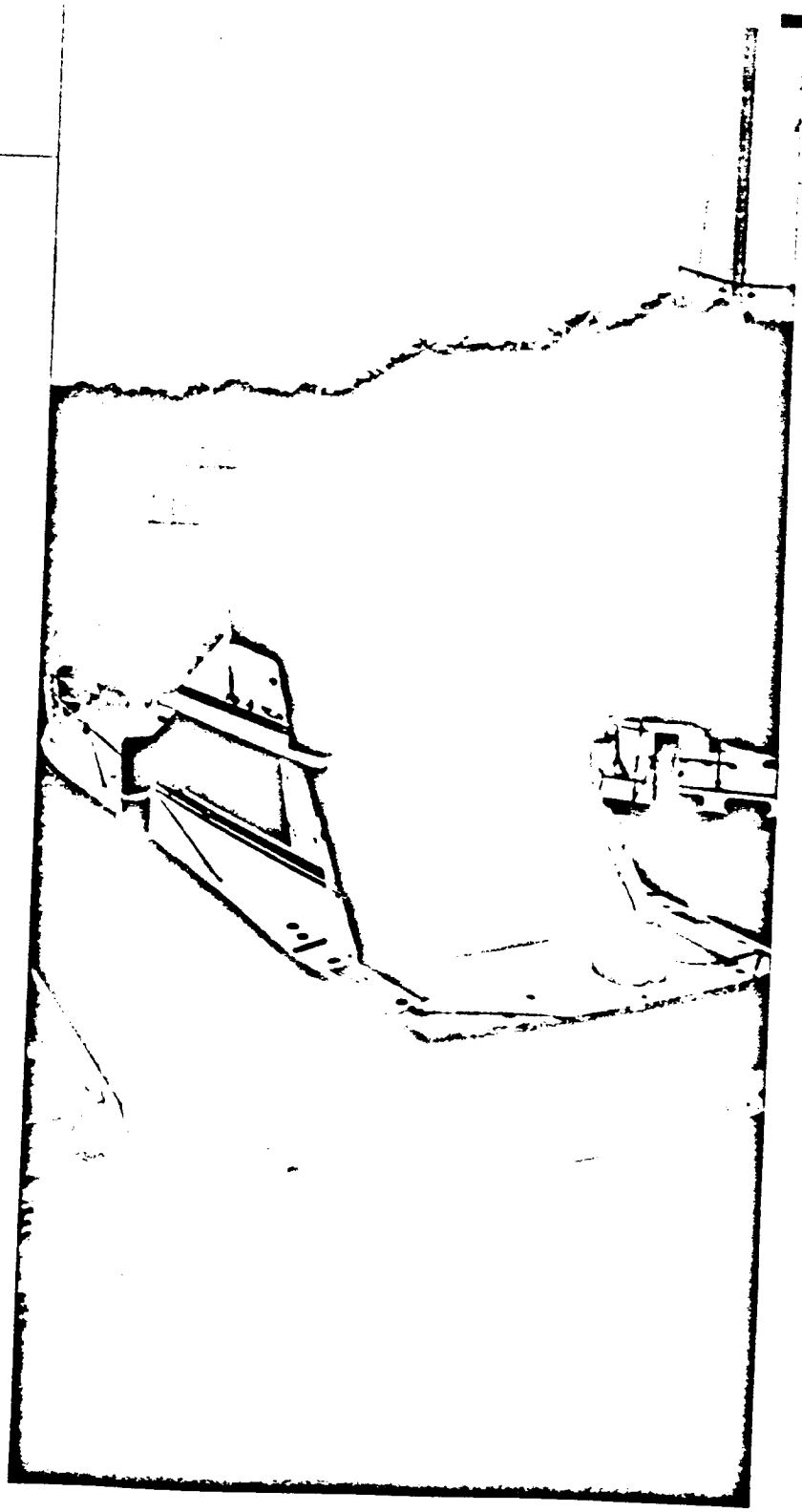

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Estuaries and Ocean Coastal Waters

Estuaries are our richest aquatic ecosystems and also the most susceptible to cumulative contamination. Estuaries are coastal waters where tidal influence mixes oceanic salt water with riverine fresh water that carries pollutants from the entire watershed. Estuarine waters include bays and tidal rivers that serve as nursery areas for most commercial fisheries and shellfish populations. Almost all of our fish and shellfish industry relies upon productive, healthy estuarine waters and their adjacent wetlands.

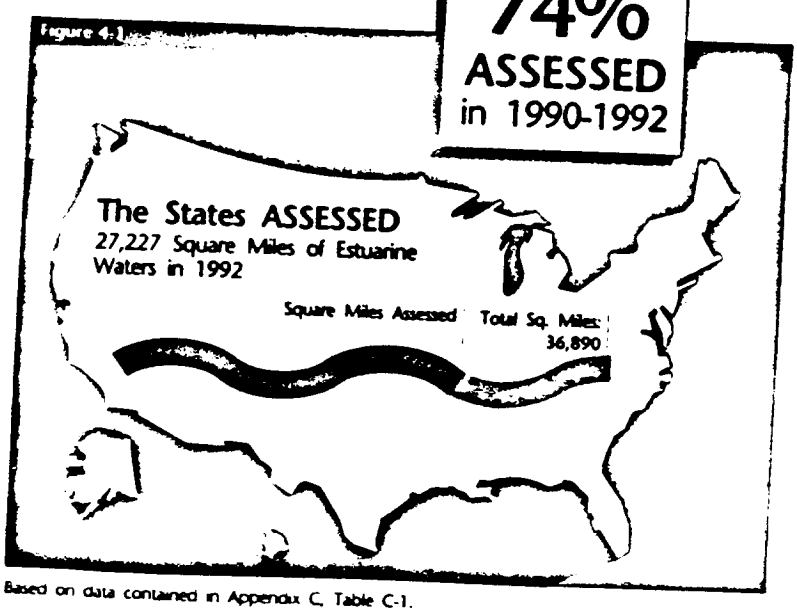
Both local and distant pollution sources threaten estuarine health. Most of the pollutants that enter rivers migrate toward the coast. As rivers approach the coast, their mouths broaden and flow decreases. The low flow and fluctuating tides, characteristic of estuarine waters, reduce flushing and trap nutrients as well as pollutants within estuarine waters. The ability to trap nutrients lays the foundation for a rich estuarine ecosystem but also makes estuaries vulnerable to overloading.

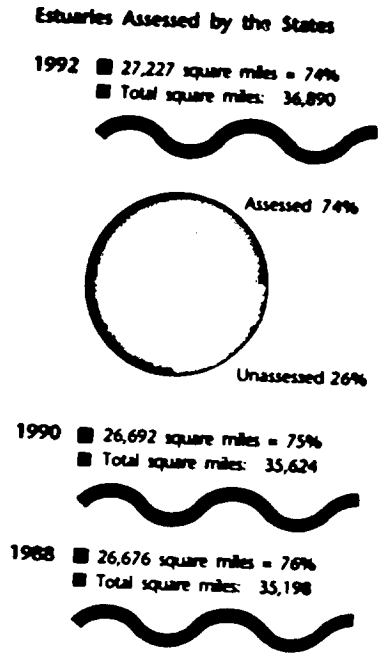
Historic development patterns have amplified natural trapping functions and overloaded estuaries from Boston Harbor to San

ESTUARIES are our richest aquatic ecosystems and also the most susceptible to cumulative contamination.

74% ASSESSED in 1990-1992

Figure 4-1





Based on data contained in Appendix C, Table C-1.

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TWENTY-THREE STATES reported overall use support status for estuarine waters.

Francisco Bay. Historically, industrial development clustered around estuarine bays with access to shipping and an adjacent waterbody for waste disposal. Population centers grew up around the industrial sites and added sewage to estuarine waters. Now, many coastal cities must develop alternative disposal systems for their outdated combined sewer systems.

Estuaries

Overall Use Support

Twenty-three States (including the Delaware River Basin Commission and Territories) reported overall use support status for estuarine waters (Appendix C, Table C-1, contains individual State data). In addition, California and New Jersey reported individual use support in estuarine waters but did not summarize overall use support. The EPA assumed that aquatic life use support status represented overall use support status in these two States. Altogether, the States assessed 27,227 square miles of estuarine waters representing 74% of the total estuarine waters in the lower 48 States (Figure 4-1). Fifty-six percent of the assessed waters fully support their designated beneficial uses; an additional 12% fully support designated uses but are threatened by pollution (Figure 4-2). Impaired waters include 23% of the estuarine waters partially supporting their designated uses and 9% of the waters not supporting their designated uses.

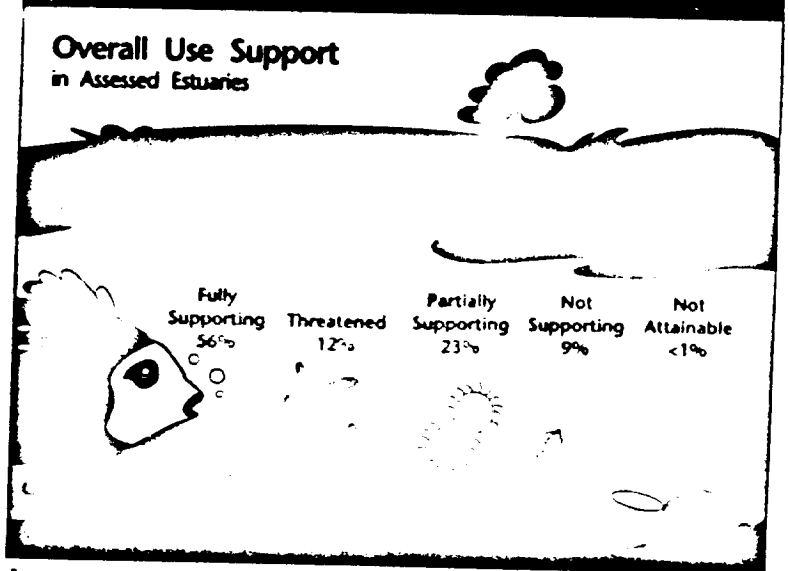
Total estuaries = 36,890 square miles
Total assessed = 27,227 square miles

- 74% assessed
- 26% unassessed

Of the assessed estuarine waters:
- 41% were monitored
- 33% were evaluated
- 26% were not specified

Figure 4-2

Overall Use Support
in Assessed Estuaries



Based on data contained in Appendix C, Table C-1.

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Four of the 29 estuarine States and Territories did not submit designated use assessments for their estuarine waters. Four of the 25 States that did submit estuarine use support information reported that almost none of their estuarine waters fully supported designated uses (Delaware, the District of Columbia, California, and Oregon). These States may have focused assessment and monitoring efforts on estuaries with known or suspected water quality problems.

Individual Use Support

For the first time, 19 States reported individual use support status for estuarine waters (see Appendix C, Table C-2). Data suggest that shellfishing use is the most impaired individual use (Figure 4-3). Nineteen percent of the assessed waters do not support shellfish harvesting use and 11% partially support shellfish harvesting use. In addition, almost one-quarter of the assessed estuaries do not fully support aquatic life.

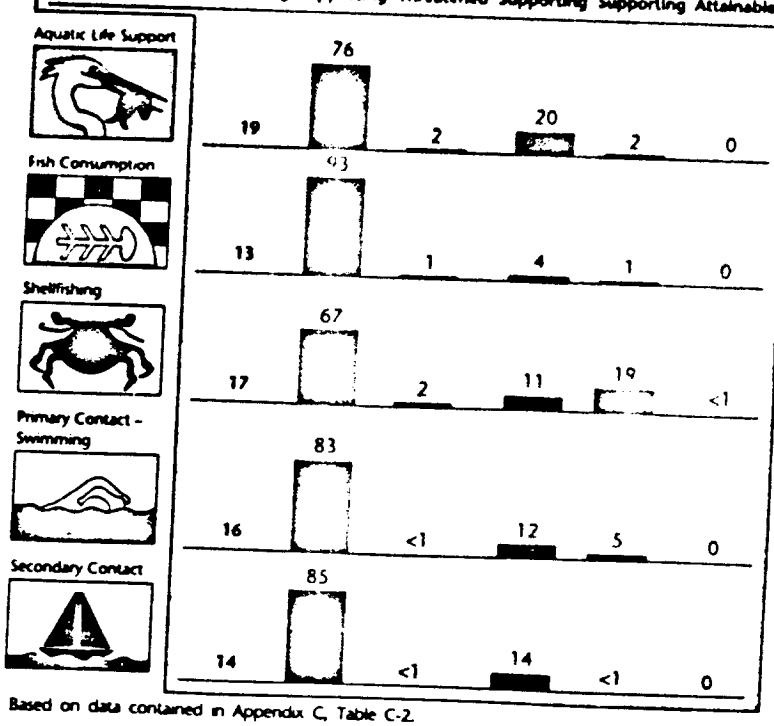
Causes of Impairment

Twenty-three States reported the extent of estuarine waters impaired by individual pollutants (see Appendix C, Table C-3, for individual State data). Several pollutants may prevent a waterbody from fully supporting its designated uses. Therefore, States count a square mile of an estuary impacted by multiple pollutants under several cause categories (although the estuarine area was counted only once as an impaired waterbody). The relative extent of each cause is represented by the fraction of the total impaired estuarine acreage (in the States reporting causes of impairments in

Estuaries fully support shellfishing in 67% of the waters assessed

Figure 4-3

Individual Use Support in Estuaries



Based on data contained in Appendix C, Table C-2.

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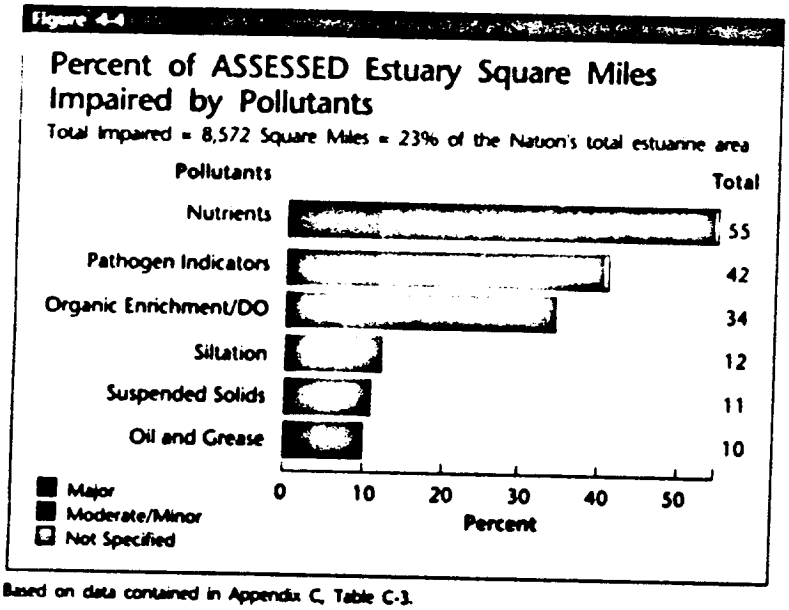
Figure 4-4

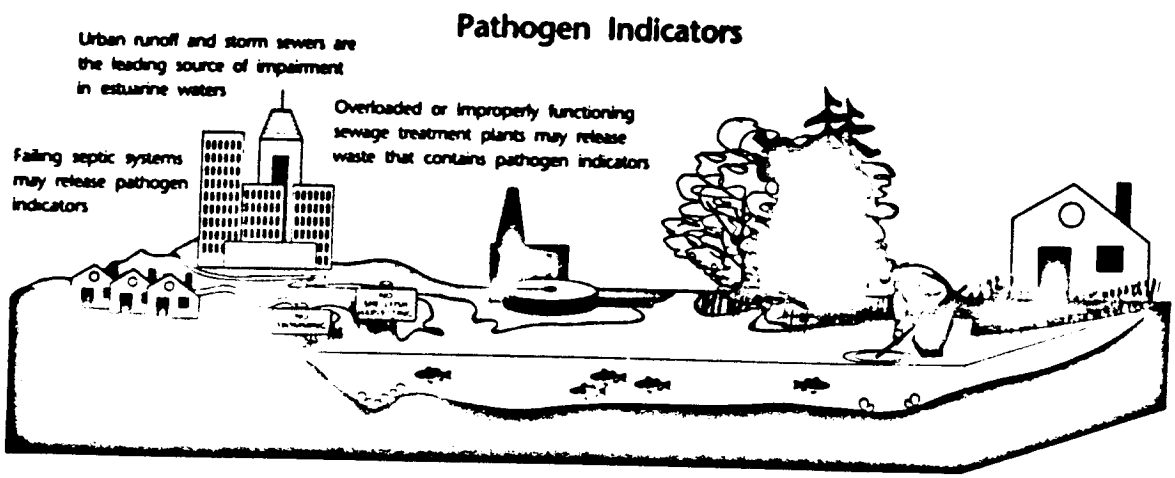


Based on data contained in Appendix C, Table C-3.

estuarine waters) attributed to each cause category.

As with rivers and lakes, nutrients, pathogen indicators, organic enrichment and low dissolved oxygen concentrations, and siltation were among the top five causes of water quality impairment (Figure 4-4). Nutrients affected 55% of the 8,572 square miles of impaired estuarine waters in the States reporting causes of estuarine impairments. Pathogen indicators (which indicate sewage contamination and cause shellfish harvesting restrictions) followed nutrients, affecting 42% of the impaired waters (Figure 4-5). Organic enrichment and low dissolved oxygen concentrations impacted 34% of the impaired estuaries, and siltation affected 12%.

Figure 4-5



Pathogen indicators, such as fecal coliform bacteria, provide evidence that an estuary is contaminated with fecal material that may contain pathogenic bacteria and viruses harmful to people. Often, the pathogenic viruses and bacteria do not adversely impact aquatic life, such as fish and shellfish. However, shellfish may accumulate bacteria and viruses that cause human diseases when ingested. Therefore, officials restrict shellfish harvesting in contaminated waters to protect public health. Pathogen indicators also impair swimming uses because some pathogenic bacteria and viruses can be transmitted by contact with contaminated water.

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Sources of Impairment

Twenty-two States reported the extent of estuarine waters impaired by individual sources of pollutants (see Appendix C, Table C-4). States counted any area impacted by multiple sources under each source category, although the area was counted only once as an impaired waterbody. As with causes, the relative importance of each source was determined by dividing the area impaired by an individual source by the total impaired estuarine area in the States reporting sources of estuarine impairments.

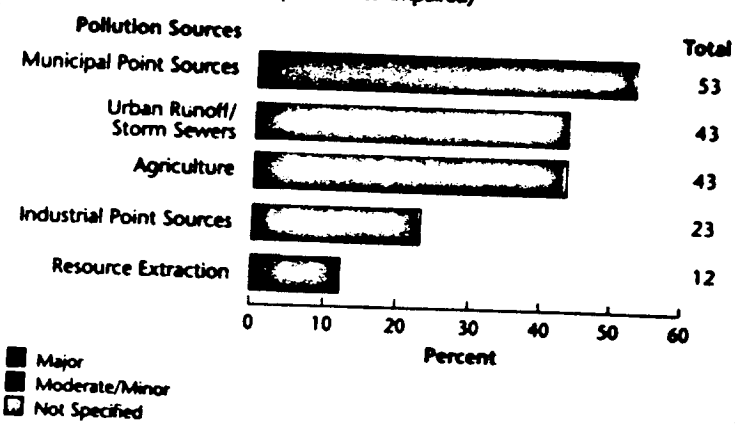
The States identified municipal wastewater treatment plants as the most pervasive source of pollution in assessed estuarine waters (Figure 4-6). Municipal point sources impaired 53% of the impaired estuarine waters in the 22 States reporting source information. Urban runoff and storm sewers impacted 43% of the impaired estuarine waters and agriculture also affected 43%. Industrial point sources affected 23% of the impaired estuarine waters and resource extraction affected 12%. In estuarine waters, point sources contribute significantly to water quality degradation because population centers and industrial centers are often located adjacent to estuarine waters.

MUNICIPAL POINT SOURCES are the leading pollution problem in the Nation's estuaries.

Figure 4-6

Percent of ASSESSED Estuary Square Miles Impaired by Sources of Pollution

(8,303 assessed estuarine square miles impaired)



Total estuaries = 36,890 square miles
Total assessed = 27,227 square miles

74% assessed
26% unassessed

Based on data contained in Appendix C, Table C-4.

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HIGHLIGHT HIGHLIGHT HIGHLIGHT

A Regional Assessment of the Ecological Condition of Estuaries

Millions of dollars are spent on pollution control problems in the United States and more than $133 billion is spent to monitor the condition of the marine environment by Federal, State, and local agencies; public utilities; and private corporations.* Most of these programs address specific local pollution problems; however, it is difficult to assess the effectiveness of these programs for protecting the environment at national and regional scales and over extended periods of time. The EPA considers it critical to establish monitoring, research, and assessment programs to determine the effectiveness of pollution control strategies and to substantiate the science upon which these strategies are based.

To address these issues, the Environmental Monitoring and Assessment Program (EMAP) is being developed as a national program by EPA's Office of Research and Development (ORD). EMAP is an integrated Federal program examining the condition of the Nation's ecological resources. While ORD is coordinating, planning, and developing EMAP; other Federal agencies (e.g., Agricultural Research Service, U.S. Forest Service, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration) participate in the collection and analysis of EMAP data and will use them to guide their policy decisions, as appropriate.

One component of EMAP is designed to quantitatively assess the condition of the Nation's estuarine resources using ecological indicators. During the period 1990-1993 (and continuing annually), NOAA, EPA regions, State agencies, and universities have assisted ORD in planning and implementing EMAP estuarine demonstration projects in the Virginian Province (between Cape Cod, MA, and the mouth of Chesapeake Bay), the Louisianian Province (between Tampa Bay, FL, and the Mexican border), and the Carolinian Province (between Chesapeake Bay and Indian River Lagoon, FL).

EMAP-Estuaries has been developed by EPA/ORD because an integrated monitoring and assessment program that samples estuarine resources in a probability-based manner offers considerable additional information to historical monitoring approaches. The EMAP approach provides improved definition of the extent and magnitude of pollution problems at regional and national scales. Simultaneous, probability-based sampling of pollution exposure, environmental condition, and biological resources is the important central focus of

*Managing Troubled Waters: The Role of Marine Environmental Monitoring. National Research Council, 1990.

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EMAP-Estuaries. This approach enables estimates to be made of the uncertainty associated with assessments and will improve our ability to identify ecological responses to pollution. EMAP-Estuaries (and eventually other resource groups within EMAP, e.g., surface waters, forests) will provide objective assessments of the severity and extent of environmental problems on an historical and regional scale and the degree to which degraded resources are responding to efforts to protect or restore them.

EMAP-Estuaries

In 1990-1993, EMAP-Estuaries teams annually sampled about 150 sites in the Virginian Province and about 165 sites in the Louisianian Province. Beginning in 1994 about 100 sites will be sampled annually in the Carolinian Province. The specific number of sites may vary in any year by about 5% due to the nature of the probability-based sampling design. This design is used to select sampling sites throughout the regions being assessed in proportion to the areal distribution of the estuarine resources in the region. The sampling teams measure indicators that can be directly measured in the field to represent biotic integrity, ecosystem quality, and societal values of estuarine resources. These indicators represent key aspects of the estuarine ecosystem such as benthic and fish community parameters, health condition of fish, and degree of eutrophication. In addition, several abiotic condition indicators are measured to characterize the environment associated with these estuarine ecosystems, including sediment contaminants and toxicity, water quality, dissolved oxygen, and habitat characteristics. By measuring these two types of indicators concurrently, EMAP-Estuaries can determine the degree that observed ecological degradation appears to be associated with specific types of environmental exposures.

Biotic Integrity

The presence of a healthy, diverse, and sustainable biological community reflects strong biotic integrity. The EMAP-Estuaries teams evaluated biotic integrity in the Virginian and Louisianian Provinces in 1991 by measuring species composition and abundance of bottom-dwelling organisms and the condition of fish communities. Benthic organisms are sensitive to pollution and integrate responses to pollution over a long period of time. Fish can bioaccumulate contaminants and

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their health condition can deteriorate with continued exposure to environmental stresses. Preliminary data from 1991 indicate that degraded benthic communities populate 19 ± 8% of the estuarine area in the Virginian Province and 31 ± 9% of the estuarine area in the Louisianian Province (Figure 1).

Ecosystem Quality

Ecosystem quality refers to the condition of the environment in which organisms live. EMAP-Estuaries measured dissolved oxygen (DO) concentrations in the water column and toxic contaminants concentrations in sediments and tested sediment toxicity to evaluate this second component of ecological integrity in the two demonstration provinces.

The EMAP-Estuaries teams compared DO concentrations measured in bottom waters to two threshold values, 5 ppm and 2 ppm. Some fish and benthic organisms cannot tolerate DO concentrations below 5 ppm; therefore, many States set minimum DO standards at 5 ppm to support aquatic life. Many estuarine organisms are adversely affected if DO concentrations fall below 2 ppm. Dissolved oxygen concentrations fell below 5 ppm in bottom waters in approximately 35 ± 10% of the estuarine bottom waters of the Virginian Province and in 21 ± 9% of the bottom waters of the Louisianian Province (Figure 2). Bottom dissolved oxygen concentrations fell below 2 ppm in 6 ± 5% of the Virginian Province and 12 ± 6% of the Louisianian Province. However, about half of hypoxic waters in the Louisianian Province were below 2 ppm only in the early morning hours (2 a.m.-7 a.m.) representing cyclic conditions. Under these cyclic conditions, acceptable DO concentrations exist most of the time with poor conditions occurring about 20% to 30% of the time.

The EMAP teams also evaluated the potential

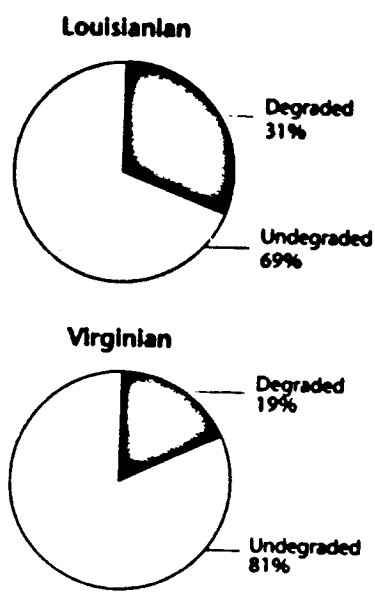

Figure 1. Benthic resources.

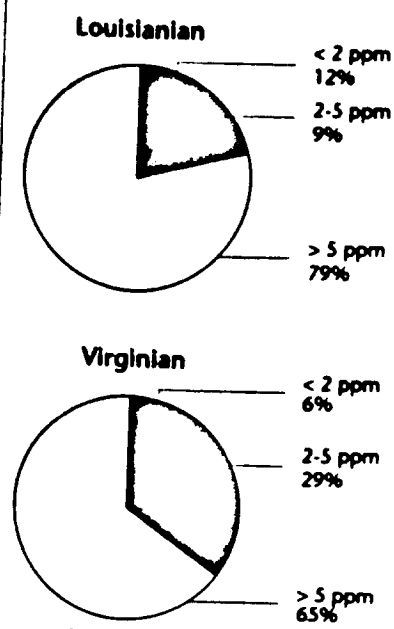

Figure 2. Dissolved oxygen concentrations.

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for sublethal effects from sediment contamination in estuaries. The teams compared contaminant concentrations in sediment samples collected at all sites to ER-L values. ER-L values represent concentrations at which biological effects (both sublethal and lethal) were observed in at least 10 percent of the contaminant exposure studies reviewed in the literature.

Metals were the most prevalent contaminants found at concentrations exceeding ER-L values indicating biological concern. In the Virginian Province, 38 ± 7% of the estuarine sediments contained contaminant concentrations of biological concern. Lead, nickel, and zinc most frequently exceeded ER-L values. Sampling detected organic contaminants at concentrations of biological concern in 12 ± 7% of Virginian Province sediments (Figure 3).

In the Louisianian Province, 33 ± 9% of the estuarine sediments contained elevated concentrations of metals, primarily mercury, arsenic, and chromium. Pesticides followed metals with 31 ± 8% of the province sediments containing concentrations that exceeded ER-L values. Dieldrin, chlordane, and DDT were the most widespread pesticides observed in the Louisianian Province.

Societal Values

The EMAP teams evaluated the extent of marine debris, measured water clarity, and measured contaminant levels in selected seafood to determine how well estuarine waters attain societal values. Marine debris has multiple deleterious effects on coastal economies and public perceptions of coastal health. Marine debris decreases the market potential for fish, damages fishing gear and vessels, and can reduce tourism. The EMAP teams estimated that trash was present in 17 ± 5% of the Virginian and Louisianian Provinces (Figure 4).

Society values clear waters, which contribute to healthy, productive aquatic communities. However, clarity varies greatly in estuaries and should not necessarily be compared between estuarine water bodies. A healthy estuary may be turbid due to local geomorphology or natural inputs of detritus. In other estuaries, reduced clarity may indicate unhealthy conditions resulting from pollutant inputs of sediments and nutrients. Although EMAP cannot distinguish between reduced clarity caused by pollution or natural sources, the data collected during the pilot projects establishes a baseline against which future changes in water clarity may be assessed. The EMAP teams found that 14 ± 6% of the Virginian Province had clarity of less than 1 meter, the depth of

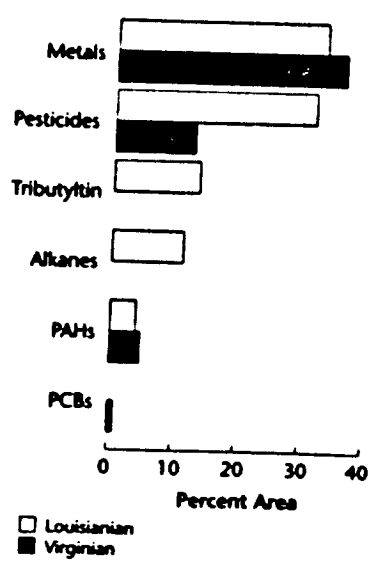

Figure 3. Sediment contamination exceeding ER-L values.

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one's feet when wading in waist-deep water. Waters in the Virginian Province were characterized by a visibility of no better than 0.3 meters (approximately 1 foot) in less than 1% of its estuarine area. About 55 ± 11% of the Louisianian Province had water clarity of less than 1 meter, including 27 ± 10% of the Province's waters with clarity less than 0.3 meters deep (Figure 5).

Contaminants in the edible portions of commercially and recreationally important fish and shellfish are important social measures of acceptable estuarine condition. At present, the Food and Drug Administration (FDA) provides action limits for fish and shellfish denoting safety for consumption. While EMAP-Estuaries does not provide a comprehensive evaluation of all fish and shellfish, selected target species were examined. These target species included weakfish, flounders, white perch, and croakers in the Virginian Province and Atlantic croaker, catfish, and shrimp in the Louisianian Province. Only fillet or tailmeat materials were examined. No fish taken from Virginian waters were observed to exceed the FDA limits while only 1% of the marine catfish collected in the Louisianian

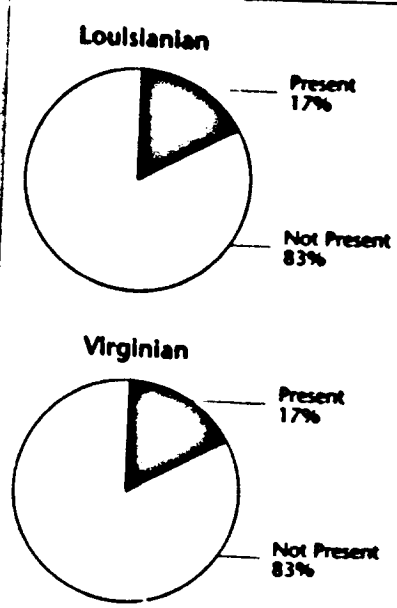

Figure 4. Presence of marine debris and trash.

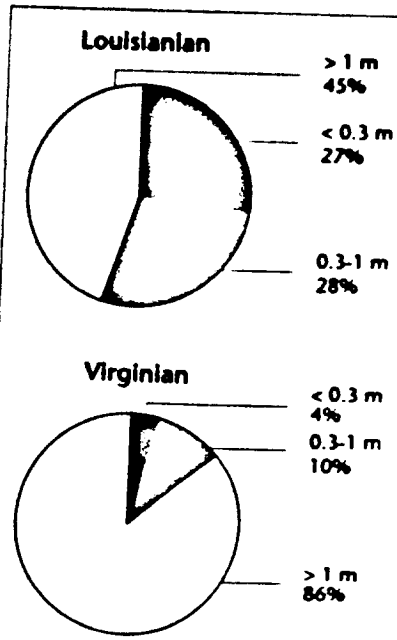

Figure 5. Water clarity.

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Province exceeded the FDA limit for mercury. A more complete risk assessment associated with the contaminant levels observed in fish and shellfish from the Virginian and Louisianian Provinces is presently under way.

Overall Estuarine Condition

As the EMAP-Estuaries program reaches full implementation, a single index will be developed to summarize the overall condition of estuarine resources within each province and to accumulate province measures to create a national estimate of estuarine condition. The index may incorporate measures of fishability, swimmability, and aesthetics with measures of biotic integrity based on benthic communities and fish assemblages. For the demonstration studies, overall condition was estimated in each province by integrating biotic integrity indicators and societal value indicators. The results indicate that 42 ± 7% of the Virginian Province and 53 ± 9% of the Louisianian Province showed evidence of degraded biological resources or degraded ability to support activities valued by society (Figure 6).

The Virginian and Louisianian Provinces represent about 40% of the estuarine resources in the United States. At present, our best estimate of estuarine condition in the United States falls somewhere between the assumption that the remaining estuarine resources (Southeast, West Coast) are in acceptable condition and the estuarine resources in these areas are in similar condition to those observed along the mid-Atlantic and Gulf coasts. These assumptions would bound the overall national estimate of estuarine condition between 23% and 47% of the resource showing evidence of degraded biological resources or degraded ability to support human activities.

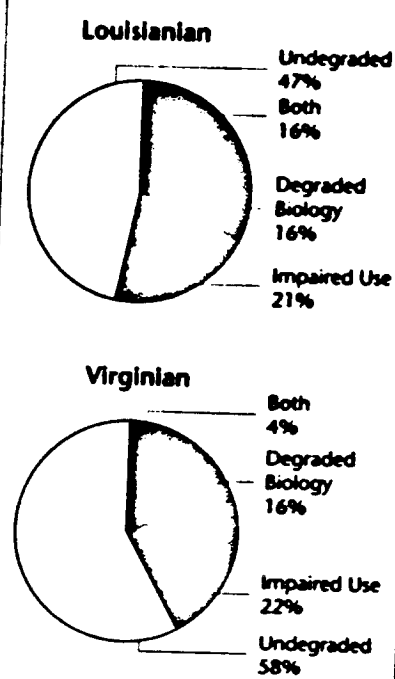

Figure 6. Overall condition of estuarine waters.

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HIGHLIGHT HIGHLIGHT HIGHLIGHT

Chemical Contamination in Coastal Sediments*

Background

The National Oceanic and Atmospheric Administration (NOAA) created the National Status and Trends (NS&T) Program to monitor trends of chemical contamination in coastal waters and to determine biological responses to contamination. Since 1984, NOAA has analyzed seven trace metals and four organic contaminants (see Table 1) in sediments, bottom-feeding fish, and mussels and oysters collected from almost 300 NS&T sites around the United States.

The NS&T Program was designed to describe national distributions of contamination; the program was not designed to identify the most contaminated sites in the country. Therefore, NOAA selected monitoring sites that represent large coastal areas and avoided sites in small-scale patches of contamination, or "hot spots." In particular, the Agency avoided sites that were located near known wastewater discharge points.

The selected sites were not uniformly distributed. Almost half of the sites were located in urban estuaries within 10 miles of population centers in excess of 100,000 people. The distribution is based on the assumption that contamination is more severe, more variable, and more likely to cause biological impacts in urban coastal areas than in rural areas. The monitoring sites are also more densely situated in estuaries than in open shorelines.

Nationwide Distribution of Contaminants in Sediment

NOAA detected low concentrations of contaminants in the sediment samples collected at the vast majority of sampling sites. The Agency defined the upper 17% of observed contaminant concentrations as "high" concentrations of contaminants. On the national scale, high contaminant concentrations in sediment were associated with urbanized areas of the northeast States, San Diego, Los Angeles, and Seattle. High contaminant concentrations were relatively rare in most of the Southeast and along the Gulf of Mexico coast. This association of higher sediment contamination with

*The information contained in this highlight was extracted from *Coastal Environmental Quality in the United States, 1990 – Chemical Contamination in Sediment and Tissues*, published by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland.

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highly populated areas is not a surprising result. Nevertheless, it is important to note that these results come from sites that are considered to be "representative" of conditions throughout the U.S. coastal zone.

The high sediment contamination levels detected at NS&T sites are generally lower than those expected to cause sediment toxicity. NOAA did not find many cases of biological responses to high sediment contaminant concentrations, such as liver tumors in fish. However, the NS&T program provides an overall picture of sediment contamination in the Nation's coastal waters and does not describe conditions at individual sites. Studies of individual sites have detected higher concentrations of contaminants in sediments than were detected at any of the NS&T sites. Therefore, it is important for States, universities, and local agencies to conduct site-specific studies to complement the NS&T Program and provide the detailed information needed for local decisionmaking.

NOAA is beginning to define temporal trends in contaminant levels at NS&T sites from annual analyses of mussels and oysters. Comparing data collected over a 10-year period or longer indicates that concentrations of most contaminants measured in the NS&T Program may be decreasing. With the exception of copper, there is little evidence that contaminant concentrations are increasing.

[illegible] Chemicals Measured in NOAA's National Status and Trends Program

Trace Metals	Organic Compounds
Cadmium	Total DDT (DDT, DDE, and DDD)
Chromium	Total PCBs (sum of 18 types of PCBs)
Copper	Total chlordane
Lead	Total polychlorinated aromatic hydrocarbons (PAHs)
Mercury	
Silver	
Zinc	

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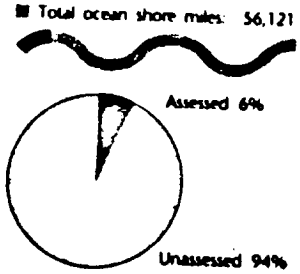
Ocean Coastal Waters Assessed by the States

Total ocean coastal waters (including Alaska) = 56,121 miles

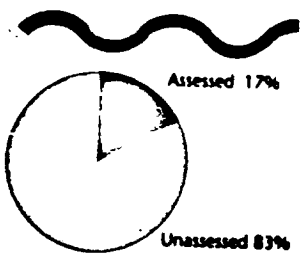
Including Alaska's Ocean Coastal Waters

■ 3,398 miles = 6%
■ Total ocean shore miles: 56,121



Excluding Alaska's Ocean Coastal Waters

1992 ■ 3,398 miles = 17%
■ Total ocean shore miles: 20,121



1990 ■ 4,230 miles = 22%
■ Total ocean shore miles: 19,200

1988 ■ 3,755 miles = 20%
■ Total ocean shore miles: 19,200

Of the assessed ocean shore miles:
- 28% were monitored
- 47% were evaluated
- 25% were not specified

Ocean Coastal Waters

Overall Use Support

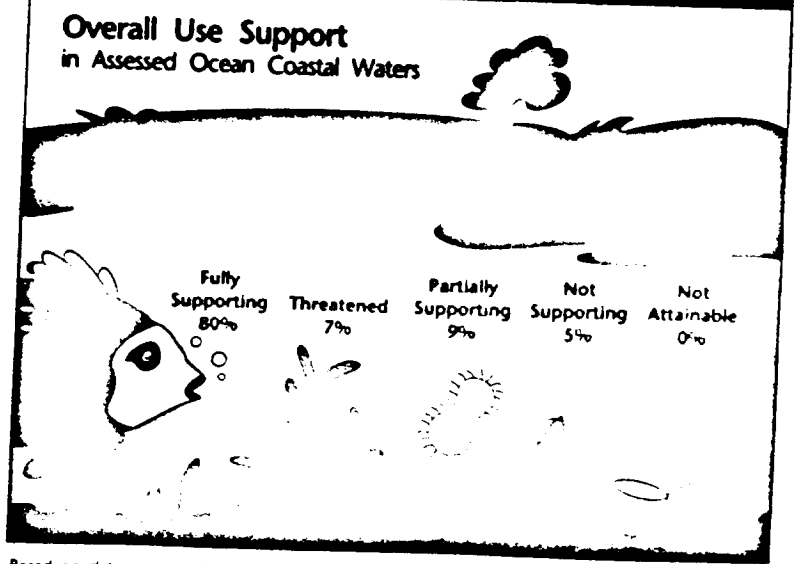
Twelve of the 29 coastal States and Territories assessed only 6% of the 56,121 miles of ocean coastline (including Alaska's 36,000 miles of ocean coastline) or 17% of the 20,121 miles of national ocean coastline (excluding Alaska) (see Appendix C, Table C-5, for individual State information). Most of the assessed waters fully support designated beneficial uses (80%) (Figure 4-7). Another 7% fully support uses but are threatened by pollution. Nine percent of the assessed shoreline miles partially support designated uses and 5% do not support designated uses. Because only 12 States submitted use support data, these figures do not represent the extent of conditions in ocean coastal waters throughout the 29 coastal States.

Individual Use Support

Ten of the 29 coastal States reported attainment of aquatic life use in ocean coastal waters (see Appendix C, Table C-6, for individual State data). Fewer States reported support of other individual uses. General conclusions cannot be drawn from information representing such a small fraction of the Nation's ocean coastal waters (Figure 4-8).

Figure 4-7

Overall Use Support
in Assessed Ocean Coastal Waters



Based on data contained in Appendix C, Table C-5.

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Causes and Sources of Impairment

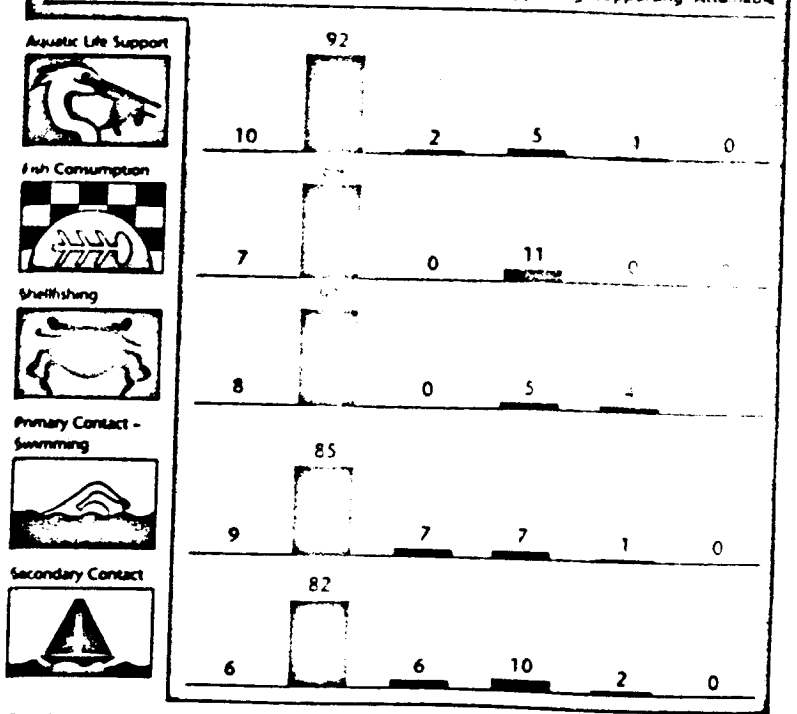
Only 5 of the 29 coastal States identified individual pollutants responsible for less than full support of designated uses in assessed ocean coastal waters (Appendix C, Table C-7). These States reported that pathogen indicators, metals, priority organics, and unknown toxicity caused more impairments than any other contaminants (Figure 4-9). However, this information applies to only 1% of the ocean shoreline along the contiguous States, which may explain why the data portray toxic pollutants as a more pervasive problem in ocean coastal waters than in estuarine waters. States may be targeting their limited ocean coastal sampling in areas with suspected toxicity problems.

Five States also listed sources of pollutants preventing designated use support in 1% of the Nation's ocean shore miles (Appendix C, Table C-8). These States identified urban runoff and storm sewers as the leading source of contamination in ocean coastal waters, followed by land disposal (including septic tanks), municipal point sources, and contaminated sediments (Figure 4-10).

Ocean coastal waters fully support aquatic life in 92% of assessed waters in 10 coastal States.

Figure 4-8

Individual Use Support in Ocean Coastal Waters



Based on data contained in Appendix C, Table C-6.

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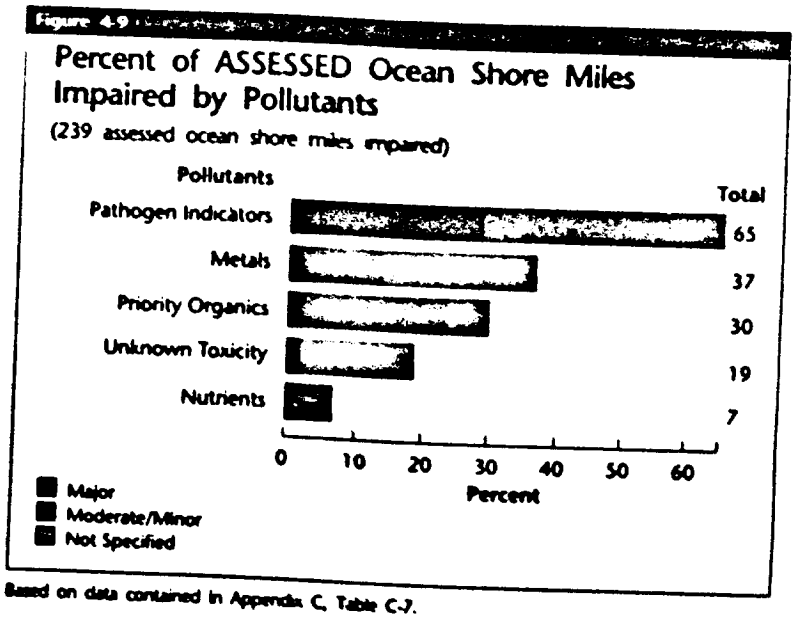
Total ocean shore miles = 20,121 miles (excluding Alaska)
Total assessed = 3,398 miles

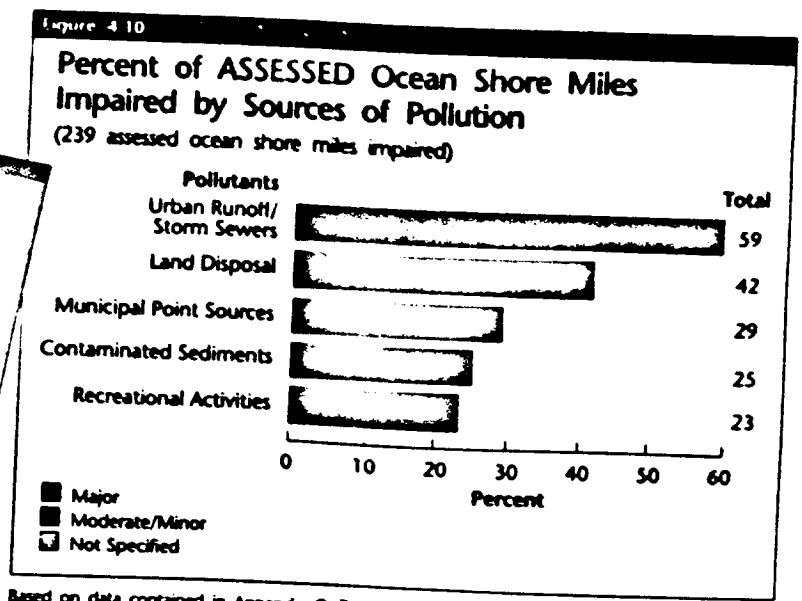
■ 17% assessed
■ 83% unassessed

Figure 4-9



Based on data contained in Appendix C, Table C-7.

Figure 4-10



Based on data contained in Appendix C, Table C-8.

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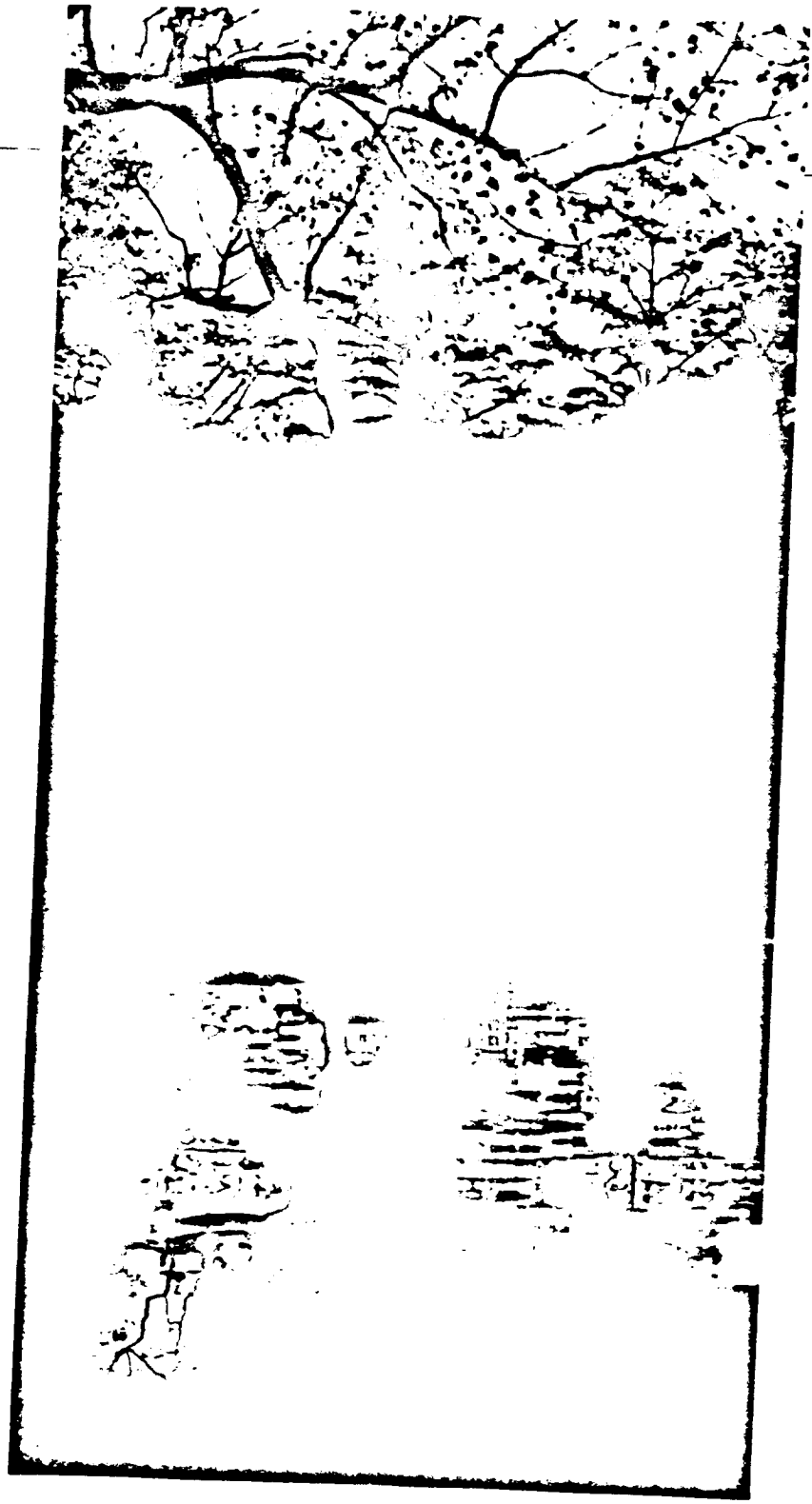

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Wetlands

Introduction

Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (Figure 5-1). Wetlands generally include swamps, marshes, bogs, and similar areas. This is the definition of wetlands as it appears in the regulations jointly issued by the Army Corps of Engineers (COE) and the U.S. EPA (33 CFR Part 328.3(b), 40 CFR Part 232.2 (r), and 40 CFR Part 230.3(t)).

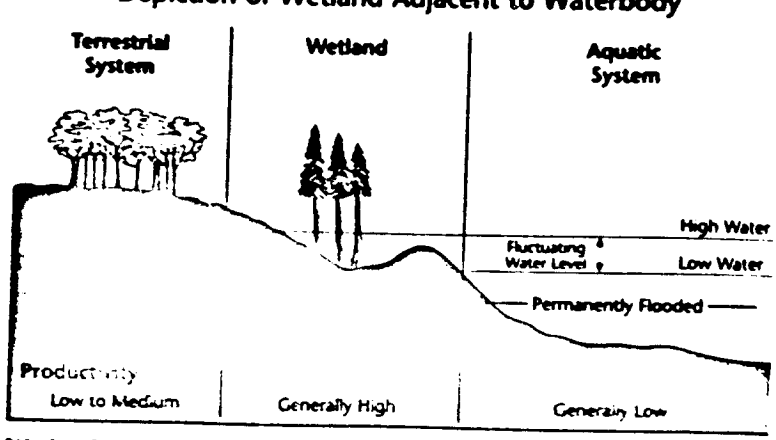
A wide variety of wetlands exist across the country as a result of regional and local differences in hydrology, vegetation, water chemistry, soils, topography, climate, and other factors. Wetlands type is determined primarily by local hydrology, the unique pattern of water flow through an area. In general, there are two broad categories of wetlands: coastal and inland wetlands.

With the exception of the Great Lakes coastal wetlands, coastal wetlands are closely linked to estuaries, where sea water mixes with fresh water to form an environment of varying salinity and fluctuating water levels due to tidal action. Coastal marshes dominated by grasses and halophytic (salt-loving) plants are particularly abundant along the Atlantic and Gulf coasts due to the gradual slope of the land. Mangrove swamps, which are dominated by halophytic shrubs and trees, are common in Hawaii, Puerto Rico, and in southern Florida.

Inland wetlands are most common on floodplains along rivers and streams, in isolated depressions surrounded by dry land, and along the margins of lakes and ponds. Inland wetlands include marshes and wet meadows dominated by grasses and herbs, shrub swamps, and wooded swamps dominated by trees, such as hardwood forests along floodplains. Some regional wetlands types include the pocosins of North

Figure 5-1

Depiction of Wetland Adjacent to Waterbody



Wetlands are often found at the interface between dry terrestrial ecosystems, such as upland forests and grasslands, and permanently wet aquatic ecosystems, such as lakes, rivers, and oceans.

Reprinted with modifications, by permission, from Mitsch/Gosselink: *Wetlands* 1986, fig. 1-4, p. 10. ©1986, Van Nostrand Reinhold.

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NOTE

States assessed only 4% of their wetlands. Therefore, these use support figures should not be extrapolated to represent national trends in wetlands integrity.

Carolina, bogs and fens of the northeastern and north central States and Alaska, inland saline and alkaline marshes and riparian wetlands of the arid and semiarid West, vernal pools of California, playa lakes of the Southwest, cypress-gum swamps of the South, wet tundra of Alaska, the South Florida Everglades, and prairie potholes of Minnesota, Iowa, and the Dakotas.

Values and Functions of Wetlands

In their natural condition, wetlands provide many benefits, including food and habitat for fish and wildlife, flood protection, shoreline erosion control, natural products for human use, ground water exchange, water quality improvement, and opportunities for recreation, education, and research.

Wetlands are critical to the survival of a wide variety of animals and plants, including numerous rare and endangered species. Wetlands are also primary habitats for many species, such as the wood duck, muskrat, and swamp rose. For others, wetlands provide important seasonal habitats where food, water, and cover are plentiful.

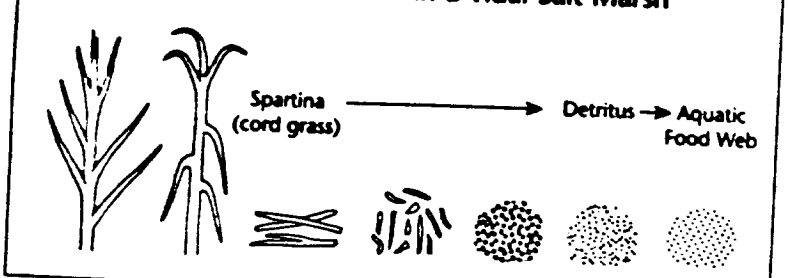
Wetlands are among the most productive natural ecosystems in the world. They produce great volumes of food as leaves and stems break down in the water to form detritus (Figure 5-2). This enriched material is the principal food for many aquatic invertebrates, various shellfish, and forage fish that are food for larger commercial and recreational fish species such as bluefish and striped bass.

Wetlands function like natural basins, storing either floodwater that overflows riverbanks or surface water that collects in isolated depressions. By doing so, wetlands help protect adjacent and downstream property from flood damage. Trees and other wetlands vegetation help slow the speed of flood waters. This action, combined with water storage, can lower flood heights and reduce the water's erosive potential. In agricultural areas, wetlands can help reduce the likelihood of flood damage to crops. Wetlands within and upstream of urban areas are especially valuable for flood protection, since urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage.

Wetlands are often located between rivers and high ground and are therefore able to store flood waters and reduce channel erosion. Wetlands bind soil, dampen wave action, and reduce current velocity through friction.

Figure 5-2

Formation of Detritus in a Tidal Salt Marsh



Decomposition processes in salt marshes fragment original detritus (e.g., dead Spartina leaves and stems) into smaller pieces. The smaller, bacteria-rich detritus provides more nutrition for animals than live Spartina tissue. The enriched detritus is the principal food for many aquatic invertebrates, shellfish, and forage fish.

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Wetlands produce a wealth of natural products, including fish and shellfish, timber, wildlife, and wild nce. Much of the Nation's fishing and shellfishing industry harvests wetlands-dependent species. For example, in the Southeast, 96% of the commercial catch and over 50% of the recreational harvest are fish and shellfish that depend on the estuary-coastal wetlands system. Waterfowl hunters spend over $300 million annually to harvest wetlands-dependent birds.

Wetlands help maintain and improve water quality by intercepting surface water runoff before it reaches open water, removing or retaining nutrients, processing chemical and organic wastes, and reducing sediment loads to receiving waters.

Wetlands provide considerable opportunities for popular recreational activities such as hiking, bird watching, fishing, and boating. An estimated 50 million people spend nearly $10 billion each year observing and photographing wetlands-dependent birds.

Consequences of Wetlands Loss and Degradation

The loss or degradation of wetlands can lead to serious consequences, including increased flooding; species decline, extinction, or deformity; and decline in water quality. The following are a few examples of the consequences of wetlands loss and degradation.

In Massachusetts, the U.S. Army Corps of Engineers estimated that over $17 million of annual flood damage would result from the destruction of 8,422 acres of wetlands in the Charles River Basin. The Corps decided to preserve the wetlands rather than construct expensive flood control facilities.

Wetlands in the Kesterson Wildlife Refuge in California were degraded after being continuously flooded with agricultural irrigation return flow waters that contained high concentrations of selenium. Largemouth bass, striped bass, and catfish disappeared from Kesterson National Wildlife Refuge in 1982. In the spring of 1983, waterfowl eggs hatched less frequently and their embryos suffered more deformities. Cost estimates for the Refuge cleanup and restoration of its wetlands now exceed $5 billion.

The channelization of the Kissimmee River in South Florida in the 1960s disrupted the ecological balance of the entire region. Marshlands have disappeared because channelization minimizes or prevents natural spillover of water. Habitat loss has caused wading bird populations to drop by 90% and white-tailed deer populations by 50%. Some argue that the drainage of wetlands has disrupted the normal rain cycle, creating the potential for a long-term drought in South Florida. The dechannelization of the Kissimmee River and the restoration of wetlands will cost an estimated $280 million.

Forested riparian wetlands play an important role in reducing nutrient loading into the Chesapeake Bay. In one study, a riparian forest in a predominantly agricultural watershed was shown to remove approximately 80% of the

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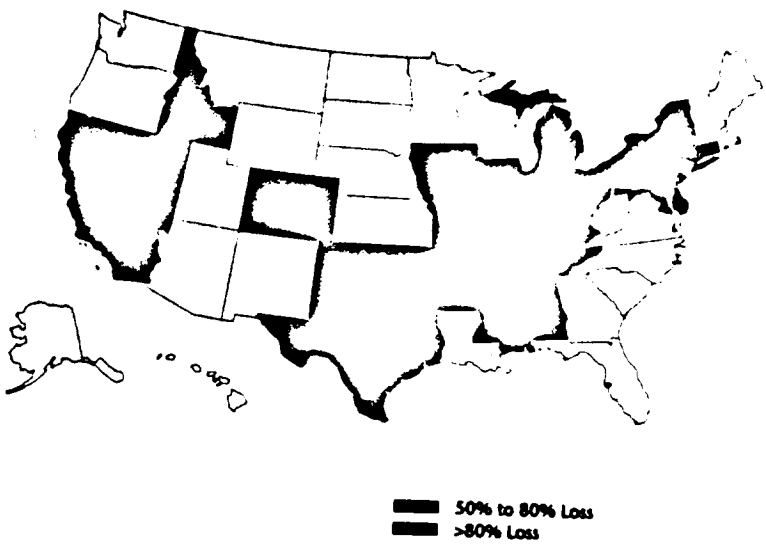
phosphorus and 89% of the nitrogen from the water before entering a tributary of the Chesapeake Bay. Destruction of wetlands that reduce the amount of nutrients entering the Bay would lead to an increase in undesirable weed growth and algae blooms. When algae decomposes, oxygen is used up, threatening fish and other oxygen-dependent life forms.

Figure 5-3

States with More Than 50% Wetlands Loss



Twenty-two States have lost at least 50% of their original wetlands. Seven of these 22 (California, Indiana, Illinois, Iowa, Missouri, Kentucky, and Ohio) have lost more than 80% of their original wetlands.

Source: Dahl, T.E. 1990. *Wetlands Losses in the United States 1780's to 1980's.* U.S. Department of the Interior, Fish and Wildlife Service.

Extent of the Resource

Wetlands Loss in the United States

It is estimated that over 200 million acres of wetlands existed in the lower 48 States at the time of European settlement. Since then, extensive wetlands acreage has been lost, with many of the original wetlands drained and converted to farmland and urban development. Today, less than half of our original wetlands remain. The losses amount to an area equal to the size of California (see Figure 5-3). According to the U.S. Fish and Wildlife Service's *Wetlands Losses in the United States 1780's to 1980's*, the three States that have sustained the greatest percentage of wetlands loss are California (91%), Ohio (90%), and Iowa (89%).

Massachusetts reported that it continues to lose an estimated 1,000 acres per year. South Dakota reported that, since enactment of the Swampbuster provisions of the Food Security Act, annual losses of wetlands in the State due to drainage, excavation, and fill has decreased by 50%. Wisconsin tracks individual Section 404 permits, and, from 1982-1990, a total of 11,800 acres of wetlands were lost from permitted discharges of dredged or fill material. A study in southeast Wisconsin showed that when losses from impacts not related to the Section 404 program were considered, the loss total tripled.

Detailed wetlands maps and status and trends reports are used to track the quantity of wetlands nationally. Detailed maps provide site-specific information on wetlands,

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and status and trend information is used to evaluate changes to the resource in 10-year intervals based on a subset of the Nation's wetlands. The U.S. Fish and Wildlife Service (FWS) has the statutory mandate to conduct these efforts and has completed inventory maps for 67% of all States except Alaska and has digitized 15% for the lower States (as of the beginning of 1993). The FWS is the primary source of inventory information for States. Additionally, some States use information from the Soil Conservation Service (SCS) or the National Oceanic and Atmospheric Administration (NOAA). In some instances, States map their own wetlands or supplement national inventories with State inventories.

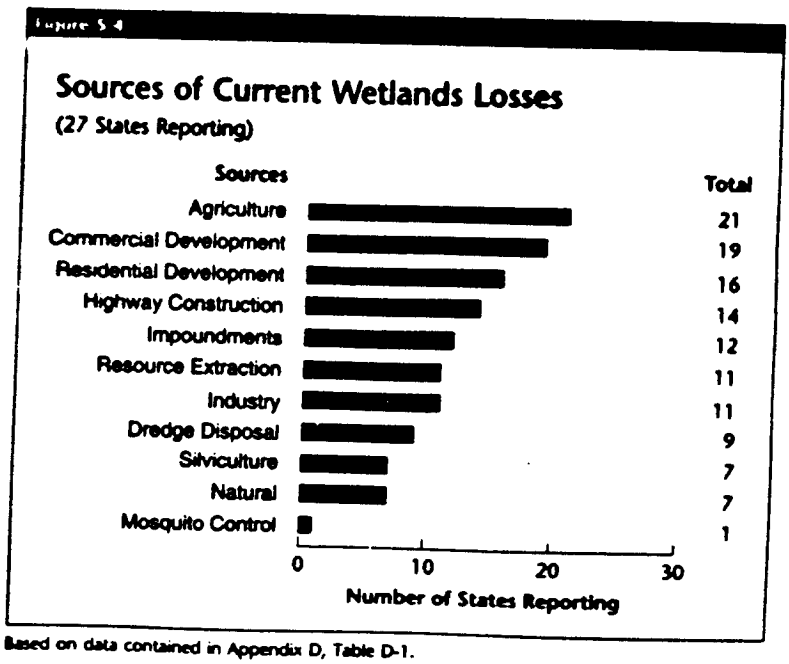
According to the FWS status and trends reports, the average annual loss of wetlands has decreased over the past 40 years. The average annual loss from the mid-1950s to the mid-1970s was 458,000 acres, and from the mid-1970s to mid-1980s it was 290,000 acres. Agriculture was responsible for 87% of the loss from the mid-1950s to the mid-1970s and 54% of the loss from the mid-1970s to the mid-1980s.

Twenty-seven States listed sources of current wetlands loss in their 1992 305(b) reports (Figure 5-4). Agriculture and commercial development were cited as the leading sources of current losses (see Appendix D, Table D-1, for individual State information). Other losses were due to residential development, highway construction, impoundments, and resource extraction.

Eighteen States and one Territory reported on efforts to inventory wetlands. Some of the programs are designed to augment the FWS's National Wetlands Inventory, while others are designed to produce status and trend information. Some of the programs have already been completed and others have been authorized but not funded.

■ Massachusetts reported that the National Wetlands Inventory (NWI) maps provide a good baseline for wetlands resources, but that considerable construction activity and wetlands impacts have occurred since the maps were produced in the late 1970s. In addition, NWI maps at a 1:24,000 scale do not show many wetlands smaller than 1 acre in size. In response, the Massachusetts Division of Wetlands and Waterways, through the Wetlands

Figure 5-4



Based on data contained in Appendix D, Table D-1.

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Conservancy Program, has initiated a project to develop more detailed, larger-scale (1:5000) maps to provide a baseline of wetlands resources.

Massachusetts's inventory will be conducted over the next 5 to 10 years and the Conservancy Program will map and classify all wetlands in Massachusetts greater than or equal to 1/4 acre in size. This geographic information will be entered into the Massachusetts Geographic Information System (GIS) and will be used to compile and automate highly accurate location data for hazardous waste sites and other regulated activities. The information from the inventory will be used in conjunction with the permit tracking system to quantify wetlands losses.

- Delaware reported that it updated the FWS maps from 1983 for its tidal waters and entered the information into a database for State and local agencies to use to make land use decisions.

- Georgia Department of Natural Resources developed a digitized land cover/wetlands database for the entire State based on LANDSAT satellite imagery taken in 1989-1990.

- Ohio reported that its Department of Natural Resources is conducting a statewide wetlands inventory with the U.S. Soil Conservation Service. The program reviews digital LANDSAT data and compares them with digitized soils data from the SCS. The State completed classifying the data in 1992 and is now conducting field verification.

- Oregon Division of State Lands, the FWS, and the Portland Metropolitan Service District completed inventories and maps at a scale of 1:24,000.

- Puerto Rico's Department of Natural Resources published an inventory of mangroves in 1989.

- The Virgin Islands Department of Planning and Natural Resources is conducting an inventory of wetlands in their territory and, in the interim, will rely on digitized NWI data.

- Pennsylvania reported that it has been monitoring wetlands status and trends yearly for its coastal zone since 1986. Federal and State enforcement agencies also document wetlands losses with annual helicopter overflights.

- Arizona will inventory and classify riparian areas throughout the State. The State defines riparian areas as aquatic or terrestrial ecosystems that are associated with bodies of waters or are dependent upon the existence of surface or subsurface water drainage.

- The Utah Division of Wildlife Resources received a grant from EPA to create a statewide wetlands inventory using a GIS and to develop a statewide classification and ranking model specific to Utah.

- Idaho reported that the main work to determine the extent of its wetlands is being done by the FWS, which is currently mapping wetlands in Idaho. In addition, they mentioned some local efforts scattered throughout the State.

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■ Washington's Department of Ecology issued grants to 16 local jurisdictions to perform field wetlands inventories. The Department developed inventory guidance, including specific inventory methods, a wetlands function and value characterization, and a four-tier rating system. It also initiated the development of a State-wide wetlands database.

■ Between 1981 and 1986, the Michigan Department of Natural Resources conducted a statewide land cover/use inventory, including wetlands. The State obtained data from infrared aerial photographs, digitized them, and entered them into the computerized Michigan Resource Inventory System. The State classified wetlands into seven categories, which do not correspond to the Cowardin classification system developed by the FWS.

■ The Texas Parks and Wildlife Department initiated a statewide habitat mapping project. The project used LANDSAT data and produced vegetation cover maps and detailed numerical inventory data for coastal marshes, swamps, bottomland hardwoods, and other forested wetlands.

■ Florida completed a comprehensive statewide wildlife habitat inventory in 1990, which included several wetlands types. However, the State reported that it has not implemented a wetlands inventory program required in the Warren S. Henderson Wetlands Protection Act passed in 1984 because of funding limitations. Florida legislation requires reporting of wetlands acreage affected by permitting activities. The State tracks wetlands conversions and mitigation efforts authorized under the dredge and fill program. Many violations are reported by the public.

■ New York requires regulatory inventories of tidal wetlands on Long Island, in New York City, and in certain counties along the Hudson River. State statutes also require inventories of freshwater wetlands protected by State law.

■ South Carolina received a fiscal year 1991 State wetlands grant to develop a statewide land use/land cover inventory using satellite imagery and Ecological Monitoring and Assessment Program (EMAP) classification. Wetlands are a component of this project.

■ Kentucky is currently digitizing all NWI maps and Tennessee has already digitized NWI maps in the western part of the State where 85 percent of the State's wetlands are located.

Integrity of the Resource

Monitoring programs should and could provide the data needed to identify integrity degradation in wetlands and sources of that degradation, but specific wetlands monitoring programs are still in their infancy. Five States described water quality and habitat monitoring efforts for wetlands. Three of these States currently monitor some wetlands and two States have proposed or are considering wetlands

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monitoring
monitoring program

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monitoring programs. No State is currently operating a statewide wetlands monitoring program.

■ Massachusetts requested an EPA wetlands grant to create a standard operating procedure for collecting wetlands data. An EPA-funded project is currently under way to develop a two-tiered approach for functional assessment of wetlands. The State requires project proponents to monitor specific project elements.

■ Montana's Water Quality Bureau will monitor 20 water quality impaired wetlands and 40 minimally impaired wetlands. The data will establish baseline water quality and biological conditions needed to develop wetlands standards. The Montana Department of Transportation will also develop a monitoring program to judge the effectiveness of existing wetlands mitigation projects.

■ As part of its efforts to develop water quality standards for wetlands, the Texas Water Commission currently monitors water quality, associated biota, and beneficial uses at selected minimally impacted coastal wetlands. The program will be expanded to monitor other wetlands types as personnel and funds become available.

■ Washington State does not have an established monitoring program for assessing use support of wetlands, but it has studied plant and animal habitat diversity in addition to chemical and physical water quality parameters in wetlands.

■ Wisconsin is considering wetlands initiatives that include monitoring wetlands communities and habitats.

Designated Use Support in Wetlands

Only eight States (California, Colorado, Hawaii, Iowa, Kansas, North Carolina, Nevada, and Oklahoma) provided information on overall use support in some portion of their wetlands (see Appendix D, Table D-2). Half of the 10,516,774 acres of assessed wetlands acreage fully support their designated uses (Figure 5-5), but this information pertains to less than 4 percent of the total wetlands in the United States. Of the assessed acres, 98% are in North Carolina. Therefore, the use support figures should not be extrapolated to represent national trends in wetlands integrity.

More States will assess use support in wetlands as they develop standards for wetlands. Many States are still in the process of developing wetlands water quality standards, which provide the baseline for determining beneficial use support (see Chapter 16). Improved standards will also provide a firmer foundation for assessing impairments in wetlands in those States already reporting use support in wetlands. Hawaii, for example, reports that it assessed 100% of its wetlands but also reports that it is still developing wetlands-specific use classifications and that few of their existing water quality standards can be applied to wetlands. Wetlands-specific water quality standards will help eliminate some of these apparent inconsistencies.

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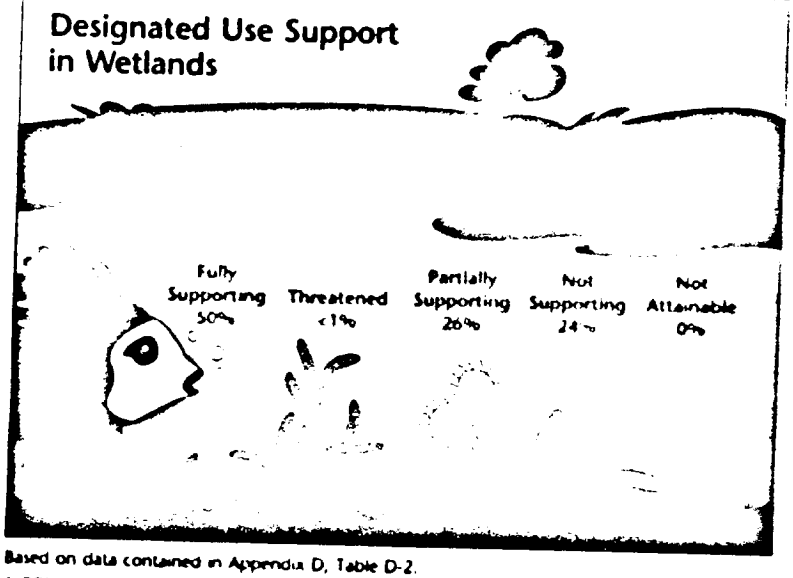
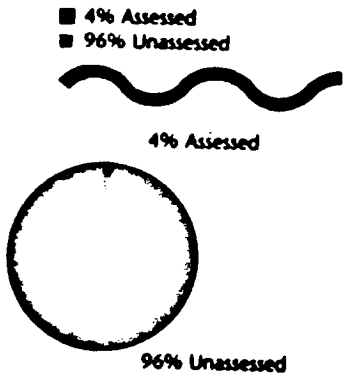
Figure 5-5

Designated Use Support in Wetlands

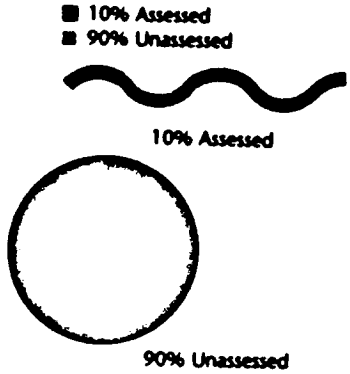


Total wetlands (including Alaska) = 277 million acres
Total assessed = 10,516,774 acres

Including Alaska's wetlands



Excluding Alaska's wetlands



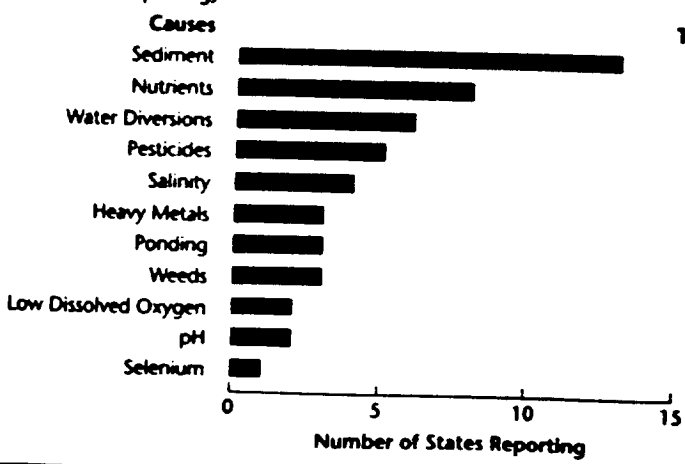
Based on data contained in Appendix D, Table D-2.

NOTE: This information on designated use support represents data from only eight States, some of which do not have water quality standards for wetlands. In addition, 98% of the assessed wetlands are in one State, so national trends should not be drawn from these data.

Figure 5-6

Causes Degrading Wetlands Integrity

(14 States Reporting)



Based on data contained in Appendix D, Table D-3.

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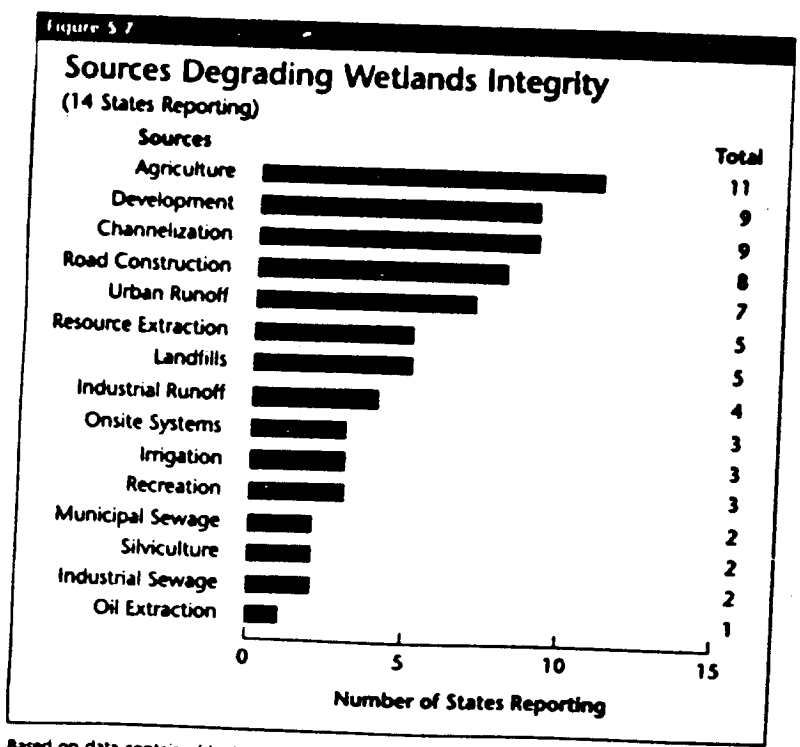
More information on wetlands can be obtained from EPA's Wetlands Hotline at 1-800-832-7828, between 9 a.m. and 5 p.m. Eastern Standard Time.

The States have even fewer data to quantify the extent of pollutants degrading wetlands and the sources of these pollutants. Although most States cannot quantify wetlands area impacted by individual pollutants and sources, 14 States identified pollutants and sources known to degrade wetlands integrity to some extent (Figures 5-6 and 5-7). These States listed sediment as the most pervasive pollutant impacting wetlands, followed by nutrients, water diversions, and pesticides. Agriculture topped the list of sources degrading wetlands, followed closely by development, channelization, road construction, and urban runoff (see Appendix D, Tables D-3 and D-4, for individual State information).

Figure 5-7



Based on data contained in Appendix D, Table D-4.

Summary

Currently, most States are not equipped to report on the integrity of their wetlands. Only eight States reported attainment of designated uses for wetlands in 1992. National trends cannot be drawn from this limited information. This is expected to change, however, as States adopt wetlands water quality standards and enhance their existing monitoring programs to more accurately assess designated use support in their wetlands. In addition, EPA's EMAP for wetlands will provide indicators and procedures that States may eventually be able to adapt to their own programs. The EMAP indicators and procedures may also provide consistent macroscale information on wetlands conditions in the future.

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Ground Water Quality

Introduction

The protection of our Nation's ground water resources has received widespread attention at all levels of government. The need to protect this vital resource to sustain the life and health of citizens and the ecosystem is becoming increasingly clear. Ground water is used for domestic and municipal drinking water supplies, irrigation and livestock, and industrial processes. Ground water also supports the health of related surface water ecosystems, including lakes, rivers, streams, wetlands, and estuaries. In many parts of the Nation, ground water serves as the only reliable source of drinking or irrigation water. However, the quality of this vital resource is threatened by a number of land-use activities.

As a result of the growing public awareness of the importance of our ground water resources, EPA has issued guidance for Comprehensive State Ground Water Protection Programs. These programs will be the focal point for long-term joint commitments between the Federal Government and the States and will provide for a more coherent and comprehensive approach to ground water protection. The States have identified a broad range of ground water contaminants and contamination sources that threaten the integrity of the resource. Controlling these sources of contamination and preventing further contamination of the resource have become the focus of a number of State and Federal programs.

EPA compiled the information reported in this chapter primarily from 1992 305(b) State Water Quality Reports required under the Clean Water Act. EPA requested that each State provide information concerning its ground water quality and protection initiatives, along with information on sources of ground water contamination and the principal contaminants of concern. In addition to the data reported in the State 305(b) reports, this chapter provides information obtained from the U.S. Geological Survey Open-File Report 92-63 entitled *Preliminary Estimates of Water Use in the United States, 1990* and information reported by other Federal agencies.

This chapter consists of three sections that summarize the following ground water information: use, quality, and indicators.

GROUND WATER provides drinking water for 53% of the population.

Ground Water Use

Ground water withdrawals in 1990 accounted for approximately 20% of the Nation's total water withdrawals. Ground water withdrawals increased significantly between 1950 and 1980 from 34 billion gallons/day (gal/d) to 83 billion gal/d. The 1990 estimate of total ground water withdrawals is

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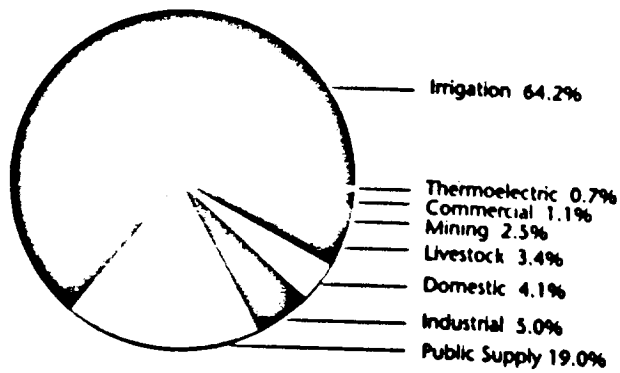
Figure 6-1

National Ground Water Withdrawals by Water Use Category

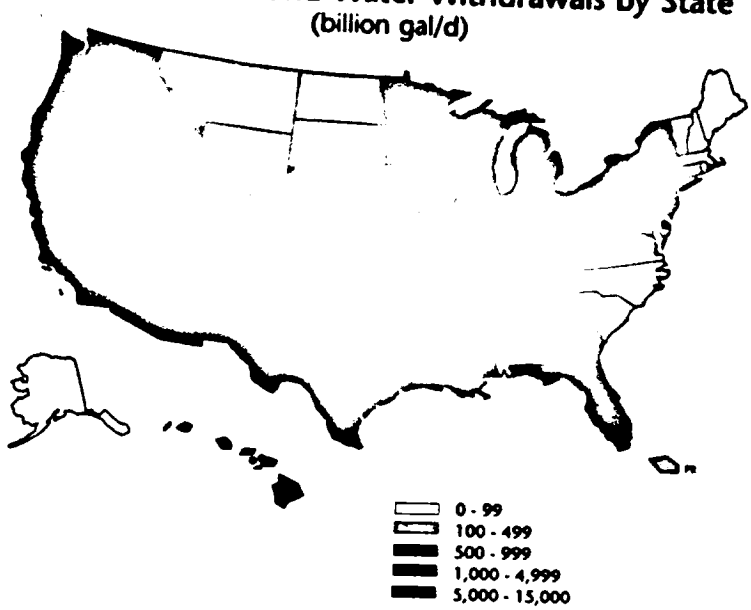


Source: Open-File Report 92-63, U.S. Geological Survey.

IRRIGATION accounted for more than 64% of ground water use

Figure 6-2

Total Fresh Ground Water Withdrawals by State (billion gal/d)



Source: Open-File Report 92-63, U.S. Geological Survey.

81 billion gal/d. This is consistent with a general decrease in the rate of increase in ground water withdrawals from 1970 to 1980 and with a decrease in total ground water withdrawals from 1985 to 1990. While public, domestic, and commercial water supply withdrawals and withdrawals for mining and thermoelectric power continued to increase between 1985 and 1990, withdrawals for irrigation and industrial supply declined.

Nationally, ground water provides drinking water for 53% of the total population and nearly all of the rural population. National ground water withdrawals by water use category are shown in Figure 6-1. Irrigation accounts for the largest percentage of ground water withdrawals with approximately 51 billion gal/d or 64% of total withdrawals. Public water supplies account for approximately 19% of the total ground water withdrawals. Industrial, domestic, livestock, mining,

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commercial, and thermoelectric withdrawals account for a total of 17% of withdrawals.

Figure 6-2 depicts the total fresh ground water withdrawals by State. Nine States accounted for 72% of the Nation's total ground water use. In 1990-1991, California withdrew a total of 14.6 billion gal/d, approximately 10.7 billion gal/d of which was used for irrigation. Idaho and Texas withdrew 7.6 and 7.4 billion gal/d, with 6.6 and 5.6 billion gal/d, respectively, used for irrigation. Ground water withdrawals from Arkansas, Colorado, Kansas, and Nebraska were used primarily for irrigation accounting for 92% of the withdrawals. The remaining two States were Florida and Arizona; 72% of Arizona's ground water was used for irrigation. Irrigation and public water supply combined account for 78% of withdrawals in Florida.

Ground water is withdrawn for a number of purposes, which vary considerably depending on the

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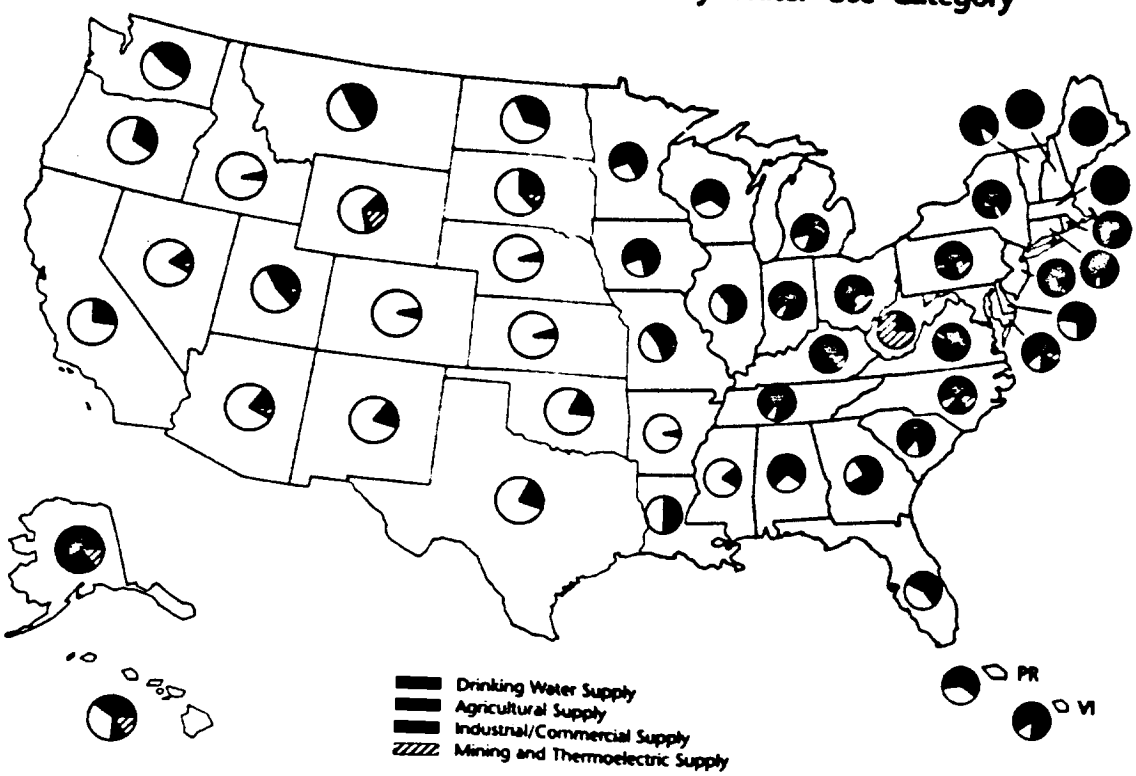
Figure 6-3

Fresh Ground Water Withdrawals by Water Use Category



Source: Open-File Report 92-63, U.S. Geological Survey.

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region. Fresh ground water withdrawal with breakdowns of water use categories is shown in Figure 6-3. In the East and South, withdrawals are used primarily for industrial, domestic, commercial, and public water supply purposes. In the West, most ground water is withdrawn for agricultural supply.

29 STATES judged their ground water quality to be good or excellent

Ground Water Quality

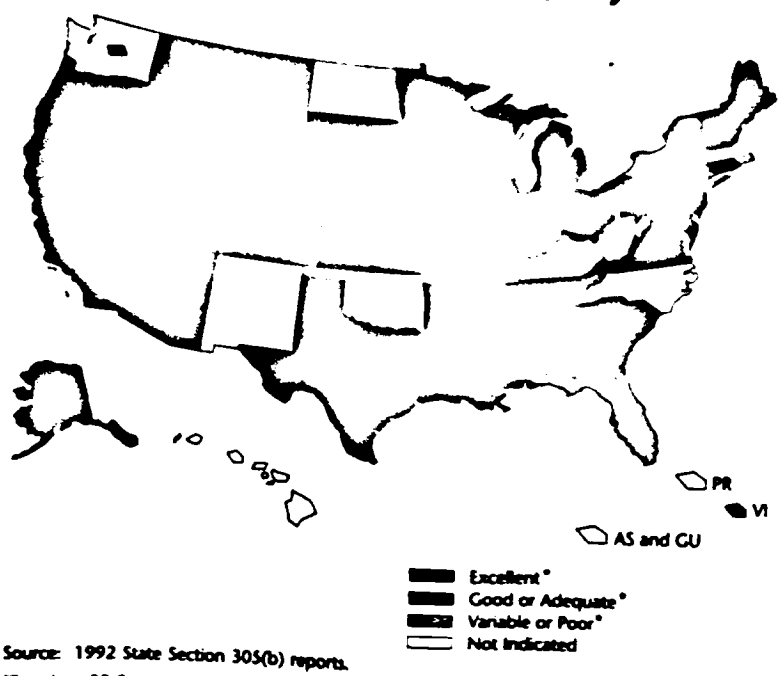
For the 1992 Section 305(b) State Water Quality Reports, EPA requested that States use best professional judgment to assess the overall quality of their ground water. Overall, the Nation's ground water quality is good to excellent (Figure 6-4). Thirty-eight States made some judgment concerning the quality of their ground water: 11 States judged their ground water quality to be excellent, 18 States judged their ground water quality to be good, and 9 States reported that their overall ground water quality was variable or poor. One problem in assessing national ground water quality trends stems from the lack of consistent and reliable ground water quality indicators. While the overall quality of the Nation's ground water resource appears to be good, local ground water contamination problems are widespread in every State.

In 1985, the National Governor's Association (NGA) began conducting biennial surveys to identify State restrictions imposed on contaminated or hazardous sites. In 1992, the NGA published a report entitled *Restrictions Imposed on Contaminated Sites: A Status of State Actions*, covering information obtained during the 1991 survey. This report cites 1,295 incidents of ground water use restrictions imposed at contaminated sites, an increase of 37% from the number reported in 1989 (948 incidents) and nearly four times the number reported in 1987 (331 incidents). The imposed use restrictions include restricted ground water use for drinking, the need for treatment or blending of contaminated ground water to meet drinking water standards, restrictions on ground water use for irrigation or food processing purposes, and the issuance of ground water use advisories.

The NGA also gathered information on State well closings in an

Figure 6-4

Overall Ground Water Quality



Source: 1992 State Section 305(b) reports.
*Based on 38 States reporting.

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effort to gain insight into ground water quality around contaminated sites. The 1992 report lists a total of 14,324 well closures and restrictions, based on State responses to a survey question concerning restrictions imposed on contaminated sites. The number of well closures and restrictions represents a very small percentage of the total number of wells supplying water for irrigation, domestic use, industrial use, and other uses across the country. The primary ground water contaminants that resulted in the reported well closures include benzene, trichloroethylene, tetrachloroethylene, other volatile organic compounds (VOCs), ethylene dibromide, fertilizers, and nitrates.

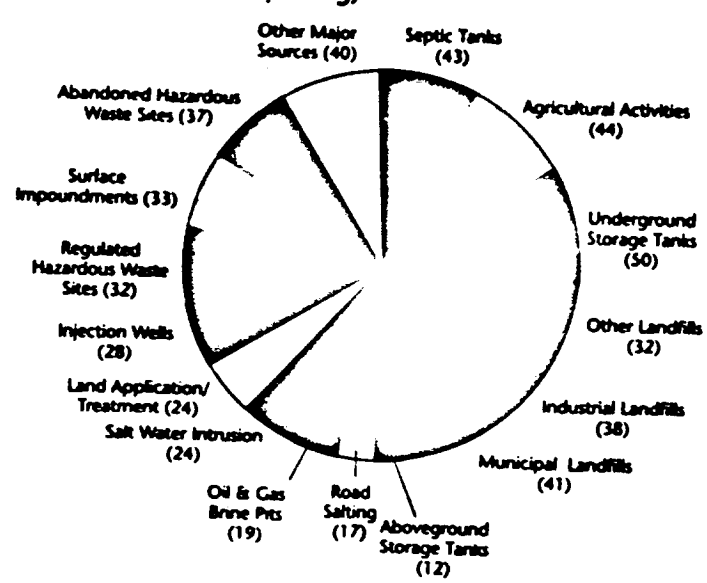
Many States are undertaking studies and programs to better understand the quality of their ground water, to identify potential contamination sources, and to determine ways to protect the resource from further contamination. Twenty-six States reported that they have conducted statewide ground water monitoring studies that focus on one or more contaminants, and an additional six States reported on statewide programs that are under development. The contaminants assessed in these large-scale monitoring efforts include pesticides, nitrates, volatile organic chemicals, radionuclides, chloride, iron, and bacteria.

Eighteen States reported on regional ground water studies conducted in sensitive ground water basins or other areas of concern. Contaminants of concern in these regional studies include pesticides, nitrates, volatile organic chemicals, bacteria, chloride, and radionuclides. Reported underground chemical storage or releases and waste disposal sites in all States require monitoring under a number of Federal statutes. In addition, 25 States reported on site-specific monitoring efforts surrounding contamination point sources such as landfills, underground fuel and chemical storage facilities, hazardous waste surface impoundments, mining sites, and spray irrigation sites. The principal contaminants of concern at these monitoring sites are petroleum hydrocarbons, volatile organic chemicals, acidic mine drainage, metals, and nutrients.

26 STATES reported that they conducted statewide ground water monitoring studies of one or more contaminants.

Figure 6.5

Sources of Contamination
(Number of States Reporting)



Source: 1992 State Section 305(b) reports.

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UNDER-GROUND STORAGE TANKS were cited by 39 States as the most common source of ground water contamination.

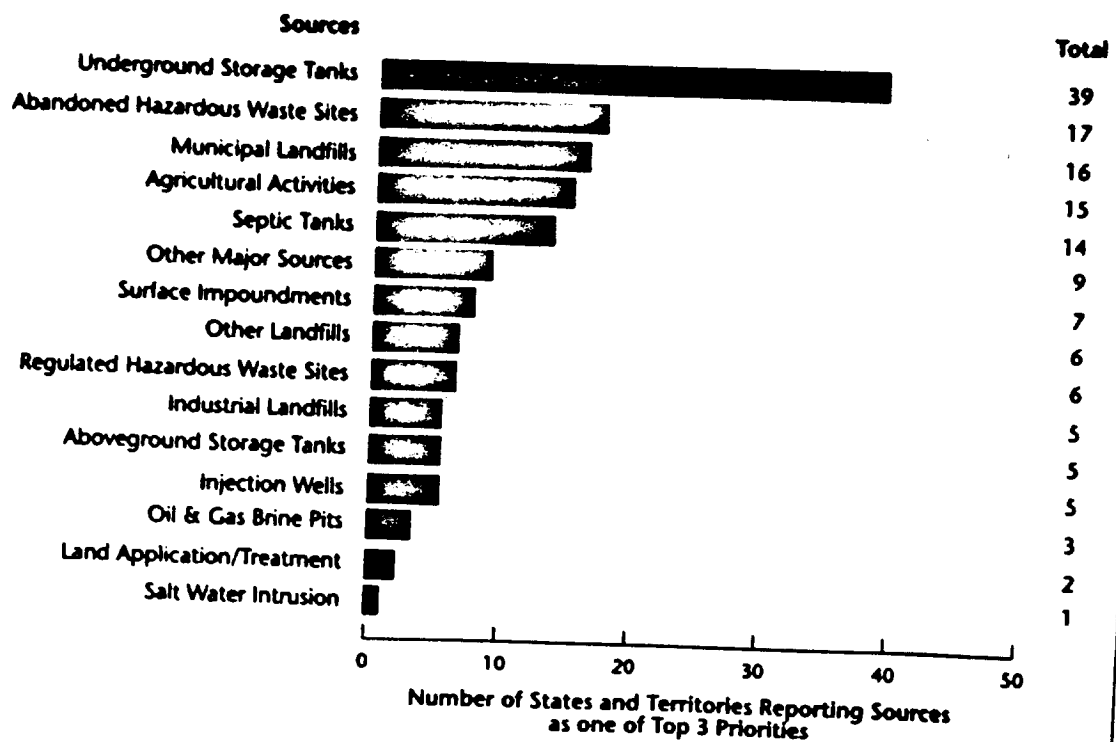
Overview of Contamination Sources

EPA requested that the States identify and rank the seventy of sources of ground water contamination in their jurisdiction. The ranking was based on the best professional judgment of State ground water experts and included consideration of many factors such as: findings of the State's ground water protection strategy or related studies, evaluations of the population at risk from contaminated drinking water, the number or location of contamination sources, evaluations of the risk posed to human health or the environment, and the suitability of existing controls.

Figure 6-5 summarizes the major sources of contamination listed by the 49 States reporting. The most frequently cited sources of

Figure 6-6

Highest Priority Contamination Sources



Source: 1992 State Section 305(b) reports.

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contamination were underground storage tanks, landfills, agricultural activities, and septic tanks. Approximately two-thirds of the States listed landfills, including municipal, industrial, and other types of landfills, as a significant source of ground water contamination, and more than 75 percent of the States reported that agricultural activities posed a significant threat to ground water quality. In addition to the sources highlighted in Figure 6-5, the States noted contamination from hazardous material spills, mining activities, urban and stormwater runoff, abandoned or improperly constructed water wells, and agricultural drainage wells.

Figure 6-6 depicts the highest priority contamination sources as ranked by the States. Underground storage tanks continue to be the most frequently ranked high-priority contamination source. Abandoned hazardous waste sites, municipal landfills, agricultural activities, and septic tanks were the next most frequently reported sources. These rankings were relatively unchanged from the 1990 State reports. Surface impoundments, landfills, and other chemical or waste storage facilities also continue to be sources of concern in the States.

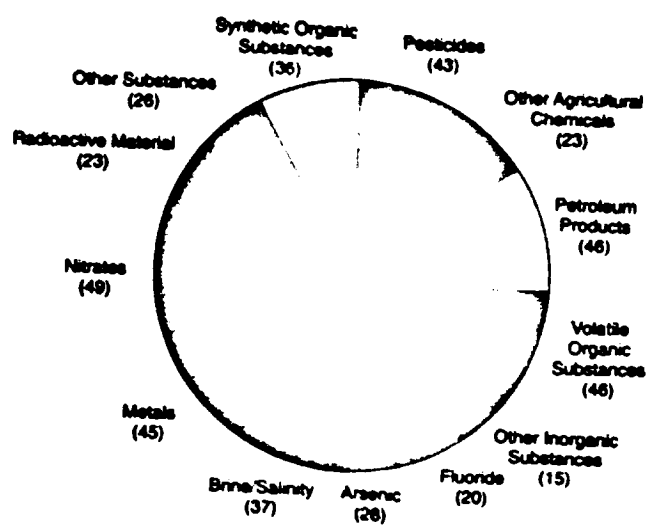
Overview of Contaminants

EPA also requested that the States identify the most prevalent contaminants observed in their ground water (see Figure 6-7). Nitrates were identified as a principal ground water contaminant by 49 States, an increase of five States from the 1990 reports. The next most frequently reported contaminants were volatile organic substances, petroleum products, metals, and pesticides. These contaminants were also reported as most frequently observed in ground water in 1990. Fluoride was reported as a principal contaminant by 21 States in 1990, but was reported by only 20 States in 1992. Among the other contaminants reported by States were bacteria, radionuclides, dissolved inorganics, septage and sewage, and acids.

49 STATES
identified nitrates as a principal ground water contaminant.

Figure 6-7

Substances Contaminating Ground Water
(Number of States Reporting)



Source: 1992 State Section 305(b) reports.

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Are Pesticides Affecting Ground Water Quality?

Case Study of the Delmarva Peninsula

The USGS began a National Water Quality Assessment (NAWQA) case study of the Delmarva Peninsula in 1986. The area of study covers 6,050 square miles including most of Delaware and the entire eastern shore of Maryland and Virginia. Nearly half of the land is used for farming; inorganic and organic fertilizers and nearly 3 million pounds of herbicides, insecticides, and fungicides are used annually in this area. The potential movement of these chemicals into ground water is a concern of the 600,000 residents who rely solely on ground water for both drinking and irrigation purposes.

The USGS sampled over 235 wells and analyzed the samples for nitrate, pesticides, and other dissolved constituents. Nitrate concentrations in 15% of the wells in the water table aquifer exceeded the maximum contaminant level (MCL) of 10 milligrams/liter (mg/L) set by the EPA. Concentrations of pesticides were generally low; 94% of the samples with detectable limits of pesticides were below the MCL set by the EPA. The pattern of contamination was found to correlate with crop type, geology, soils, land use, and ground water flow. An understanding of these factors will help to identify areas where future contamination is most likely to occur. One direct result of this study is the development and implementation of management and protection strategies by local, State, and Federal agencies. These strategies center on monitoring and protecting surface and ground water from future nitrate and pesticide contamination.

For additional information, see: *Are Fertilizers and Pesticides in the Ground Water? A Case Study of the Delmarva Peninsula, Delaware, Maryland, and Virginia.* USGS Circular 1080.

- Area with little nitrate
- Area with detectable concentrations of nitrate, generally less than 10 mg/L
- Area with detectable concentrations of nitrate, commonly near or exceeding 10 mg/L

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Indicators of Ground Water Quality

While vast amounts of ground water quality data are being collected at the community, regional, State, and national levels, there remains a growing need to standardize the collection of data on key environmental indicators. These data will allow the characterization of trends in ground water quality over space and time. The EPA Office of Ground Water and Drinking Water continues to work with States and others in the ground water community to refine a series of indicators. Preliminary indicators that have been developed to track progress and trends in ground water protection efforts at the State and national levels are:

- Maximum contaminant level (MCL) violations in public drinking water systems supplied by ground water, and the population at risk from these violations
- Extent of ground water contamination resulting from hazardous waste sites, and the population at risk from exposure to this contamination
- Detections and levels of VOCs in ground water
- Detections and levels of nitrates in ground water
- Extent of leachable agricultural pesticide use.

In its guidelines for preparation of the 1992 State 305(b) reports, the EPA encouraged States to use one or more of these indicators, where data were available, as part of their 305(b) reporting. Further guidance on the reporting of ground water indicators will be available for the preparation of 1994 State 305(b) reports.

Thirty-five States provided information on one or more of the requested ground water indicators. Twenty-eight of the States reporting provided information on nitrates, pesticides, or VOC detections from regional or local ground water monitoring studies. Other indicator parameters reported by several States included: salinity, bacteria, inorganic constituents, and radioactivity levels. The most in-depth indication of ground water quality was provided through descriptions of State monitoring programs. Some of these programs are described in the following section.

State Ground Water Monitoring Programs

A number of States have undertaken monitoring initiatives that are aimed at characterizing the overall quality of their ground water resources. Statewide initiatives commonly include the establishment of ambient monitoring networks. Many of these networks include private domestic and agricultural wells, in addition to ground water monitoring wells maintained by USGS or the States. In addition, concern over the effects of agricultural land use on ground water resources has prompted a number of States to monitor shallow and alluvial aquifers for nitrates and pesticides. Many States also maintain regional monitoring networks that focus on sensitive areas or vulnerable aquifers. Site-specific

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monitoring efforts were reported by most States. These studies typically focus on known or suspected contamination sources. The range of ground water monitoring initiatives reported by the States is demonstrated by the following approaches.

Missouri

Missouri relies on several activities to assist in forming a statewide characterization of ground water quality. Public drinking water wells serve about half the area of the State and draw from four aquifers (the confined and the unconfined Ozark bedrock aquifers of southern Missouri, and the unconsolidated alluvial aquifers of Cretaceous and Quaternary age in the Missouri Bootheel aquifer). The wells are sampled every 3 years for a large list of water quality constituents and will be tested more frequently as cities begin meeting monitoring requirements of the Safe Drinking Water Act.

For many years, the State has also provided free bacterial and nitrate testing for many private wells statewide. Since 1986, special studies by the USGS, the Missouri Department of Health, and other studies by the University of Missouri and the Department of Natural Resources have sampled several hundred private wells for pesticides and nitrates, giving an excellent profile of farm chemical levels in private wells in agricultural areas of the State.

In addition to drinking water wells, a number of monitoring wells, usually associated with the cleanup of surface or ground water contamination sites, are used to define and characterize ground water problems.

New Jersey

The prevalence of naturally occurring radionuclides in the rock formations in several areas of New Jersey has prompted a number of regional studies of well water. In 1987, 389 wells tapping crystalline rock aquifers in the Reading Prong and Newark Basin areas were monitored for radionuclides. In the Reading Prong area, radon levels in well water ranged from 36 to 24,000 picocuries per liter (pCi/L), and approximately 5% of the wells sampled were found to have radon levels that exceeded 10,000 pCi/L. In the Newark Basin area, radon levels in well water ranged from approximately 70 to 16,000 pCi/L, with the highest concentrations of radionuclides found in wells tapping a narrow uranium-rich layer of the aquifer. A 1990 study of the Kirkwood-Cohansey aquifer in the southern New Jersey Coastal Plain has also revealed the presence of radionuclides in well water. Preliminary findings indicate that 26% of the 82 wells sampled exceeded the health standards for radium.

In a study to determine whether agricultural chemicals have adversely affected ground water quality, 120 domestic, irrigation, and public water supply wells were sampled in 10 Coastal Plain counties. Residues of 22 pesticides and 3 pesticide metabolites were detected in these wells, and dissolved nitrate concentrations were found to exceed health standards in 24% of the wells sampled. In another study, the effects of heavy ground water

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withdrawals from the New Jersey Coastal Plain aquifer system and a buried valley aquifer system in the Central Passaic River basin were evaluated. Investigations have revealed the increased potential for saltwater intrusion in several areas of the New Jersey Coastal Plain and the decrease in the quantity of available potable ground water supplies. A three-dimensional computer model is being used to help predict the response of the Central Passaic River aquifer system to future ground water withdrawals.

New Mexico

Ground water quality is of paramount concern in New Mexico, since approximately 88% of the population of the State relies on ground water for their drinking water supplies. The State maintains a comprehensive monitoring program for both community and noncommunity water systems that rely on ground water. The 495 noncommunity systems in New Mexico are sampled every 4 years to monitor the levels of nitrates. In addition, the 596 community ground water systems are sampled every 3 years for nitrates, fluoride, and trace elements and every 4 years for radiological parameters. Some systems located in vulnerable areas are also sampled every 3 to 5 years for a suite of 59 potential contaminants.

New Mexico also sponsors an outreach program to benefit private well owners. The State organizes water fairs where citizens may bring samples from private wells for free testing in a mobile laboratory. The State maintains a database of test results and conducts followup testing of wells that exceed levels of concern for detected contaminants. In addition, the State maintains an inventory of all known instances of ground water contamination. The inventory covers contamination incidents dating from 1927 to the present. A total of 177 public water supply wells and 1,465 private wells have been affected by the 1,745 incidents of contamination recorded through early 1992. Most of the affected public water supply wells have been removed from use, and some level of remediation has been undertaken or is planned in 149 of the other contamination incidents.

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Are Pesticides Affecting Ground Water Quality?

Findings of the National Survey of Pesticides in Drinking Water Wells

The National Survey of Pesticides in Drinking Water Wells was a joint project of EPA's Office of Ground Water and Drinking Water (OGWDW) and Office of Pesticide Programs (OPP). It was the first national study of pesticides, pesticide degradates, and nitrates in drinking water wells. Information on the construction of rural domestic and community supply wells was also collected. The study was designed with two principal objectives:

- To determine the frequency of occurrence and concentration of pesticides and nitrates in drinking water wells nationally
- To relate the occurrence of pesticides and nitrates in drinking water wells to agronomic and hydrogeologic factors.

It is estimated that approximately 10,500,000 rural domestic wells (RDWs) and 94,600 community water system (CWS) wells supply drinking water in the United States. Approximately 1% of these wells may exceed a health-based limit for at least one pesticide. EPA estimates that about 10% of CWS wells contain detectable levels of one or more pesticides, and approximately 7% of these wells may exceed an established maximum contaminant level (MCL) or health advisory for the detected contaminant. In contrast, it was estimated that about 4% of RDWs may contain detectable levels of one or more pesticides, with approximately 28% of these wells exceeding a health-based limit. Approximately 150,000 people obtain water from RDWs that exceed health-based levels for at least one pesticide.

In the survey, the most frequently detected pesticide was a metabolite of dacthal, an herbicide primarily used on turf. The dacthal metabolite was generally detected at concentrations below the health-based action level. The only pesticides detected at concentrations that exceeded action levels were alachlor, atrazine, 1,2-dibromo-3-chloropropane (DBCP), ethylene dibromide (EDB), and lindane. Alachlor and atrazine are herbicides, DBCP and EDB are nematocides, and lindane is an insecticide.

EPA concluded that the overall chance that a given drinking water

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well has exceeded a level of concern for a pesticide is low. However, if pesticide residues are present in individual wells, they are likely to be present at high levels that pose a health risk. In contrast, it was estimated that approximately 52% of the RDWs and 57% of CWSs contain detectable levels of nitrates, with approximately 2% of RDWs and 1% of CWSs exceeding the health-based limits for nitrates.

Among the major findings of the survey were associations between the occurrence of pesticides and nitrates in drinking water wells and individual agronomic and hydrogeologic factors. These findings include

- Detections of 1,2-dibromo-3-chloropropane (DBCP) acid metabolites were related to the rate of DCPA use by urban applicators and golf courses.

- At the county level, the concentrations of nitrates in wells was positively correlated with the amount of fertilizer sold in that county.

- Detections of nitrates were less likely in areas with high levels of precipitation.

- Shallow water wells were correlated with more frequent detections of pesticides and nitrates.

- Older wells were correlated with more frequent detections of pesticides and nitrates.

In conclusion, EPA recommends that well owners who know or suspect that their well is affected by pesticides or nitrates have the water tested. Because of the many factors that may influence the contamination of drinking water wells, EPA recommends an approach that focuses on pollution prevention. Among the steps that should be considered to protect the Nation's ground water resources are appropriate applications of pesticides and fertilizers, site-specific assessments to accurately target vulnerable ground water supplies, identification and protection of ground water recharge areas and wellhead areas, more careful use of flood irrigation, and continued efforts to identify problem pesticides.

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Oklahoma

In 1983, the State established a ground water quality monitoring network covering 21 major ground water basins in Oklahoma. This network provides information on ambient ground water quality in the State. The monitoring network is being used to characterize the current status of the State's ground water resources and to identify changes in ground water quality over time. The accuracy of well location and completion information has been evaluated for all wells included in the monitoring network, and a vulnerability assessment was completed for each network well in 1989. In 1990, an additional 224 domestic, irrigation, stock, and municipal water wells were included in the network. The ground water quality monitoring network is sampled annually.

Public drinking water wells are routinely monitored for nitrates, bacteria, VOCs, and other drinking water parameters. The State maintains a database of MCL violations for these wells that includes the name and county of the water supply system, the aquifer tapped by the contaminated well, and the confirmation date for each violation. In addition, the State performs analyses of private water supplies at the request of private citizens. The State has also undertaken a 3-year sampling project to identify private drinking water wells at risk from agricultural contamination. The project is scheduled to be completed in 1994 and will address a total of 200 sites.

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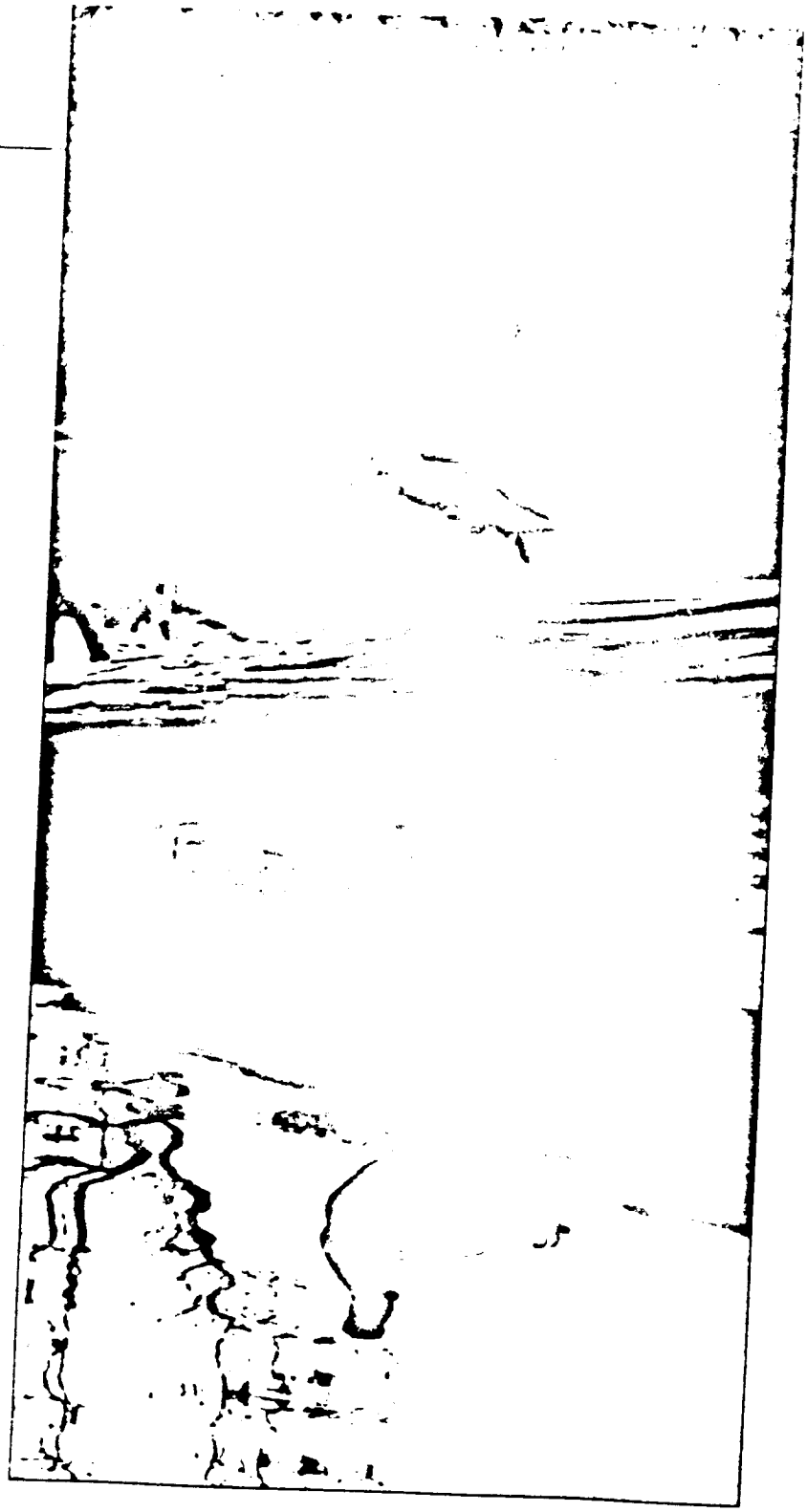

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Public Health and Aquatic Life Concerns

Water pollution threatens public health by contaminating seafood, drinking water supplies, and recreational waters with toxic substances as well as pathogenic viruses and bacteria, which cause disease. Aquatic organisms tolerate most bacteria and viruses pathogenic to humans, but many aquatic organisms are more sensitive to toxic substances than humans are. Aquatic organisms also suffer if chemical and physical conditions exceed an acceptable range. Important chemical and physical conditions include acidity, dissolved oxygen concentration, and temperature.

Public Health Concerns

Toxic Pollutants

Health officials link waterborne toxic pollutants, such as mercury, dioxin, PCBs, and some pesticides with human birth defects, cancer, neurological disorders, and kidney ailments. Once discharged to surface waters, these toxicants persist in the sediments and contaminate the food chain and the overlying water. Waterborne toxicants can enter human systems via ingestion of contaminated fish, shellfish, or drinking water supplies. Swimmers may also swallow toxic substances or absorb toxic pollutants through skin exposure in contaminated recreational waters. Fish and shellfish contamination usually poses a greater human health risk than does contaminated drinking water or recreational waters because fish and shellfish concentrate many toxic substances in their tissues. As a result, the concentration of toxicants within fish and shellfish tissues may be one million times the concentration of toxicants in the surrounding waters.

Fish Consumption Advisories

States issue fish consumption advisories to protect the public from ingesting harmful quantities of toxic pollutants in contaminated fish and shellfish. In general, advisories recommend that the public limit the quantity and frequency of fish consumption from specific waterbodies. The States tailor individual advisories to minimize health risks based on contaminant data collected in their fish tissue sampling programs. Advisories may completely ban fish consumption in severely polluted waters or limit fish consumption to several meals per month or year in cases of less severe contamination. Advisories may target a subpopulation at risk (such as children, pregnant women, or

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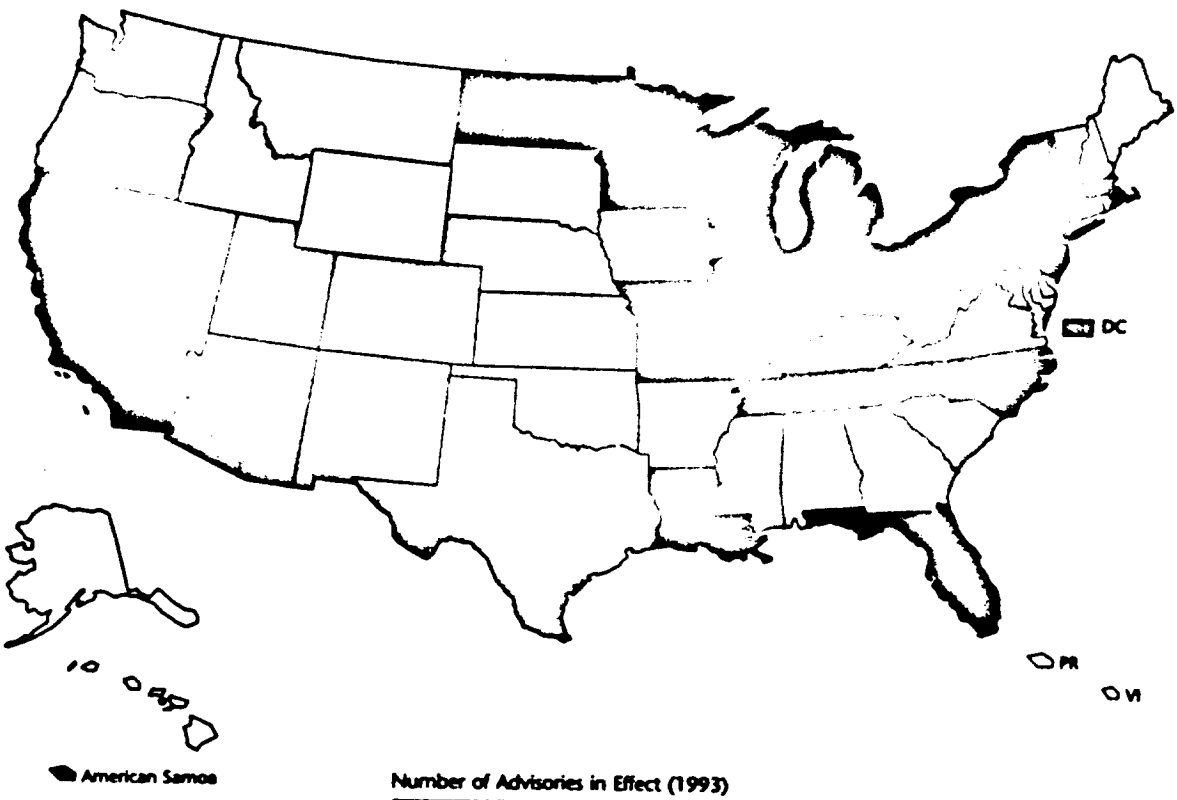
Figure 7-1

Fish Consumption Advisories in the United States



Note: States that perform routine fish tissue analysis (such as the Great Lakes States) will detect more cases of fish contamination and issue more advisories than States with less rigorous fish sampling programs.

Based on data contained in the EPA Fish Consumption Advisory Database as of September 1993 (see Appendix E, Table E-1, for individual State data).

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nursing mothers), specific fish species that concentrate toxic pollutants in their flesh, or larger fish within a species that may have accumulated higher concentrations of a pollutant over a longer lifetime than a smaller (i.e., younger) fish.

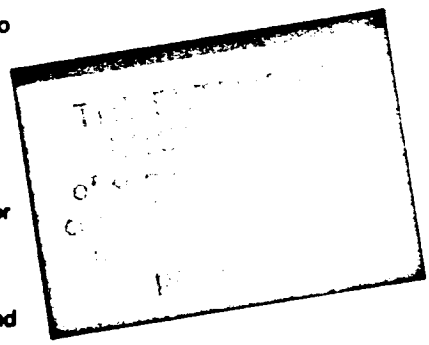
EPA evaluates the national extent of toxic contamination in fish and shellfish by counting the total number of waterbodies with consumption advisories in effect. For this year's Report to Congress, EPA used information from its new Fish Consumption Advisory Database to tabulate the number of State advisories. EPA built the database to centralize fish consumption advisory information separately maintained in various State agencies and the U.S. Fish and Wildlife Service.

The 1993 EPA Fish Consumption Advisory Database listed 1,279 advisories in effect in 47 States (Figure 7-1). The database counts one advisory per waterbody, regardless of the number of species affected and the number of toxic pollutants detected at dangerous concentrations in fish sampled within a waterbody (see Appendix E, Table E-1, for individual State data).

EPA cannot identify States with a high proportion of toxic contamination based solely on the number of fish consumption advisories issued by each State. National statistics on advisories are difficult to interpret because the intensity and coverage of State monitoring programs vary widely from State to State. Simply comparing the total number of fish advisories in each State unfairly penalizes States with superior toxicants monitoring programs that often use strict criteria for issuing consumption warnings. The EPA has advocated consistent criteria and methods for issuing fish consumption advisories in several publications released from 1991 to 1993 (see sidebar, page 89).

Mercury, PCBs, chlordane, dioxins, and DDT (with its byproducts) caused more than 93% of the fish consumption advisories in 1993 (Figure 7-2). EPA and the States have banned or restricted the use of PCBs, chlordane, and DDT for over a decade, yet these organochlorine compounds persist in the sediments and still threaten public health.

Because some fish species migrate considerable distances, it is often difficult to identify sources of pollutants causing fish consumption advisories. Migratory fish may be exposed to toxic pollutants in the sediments and water column or may ingest toxic contaminants concentrated in prey miles from the sampling areas where they are collected. In this reporting period, only

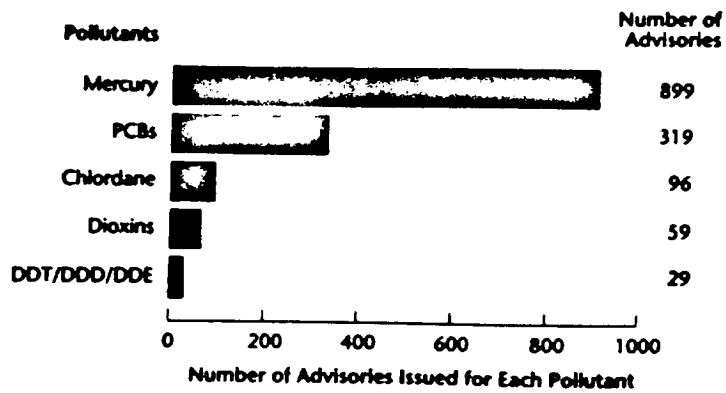


93%

of advisories were caused by mercury, PCBs, chlordane, dioxins, and DDT and its byproducts.

Figure 7-2

Pollutants Causing Fish Consumption Advisories



Based on data contained in Appendix E, Table E-2.

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The National Study of Chemical Residues in Fish (NSCRF)

This study, formerly called the National Bioaccumulation Study, was a one-time screening study undertaken by EPA to determine the prevalence of selected bioaccumulative pollutants in fish and identify sources of these pollutants. The NSCRF study began in 1986 as an outgrowth of the EPA's National Dioxin Study, a nationwide investigation of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) contamination in soil, water, sediment, air, and fish. Some of the highest concentrations of 2,3,7,8-TCDD detected in the National Dioxin Study were found in fish tissue. EPA's concern that there may be other toxic pollutants bioaccumulating in fish that may pose a risk to human health was the primary reason for conducting the NSCRF. Additionally, this study was conducted in response to a petition from the Environmental Defense Fund and the National Wildlife Federation in which EPA committed to conducting a fish contaminant monitoring survey of the occurrence of chlorinated dibenzodioxins and dibenzofurans. Fish and other aquatic biota serve as sentinels that indicate whether substances are bioaccumulating and that signal acutely toxic conditions and stresses, such as sublethal toxicity, particularly due to interactions among chemicals.

Toxic pollutants were selected for analysis in the NSCRF based on their

- potential to bioaccumulate in fish
- potential for causing human health effects
- persistence in the environment
- detectability in fish tissue.

An initial list of 403 pollutants was screened, resulting in a final list of 60 compounds. These compounds included 15 dioxins and furans, 10 polychlorinated biphenyls (PCBs), 21 pesticides/herbicides, mercury, biphenyl, and 12 other organic compounds.

Three to five adult fish of the same species and of similar size were collected at each site. At most locations, both a composite sample of a bottom-feeding fish species (e.g., carp, channel catfish, white sucker) and a composite sample of a predatory gamefish (e.g., walleye, largemouth bass, smallmouth bass) were collected. Although 119

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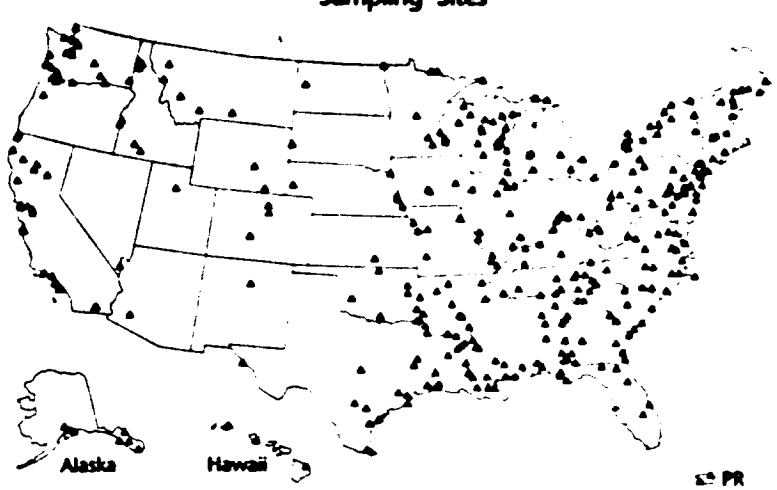
different finfish species were collected, most of the fish belonged to only 14 different species.

Fish were collected at a total of 388 unique sites throughout the United States selected by EPA Regional and State staff. The types of sites sampled included 315 targeted sites near potential point or nonpoint sources of pollution where contamination of fish was suspected, 34 background sites where chemical contamination was not anticipated, and 39 sites that were a subset of sites from the United States Geologic Survey NASQAN network (see map).

Target sites were selected based on proximity to potential sources. Fish and other aquatic biota were sampled near industrial discharges, urban areas, or areas receiving agricultural runoff. The number of sites was not allocated equally among types of sources. Some of the targeted sites were selected based on potential chlorinated dioxin and furan contamination. These sites included areas near pulp and paper mills using chlorine to bleach pulp, wood preservative facilities, users of polychlorinated phenols and phenoxides, PCB dischargers, organic chemical and pesticide manufacturers, and combustion sources (sewage sludge and municipal refuse

Location of Bioaccumulation Study Sampling Sites



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incinerators). More sites with potential dioxin/furan contamination were selected than any other chemical groups to follow up on results of the National Dioxin Study.

Fish samples were analyzed at the EPA Environmental Research Laboratory (ERL) in Duluth, Minnesota. In general, the bottom-feeding species were analyzed as whole-body samples to determine the occurrence of the study chemicals and the gamefish were analyzed as fillets to indicate the potential risks to human health from fish consumption.

The study revealed that seven dioxins/furans/congeners were detected in samples from more than 50% of the sites surveyed.* Pulp and paper mills using a chlorine-bleaching process were identified as the dominant source of 2,3,7,8-TCDD and 2,3,7,8,-tetrachloro-dibenzofuran (2,3,7,8-TCDF). Statistical correlation analyses were less definitive for the other dioxins/furans in that results showed no dominant source for any of these chemicals.

The study also showed that six pesticides, PCBs, three other industrial organic chemicals, and mercury were detected at more than 50% of the sites surveyed. Results for the other 45 chemicals studied showed no single dominant source for any of these chemicals. Although these compounds showed no dominant source, a number of observations can be made from review of the data. Two such observations involve pesticides and PCBs. A comparison of 15 agricultural and 20 background sites for 10 of the pesticides evaluated showed no significant differences between these categories. This same comparison for four other pesticides (DDE, nonachlor, chlordane, and lindane) showed that fish contamination levels were significantly higher at sites near agricultural sources. The median PCB concentration for the 20 background sites was below detection (1.25 to 6.25 parts per billion depending on the degree of chlorination) compared with values of 213 to 525 parts per billion for industrial/urban sites, paper mills using chlorine, refinery/other industry sites, nonchlorine paper mills, and Superfund sites.

*The presence of pollutants alone does not mean that risk does or does not exist at the site. EPA is currently reassessing the health effects associated with dioxins and furans and, as a consequence, has not yet evaluated the relative health and environmental risks associated with these pollutants.

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23 States identified specific sources of toxicants causing less than 11% of the reported fish consumption advisories (Figure 7-3). These States attributed fishing restrictions to industrial discharges, agriculture, urban runoff, storm sewers, resource extraction, natural conditions, and atmospheric deposition (see Appendix E, Table E-3, for individual State data).

At this time, EPA cannot detect trends in toxic contamination of fish and shellfish because the States have not established a baseline inventory of advisories and the contaminant levels that trigger advisories may vary from State to State. The States inevitably issue new advisories as they sample more sites and identify toxic contamination that previously went undetected.

Drinking Water Restrictions

Four States reported cases of surface drinking water supply closures and advisories due to priority pollutant chemicals, oil, and cyanide (see Appendix E, Table E-4, for individual State data). Chemical plant spills, an oil spill at a power plant, and priority pollutants from hazardous waste disposal sites caused the closures.

Recreational Restrictions

Three States listed contact recreation restrictions (such as beach closures) due to toxics. Tennessee closed two sites where toxicants were detected in the sediment and water column. Ohio restricted access to seven recreational sites with elevated concentrations of PCBs, dioxin,

EPA Publications About Fish Consumption Advisories

Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis. 1993. EPA 823/R-93-002. Office of Water, Office of Science and Technology, Washington, DC.

Proceedings from National Workshop on PCBs in Fish Tissue, May 11-12, 1993. In preparation. Office of Water, Washington, DC.

National Study of Chemical Residues in Fish. Volume 1. 1992. EPA 823/R-92-008a. Office of Water, Office of Science and Technology, Washington, DC.

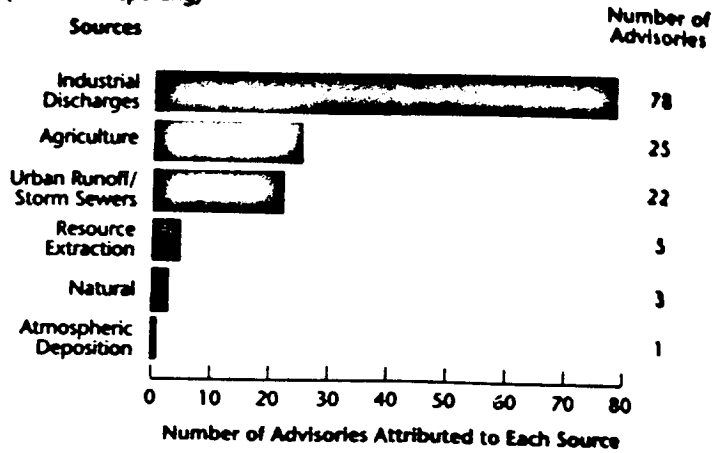
National Study of Chemical Residues in Fish. Volume 2. 1992. EPA 823/R-92-008b. Office of Water, Office of Science and Technology, Washington, DC.

Consumption Surveys for Fish and Shellfish: A Review and Analysis of Survey Methods. EPA 822/R-92-004. Office of Water, Washington, DC.

Environmental Monitoring and Assessment Program (EMAP) Near Coastal Program Laboratory Methods for Filleting and Compositing Fish for Organic and Inorganic Contaminant Analyses. 1991. Draft. Office of Research and Development, Environmental Research Laboratory, Narragansett, RI.

Figure 7-3

Sources of Contaminants Causing Fishing Advisories
(23 States Reporting)*



Based on data contained in Appendix E, Table E-3.
*Only 23 States reported sources of contaminants causing less than 11% of the 1,279 fish consumption advisories reported nationwide.

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mirex, chlordane, and polynuclear aromatic hydrocarbons (PAHs). Louisiana reported that abandoned hazardous waste sites impacted recreational waters (see Appendix E, Table E-5, for individual State data).

Bacterial and Viral Contamination

Waterborne viral and bacterial pollutants may also cause serious human illness and death. People can contract infectious hepatitis, gastroenteritis, dysentery, and cholera from waters receiving inadequately treated sewage. Bacteria and viruses may enter human systems through contact with contaminated swimming and bathing waters or through ingestion of contaminated drinking water or shellfish.

State	Number of Waterbodies with Restrictions	Area Affected (sq. miles)
Alabama	4	373
Alaska	0	0
California	—	—
Connecticut	17	122
Delaware	17	—
Delaware River Basin	2	42
District of Columbia	1	6
Florida	—	—
Georgia	6	86
Hawaii	—	—
Louisiana*	—	297
Maine	258	—
Maryland	33	188
Massachusetts	—	—
Mississippi	—	605
New Hampshire	11	19
New Jersey	—	—
New York	67	306
North Carolina	—	59
Oregon	8	56
Rhode Island	48	53
South Carolina	86	304
Texas	25	663
Virginia	69	276
Virgin Islands	—	—
Washington	—	—
Totals	652	3,455

*Louisiana reports three permanent closures due to potential pollution from industry, but does not report the number of waterbodies periodically closed by other sources.

Source: 1992 State Section 305(b) reports.

— Not reported.

Shellfish Contamination

Contaminated shellfish pose a public health risk particularly to those who consume raw shellfish. Shellfish, such as oysters, clams, and mussels, extract their food (plankton) by filtering water over their gills. In contaminated waters, shellfish accumulate bacteria and viruses on their gills and mantle and within their digestive systems. If shellfish grown in contaminated waters are not cooked properly, consumers may ingest live bacteria and viruses.

To protect public health, coastal States routinely monitor shellfish harvesting areas for bacterial contamination and restrict shellfish harvests in contaminated waters. Most often, States measure concentrations of fecal coliform bacteria such as *Enterococcus or Escherichia coli*, which are nonpathogenic bacteria that populate human digestive systems and waste products. Their presence in water samples is an indicator of sewage contamination that may pose a human health risk from pathogenic viruses and bacteria. Fecal coliforms, however, may exceed criteria even when no human sewage is present because birds and nonhuman mammals also excrete them.

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States issue several types of shellfish harvesting restrictions:

- **Prohibited Waters** violate criteria consistently; therefore, shellfish cannot be harvested at any time.

- **Restricted Waters** may be harvested if the shellfish are transferred to clean waters to reduce concentrations of bacteria.

- **Conditionally Approved Waters** temporarily exceed bacteriological criteria following predictable events (such as a storm). Shellfish from these waters may be harvested when criteria are met.

Nineteen of the 29 coastal States and Territories provided information on shellfish harvesting restrictions in their 1992 Section 305(b) reports (Table 7-1). Eighteen of these States prohibit, restrict, or conditionally approve shellfish harvesting in more than 3,455 square miles of estuarine waters. Maine and Delaware reported 275 harvesting restrictions but did not report the size of their estuaries affected by the restrictions.

Only nine States identified specific sources contaminating shellfish waters with pathogens (Figure 7-4). These States cited urban runoff and storm sewers as the source of 143 shellfish harvesting restrictions (see Appendix E, Table E-6, for individual State information). Municipal discharges caused bacterial contamination at 60 sites, marinas impacted 51 sites, and industrial discharges affected 40 sites.

The EPA cannot draw firm national conclusions from shellfish restriction data because the States issue shellfish harvesting restrictions based on varying bacteriological criteria. The quality of State shellfish monitoring programs also varies. Therefore, States with strict bacteriological criteria and progressive monitoring programs appear to have more polluted estuarine waters than other States that may monitor less vigorously or use less stringent criteria.

Drinking Water Restrictions

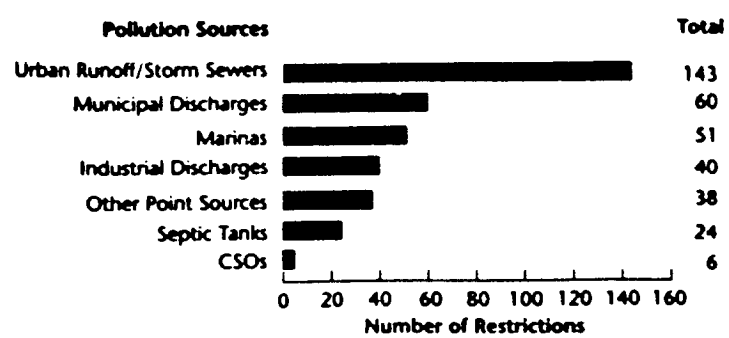
Pathogens seldom cause complete closures of drinking water supplies because disinfection procedures (such as chlorination or boiling) usually eliminate pathogenic contamination. In most cases of bacterial contamination, water officials temporarily advise consumers to boil or chemically treat their drinking water rather than to stop consumption.

Only six States and Puerto Rico reported drinking water restrictions

States cited urban runoff and storm sewers as the leading source of shellfish restrictions

Figure 7-4

Sources Associated with Shellfish Harvesting Restrictions
(9 States Reporting)



Based on data contained in Appendix E, Table E-6.

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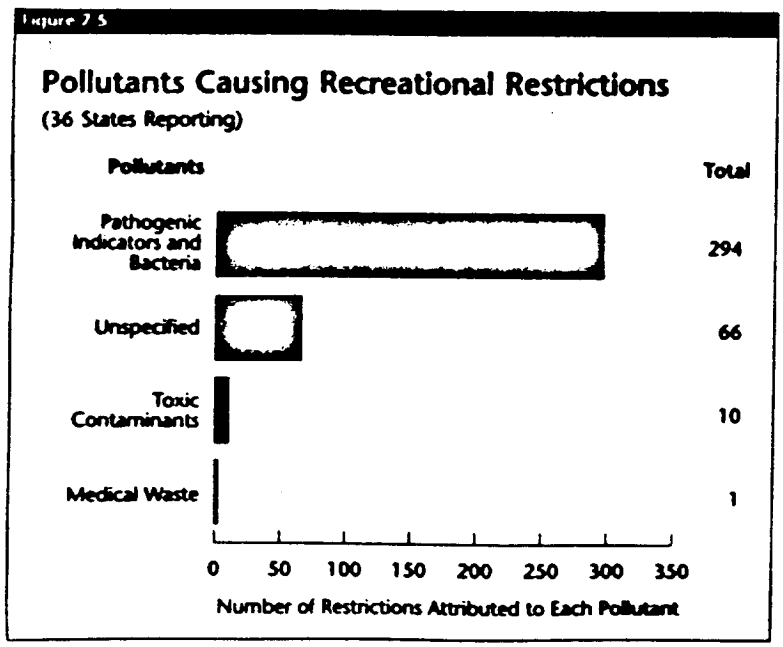
caused by pathogens (see Appendix E, Table E-4, for individual State information). These States and Puerto Rico blamed drinking water treatment plant malfunctions and raw sewage discharges for elevating bacterial concentrations above safe drinking water standards.

Recreational Restrictions

Pathogenic indicators cause most contact recreation restrictions, such as beach closures (Figure 7-5). Thirty-six States provided information on 371 recreation restrictions (see Appendix E, Table E-5, for individual State data). Twenty-five of these States restricted recreational activities in 294 cases because bacteria concentrations exceeded public health criteria. Only three States reported recreational restrictions due to toxics and only one State (New Mexico) reported a recreational closure due to medical waste on the shores of a reservoir. Six States reported that they did not restrict activities at any recreational sites during the 1991-1992 reporting cycle.

36 States provided information on recreation restrictions.

Figure 7-5



Based on data contained in Appendix E, Table E-5.

Aquatic Ecosystem Concerns

Toxic Pollutants

Many indigenous aquatic organisms are more sensitive than humans to toxic pollutants. In severe cases of contamination, toxicants destroy the aquatic ecosystem; in less severe cases, toxicants alter the species composition in aquatic ecosystems. The aquatic system deteriorates as toxic contaminants poison aquatic organisms (including fish, shellfish, benthic bottom-dwelling organisms, and plants), increase their susceptiblility to disease, interfere with their reproduction, or reduce the viability of their young. Toxic pollutants also disrupt the chemical and physical balance in an aquatic ecosystem and indirectly cause mortality.

Aquatic toxicants fall into four broad categories:

- Metals (such as copper, cadmium, and mercury)
- Priority organic chemicals, including pesticides and numerous solvents (such as toluene and benzene)

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- Other petrochemical hydrocarbons (such as oil and grease)
- Nonconventional toxics (such as ammonia and chlorine).

Physical and Chemical Conditions

Mortality of aquatic life from depleted oxygen concentrations, excessive temperatures, or high acidity can exceed the impact of toxic pollutants in aquatic habitats. Organic pollutants impose a biological oxygen demand (BOD) on receiving waters because bacteria consume oxygen as they decompose organic wastes. Nutrients also may indirectly deplete oxygen concentrations by feeding algal blooms.

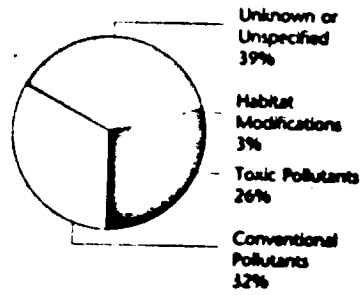
Acidity (the concentration of hydrogen ions) drives many chemical reactions in living organisms. The standard measure of acidity is pH, and a pH value of 7 represents a neutral condition. A low pH value (less than 5) indicates acidic conditions; a high pH value (greater than 9) indicates alkaline conditions. Many biological processes (such as reproduction) cannot function in either acidic or alkaline waters. High acidity also aggravates toxic contamination problems because sediments release toxicants in acidic waters. Common sources of acidity include mine drainage, runoff from mine tailings, and atmospheric deposition.

Fish Kills Caused by Pollution

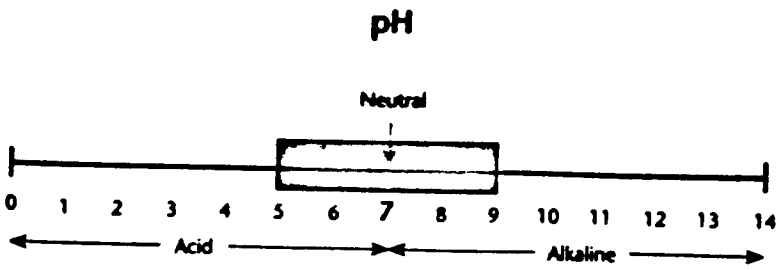
The number of fish kills provides a limited picture of pollutant impacts on aquatic life. In general, fish kill data track sporadic pollution events (such as chemical spills) rather than chronic pollution problems. Data collection methods also bias the data toward identifying kills in populated areas because most States acquire leads on fish kills from the public (such as anglers, hikers, and boaters). Fish kills in remote areas may go undetected and unreported.

Forty-three States reported that pollution caused 930 fish kills during 1990 and 1991 (Figure 7-6). More than 5 million fish died during these events (see Appendix E, Table E-7,

Causes of Pollution-Related Fish Kills (43 States Reporting)



Based on data contained in Appendix E, Table E-7.



Most aquatic organisms cannot live outside a pH range of 5-9.

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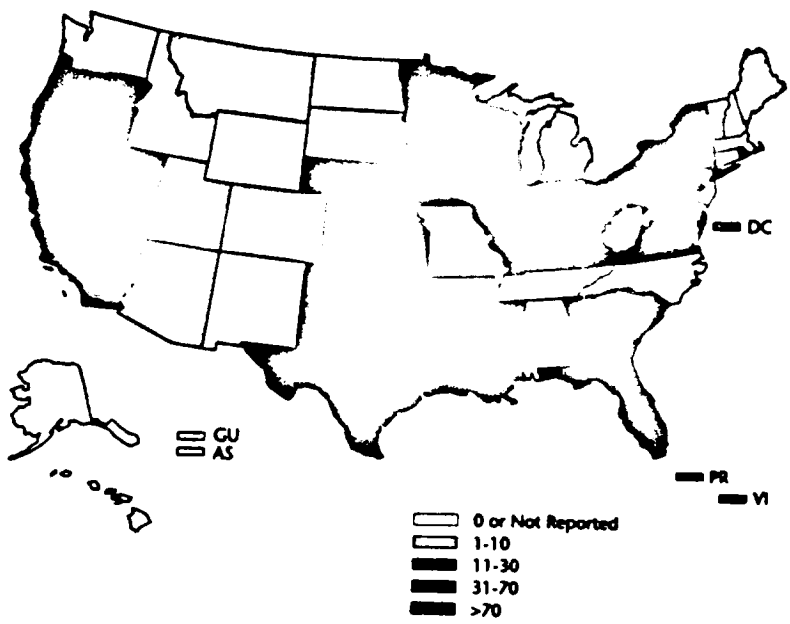
for individual State data). Toxic pollutants (including ammonia and chlorine) caused 26% of these fish kills. Conventional pollutants (including BOD, pH, suspended solids, temperature, and oil and grease) caused 32% of the reported fish kills, and habitat modification caused 3% of the reported fish kills. The States could not determine the cause of 39% of the fish kills. Fish kill investigations often fail to identify causes and sources because currents can carry dead fish downstream from the pollutant source before the kill is observed.

In some cases, toxicants trigger conventional pollutant impacts. For example, Florida reported that herbicide applications, in conjunction with high temperatures and heavy rainfall, depressed oxygen concentrations and suffocated over 45,000 fish in Lake Rousseau. The toxic herbicide caused heavy die-off of aquatic weeds, and bacteria depleted oxygen concentrations as they decomposed the dead weeds.

Thirty-nine States identified specific pollutants causing fish kills. These States attributed most fish kills to BOD and depressed oxygen

Figure 7-6

Number of Fish Kills Nationwide



Based on data contained in Appendix E, Table E-7.

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concentrations, pesticides, and a combination of manure and silage (Figure 7-7 and Appendix E, Table E-8). Manure and silage contain ammonia, which is lethal to fish, and organic substances, which increase biological oxygen demand.

Thirty-seven States listed sources of pollutants causing fish kills (Figure 7-8). Natural sources (such as high temperatures) caused the greatest number of fish kills, followed by agriculture, industrial discharges, municipal discharges, other spills (such as trucks), and pesticide applications (Appendix E, Table E-9). Pesticide applications include intentional algicide and herbicide applications on lakes to control algae and weeds.

Sediment Contamination

Most waterborne toxic pollutants settle to the bottom and bind to sediments or organic material or remain in solution in the interstitial water between the sediment particles. Bacteria degrade some toxicants in sediments, but many toxic contaminants (such as metals) persist in sediments for many years after the original toxic source has been eliminated. Contaminated sediments may reintroduce toxicants into the water column for decades.

Dredging contaminated sediments may also reintroduce toxicants into the water column and food web. Due to these impacts, sediment contamination can obstruct maintenance dredging of harbors and navigation channels. Dredge spoil disposal methods (such as open water dumping, spreading on "reclaimed" lands, and diked containment areas) may also create new aquatic life threats.

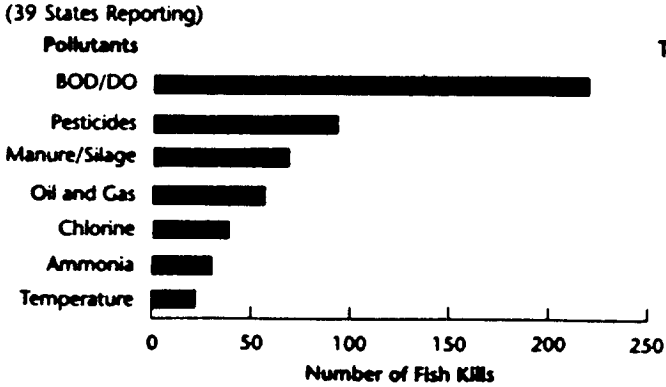
Currently, no national criteria are in effect that define harmful concentrations of pollutants in sediment. However, EPA released draft sediment criteria for five pollutants (endrin, dieldrin, phenanthrene, fluoranthene, and acenaphthene) in January 1994 for public comment and plans to publish final criteria for the five toxicants in 1995 after responding to final comments. EPA also intends to publish additional sediment criteria for two or three pollutants each year beginning in 1994 and propose methods for deriving sediment quality criteria for metals in 1994.

In 1992, 27 States reported incidents of sediment contamination in their 305(b) reports (see Appendix E, Table E-10, for individual State data). Several States preferred not to list contaminated sites until EPA publishes national criteria for screening sediment data. Other

39 States
identified specific pollutants causing fish kills

Figure 7-7

Pollutants Associated with Fish Kills
(39 States Reporting)



Based on data contained in Appendix E, Table E-8.

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States lack the analytical tools and resources to conduct extensive sediment sampling and analysis. Therefore, the following discussion probably understates the extent of sediment contamination in the Nation's surface waters.

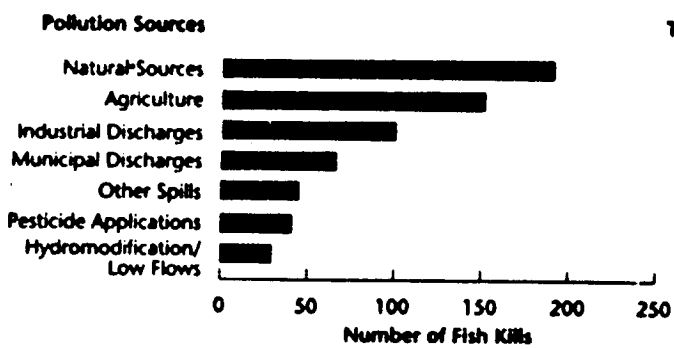
Twenty-seven States listed 770 separate sites with contaminated sediments and identified pollutants detected in sediments. These States most frequently listed metals (e.g., mercury, cadmium, and zinc), PCBs, DDT (and its byproducts), chlordane, and priority organics. These States also identified industrial and municipal discharges (past and present), landfills, resource extraction, abandoned hazardous waste disposal sites, and combined sewer overflows as the primary sources of sediment contamination.

EPA is developing the following guidance and information sources to provide States with better tools for assessing and managing sediment contamination:

- A compendium of sediment assessment methods (Fall 1992)
- Sediment criteria for toxicants (beginning in 1993)
- National Inventory of Sediment Contaminant Sources (Spring 1993)
- Sediment Remediation Methods (Spring 1993)
- EPA's Sediment Management Strategy will focus the Agency's resources on preventing, remediating, and managing disposal of dredged contaminated sediments (Spring 1993)
- A testing manual for evaluating sediment disposal in inland waters under Section 404 of the Clean Water Act (Fall 1993)
- Guidance documents describing methods for conducting acute toxicity tests, chronic toxicity tests, and bioaccumulation tests for sediments (Fall 1993)
- A national database of contaminated sediment sites (late 1993)

Figure 7.8

Sources Associated with Fish Kills
(37 States Reporting)



Based on data contained in Appendix E, Table E-9.

A 1989 National Academy of Sciences Report on contam[illegible] sediments concluded that the effects of sediment cont[illegible] tially far-reaching. This report found that contamination [illegible] ments poses a potential threat to marine resources and human [illegible] (through consumption of seafood) in numerous sites around the country – particularly near metropolitan areas.

Source: *Contaminated Marine Sediments – Assessment and Remediation*, Committee on Contaminated Marine Sediments, Marine Board, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, 1989.

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- Methods for deriving sediment quality criteria for heavy metals (late 1993).

Total Waters Affected by Toxic Pollutants

Responding to public concern about toxic pollutants, EPA requested that States track the overall extent of toxic contamination in their surface waters. Forty-eight States reported the size of waters monitored for toxicants (either in the water column, sediments, or aquatic organisms) and the total waters found to contain elevated concentrations of toxic pollutants (see Figure 7-9 and Appendix E, Table E-11, for individual State data).

Forty-six States reported that they monitored toxicants (primarily in the water column) in almost 600,000 miles of rivers and streams. These States monitored 17% of the Nation's 3.5 million river miles for toxic contamination. The States detected elevated concentrations of toxicants in only 8% of the monitored rivers and streams (Figure 7-10).

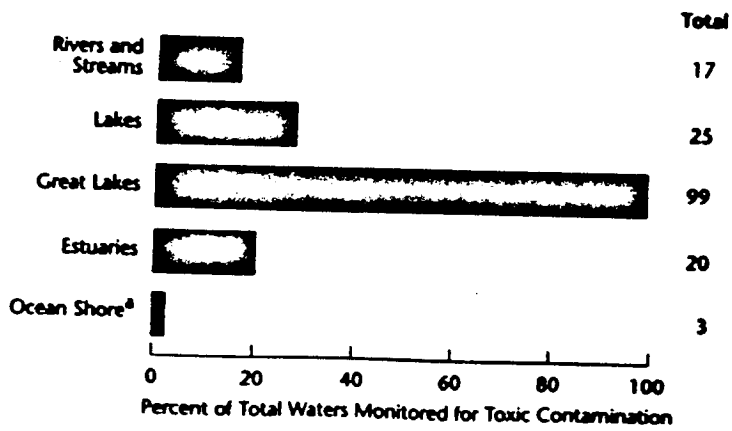
Forty-two States reported that they sampled toxicants in almost 10 million acres of lakes, reservoirs, and ponds. The monitored acres represent 25% of the Nation's 40 million lake acres. The States found elevated concentrations of toxicants in 43% of the sampled lake acres.

Eighteen coastal States sampled toxicants in 20% of the Nation's estuarine waters. These States detected elevated toxic concentrations

The results do not describe the extent of toxic contamination in all waters across the Nation because most toxic pollutants are found in the sediment and food chain, not in the water column.

Figure 7-9

Waters Monitored for Toxic Contamination



Based on data contained in Appendix E, Table E-11.
[a]Excluding the Alaska shoreline.

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- River miles monitored: 600,000
- Total river miles: 3.5 million

- Lake acres monitored: 10 million
- Total lake acres: 39,950,000

- Estuarine waters monitored: 7,307 square miles
- Total estuarine waters: 36,000 square miles

- Great Lakes miles monitored: 5,319
- Total Great Lakes shore miles: 5,382

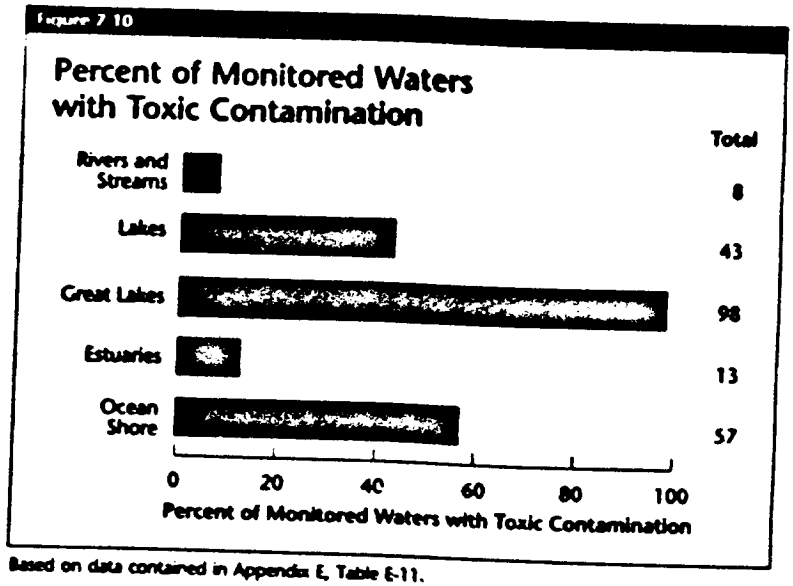
- Ocean shore miles monitored: 506
- Total ocean shore miles: 20,121 (excluding Alaska)

in 13% of the 7,307 square miles of estuarine waters that they sampled.

Only six States reportedly monitored toxicants in coastal waters. These States found elevated concentrations of toxicants in 57% of the sampled coastline, but this information cannot be applied nationally because the States monitored less than 3% of the Nation's coastal waters (excluding the Alaska shoreline).

Seven States reported that they monitored all of their Great Lakes' shoreline for toxicants (primarily in fish tissue samples) and detected elevated toxicants in 98% of the shoreline. Three States reported that they monitored toxicants in 167,178 acres of wetlands (less than one-tenth of 1%) of the Nation's wetlands. The States identified elevated concentrations of toxicants in 63% of the monitored wetlands.

Figure 7-10



Based on data contained in Appendix E, Table E-11.

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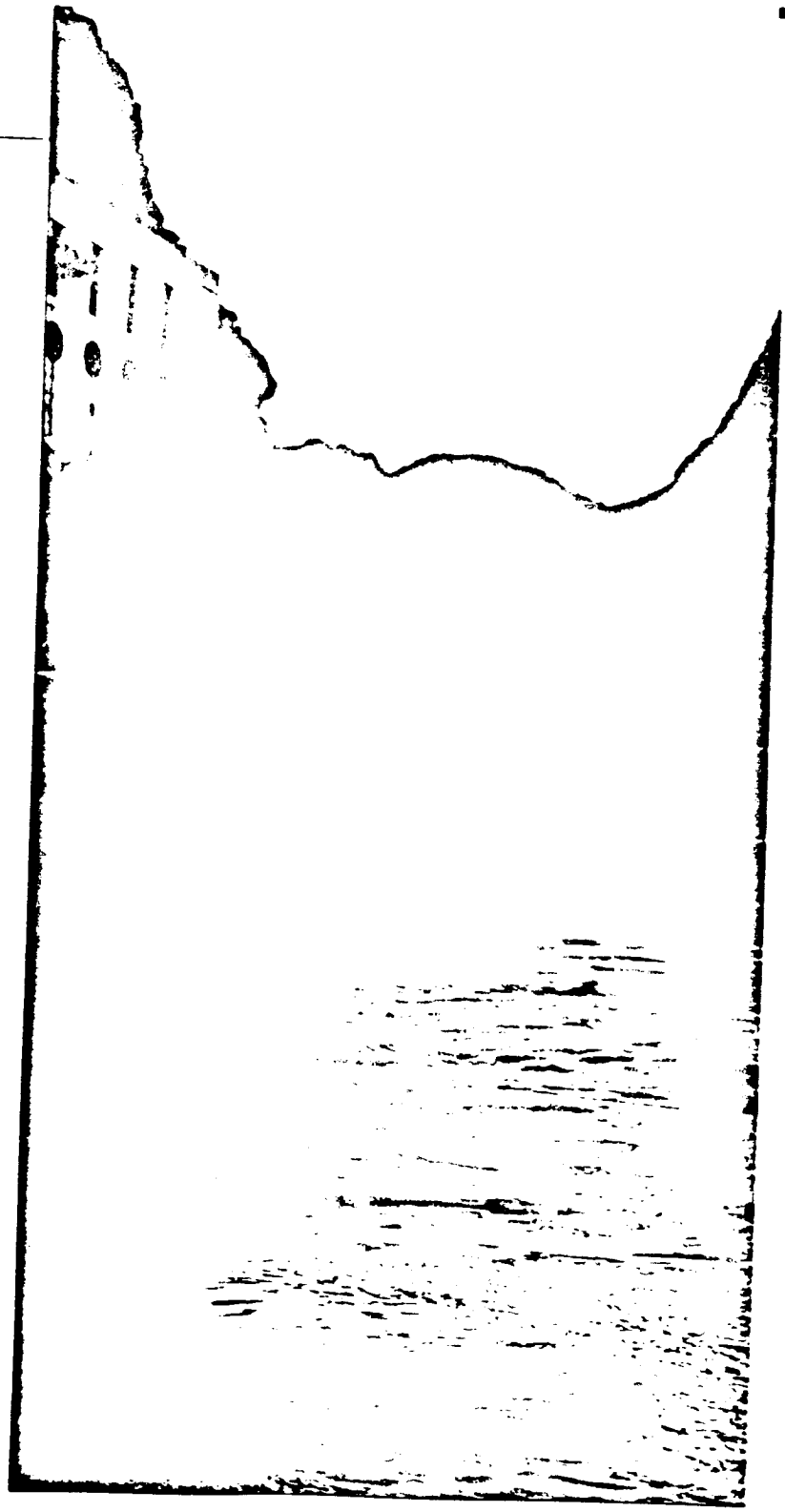

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Individual State Summaries

This section provides individual summaries of the data reported by the States, Territories, Interstate Water Basin Commissions, District of Columbia, and Gila River Indian Community in their 1992 Section 305(b) water quality assessments.

Variation among States in how these data are generated result from differences in pollution problems, monitoring priorities, and water quality criteria. Each State does not use the same method to measure use support and, in many instances, the standards against which use support is measured are different. Regional patterns of pollution also affect the data generated. In addition, some States have the funds for more sophisticated monitoring techniques while other States must rely on more conventional methods to identify pollutants of concern.

However, progress is being made in introducing consistency in assessment approaches to the 305(b) reporting process. In addition, statistically valid information on water quality status and trends in the Nation's waters will be collected in coming years by scientifically designed, broad-scale monitoring programs such as EMAP (see Chapter 10).

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Alabama

For a copy of the Alabama 1992 305(b) report, contact:

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Alabama Department of Environmental Management
Water Quality Branch
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Montgomery, AL 36130
(205) 271-7829

1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	12,292 mi	72%	2%	18%	8%
Lakes	392,474 ac	49%	30%	20%	1%
Estuaries	343 mi²	77%	—	22%	1%
Oceans	50 mi	100%	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 16% of river miles, 84% of lake acres, 56% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Agricultural runoff, municipal point sources, industrial point sources, and resource extraction impair rivers and streams with nutrients, siltation, organic materials, pathogen indicators, ammonia, pesticides, and metals. Industrial point sources impair more lake acres than any other source with priority organics and pathogen indicators. Pathogen indicators, primarily from storm sewers, urban runoff, and septic tanks, cause all of the use support violations in estuarine waters.

Programs to Correct Impairments

Alabama reduced toxic loadings into surface waters by 57 percent between 1989 and 1990. Additional reductions should result since Alabama's Department of Environmental Management (ADEM) adopted numeric standards for a broad range of toxic pollutants in 1991. All National Pollutant Discharge Elimination System (NPDES) permits issued since adoption of the numeric standards limit toxicant concentrations in wastewater discharges. (Prior to 1991, NPDES permits primarily regulated conventional pollutants, such as pH, fecal coliforms, and oxygen-demanding substances.)

ADEM is also initiating watershed projects that simultaneously address pollutants from multiple sources. The Bayview Lake Watershed Project, for example, employs artificial wetlands treatment technology to address urban runoff, acid mine drainage from coal mine tailings, and pollution from an industrial landfill.

Programs to Assess Water Quality and Program Effectiveness

ADEM is assessing habitats and resident biota at several candidate streams in order to establish reference sites for future biological monitoring.

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Alaska

For a copy of the Alaska 1992 305(b) report, contact:

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Juneau, AK 99801-1795
(907) 465-2653

1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	4,054 mi	29%	—	32%	39%
Lakes	—	—	—	—	—
Estuaries	—	—	—	—	—
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 1% of river miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Urban runoff is the major source of impaired rivers and streams, followed by placer mining, petroleum products, and sources of sewage. Urban development is also the major source of pollution in 26 impaired lakes, followed by fuel and chemical leaks and spills, septic system failures, erosion, and agricultural sources of pesticides, fertilizers, and animal wastes. The State attributes impairments at 34 estuaries to harbor activities, urban development, oil and gas development, transportation, industrial sources, municipal sewage treatment plants, and silvicultural activities. Gas and oil development on the Kenai Peninsula and the North Slope have also impaired wetlands.

Programs to Correct Impairments

Alaska's Total Maximum Daily Load (TMDL) program will address pulp mills, the seafood processing industry, placer mining, timber harvesting, and urban runoff sources. The Alaska Department of Environmental Conservation (ADEC) received $120,000 in FY92 to assess and monitor activities in support of the TMDL program. The State also intends to revise its water quality standards to include criteria for numerous toxic pollutants.

Programs to Assess Water Quality and Program Effectiveness

The State operates intensive monitoring programs to evaluate water quality at sites on the State's list of impaired waters (which includes waters suspected of degradation). The State also initiated intensive monitoring programs to study the effects of placer mining, the Exxon Valdez oil spill, the Ketchikan Pulp Mill, and heavy metal contamination in Skagway Harbor. In 1991, ADEC established the Alaska Volunteer Water Watch program, and the new State Forest Practices program includes intensive monitoring of the effectiveness of best management practices implemented to control runoff from timber activities.

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American Samoa

For a copy of the American Samoa 1992 305(b) report, contact:

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San Francisco, CA 94105
(415) 744-1591

1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	—	—	—	—	—
Lakes	—	—	—	—	—
Estuaries	—	—	—	—	—
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

— None or not reported.

Causes and Sources of Water Quality Impairments

The waters of this Territory suffer from numerous manmade sources of pollution including discharges from tuna canneries, erosion and surface runoff, discharges of domestic wastewater, direct discharges from ocean-going vessels, and careless disposal of solid wastes. Visiting vessels and local inhabitants frequently dispose of solid wastes directly into the harbor where tides transport the wastes upstream. Many villages withdraw water for domestic use from these streams, which frequently do not meet safe drinking water standards. The government water system relies primarily on ground water, which is also at risk of contamination from failing sewage disposal systems and animal wastes.

Programs to Correct Impairments

In FY90, the Territory entered into a consent agreement with the two canneries discharging 95 percent of the nutrient load into Pago Pago Harbor. As a result of the agreement, the canneries implemented high-strength waste segregation and began discharging high nutrient wastes and sludge at an ocean dump site instead of into the Harbor. Since initiation of these changes, monthly measurements of total nitrogen and total phosphorus in the Harbor have decreased by as much as 50 percent. The Territory also initiated the Nonpoint Source Management Program that sponsors demonstrations of best management practices, a Well Head Protection Program, and public education projects. Specific projects demonstrate soil stabilization techniques, swine production practices that prevent manure from contaminating waters, and ground water protection controls.

Programs to Assess Water Quality and Program Effectiveness

The Territory samples water quality monthly at 12 of the Territories' 163 streams. Shortages of trained personnel, supplies, and equipment limit monitoring and analysis.

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Arizona

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(602) 207-4545

1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	4,461 mi	18%	7%	36%	38%
Lakes	121,058 ac	4%	23%	72%	1%
Wetlands	—	—	—	—	—

*Totals represent 3% of river miles and 94% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Agriculture is the predominant source of turbidity, sediment, and nutrients in rivers and streams. Habitat and hydrologic modification (including channelization, dredging, and dam construction) is also widespread in Arizona and impacts all types of waterbodies. Ground water pollution from inorganic compounds (i.e., nitrates, sulfates, and total dissolved solids), pesticides, and radiochemicals results from agricultural and mining activities, while volatile organic chemicals, petroleum, and microorganism contamination result from leaking underground storage tanks, landfills, and poor well construction.

Programs to Correct Impairments

Arizona's Nonpoint Source Water Quality Management Plan integrates regulatory and voluntary program components. Regulatory programs include general permits for nitrogen fertilizer applications and concentrated animal feeding operations, a Pesticide Contamination Prevention Program, draft Best Management Practices (BMPs) for grazing activities, and the Aquifer Protection Permit system. The Aquifer Protection Permit system requires permits for most activities that may impact ground water from point and nonpoint sources, including landfills, storage ponds, injection wells, mine leaching practices, septic tanks, recharge projects, and point source discharges to rivers. Monitoring is required by dischargers to show no violation of Aquifer Water Quality Standards. In addition, BMPs are required for nitrogen fertilizer applications.

Programs to Assess Water Quality and Program Effectiveness

Arizona's Department of Environmental Quality (ADEQ) and the U.S. Geological Survey (USGS) monitored ambient water quality at 62 sites in 1990-1991. Baseline biological, chemical, and physical monitoring will be conducted at over 100 less impacted, perennial stream sites for use in developing biocriteria for future assessments.

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Arkansas

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	7,462 mi	49%	—	29%	22%
Lakes	355,063 ac	100%	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 8% of river miles and 67% of lake acres.

— None or not reported.

Causes and Sources of Water Quality Impairments

Siltation and turbidity primarily from agricultural sources cause the majority of impairments in rivers and streams. Contamination of shallow domestic wells and springs by human and animal wastes is the most predominant ground water problem in the State.

Programs to Correct Impairments

The Arkansas Department of Pollution Control and Ecology listed impacts from the expansion of confined animal production as a special State concern in their 1992 305(b) report. The Arkansas National Pollutant Discharge Elimination System (NPDES) permit program regulates liquid wastes from the confined animal industry in addition to industrial point sources and municipal treatment plants. Farms with liquid waste handling and storage systems must obtain a State Water Permit. This rule applies to most swine and poultry layer operations and some dairy production facilities.

The Arkansas Nonpoint Source Pollution Management Plan also educates poultry, swine, and dairy producers about best management practices (BMPs) to prevent manure from entering streams and ground water. Under the program, the University of Arkansas Agricultural Extension Service provides soil testing and analyzes proper land application rates for animal wastes. The U.S. Department of Agriculture Soil Conservation Service prepares a waste management plan for individual facilities, and the Arkansas Soil and Water Conservation Commission and Districts provide financial assistance for animal producers to voluntarily implement the waste management plans.

Programs to Assess Water Quality and Program Effectiveness

Arkansas categorizes its waters into geographically defined ecoregions. Waterbodies within an ecoregion share similar physical, chemical, and biological features as well as major pollution problems arising from land use practices common throughout an ecoregion. The ecoregion approach enables the State to identify the predominant land use in each ecoregion that threatens water quality.

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California

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	5,679 mi	13%	5%	77%	5%
Lakes	307,981 ac	7%	1%	92%	—
Estuaries	89 mi^2	—	4%	96%	—
Oceans	700 mi	90%	—	9%	1%
Wetlands	60,858 ac	1%	—	99%	—

*Totals represent 3% of river miles, 26% of lake acres, 12% of estuary square miles, 38% of ocean miles, and 26% of wetlands acres.

— None or not reported.

Causes and Sources of Water Quality Impairments

Pesticides and metals are the leading major cause of impairment in rivers, lakes, estuaries, bays, and harbors. Other causes of impairment in lakes are nutrients, siltation, suspended solids, and low dissolved oxygen. Pathogens are a moderate problem in many estuaries, and salinity and dissolved solids cause most ground water impairments. Agriculture dominates the list of major sources impairing rivers, estuaries, bays and harbors, and ground water, and land development, urban runoff, and habitat modifications are the leading sources of lake degradation.

Programs to Correct Impairments

As a result of toxicity test results, rice growers cooperated with the California Department of Food and Agriculture and modified rice cultivation practices. Improved pesticide management practices developed by the California Department of Pesticide Regulation and overseen by the Central Valley Regional Water Board decreased rice pesticide concentrations in the City of Sacramento's water supply by 99.5 percent.

Programs to Assess Water Quality and Program Effectiveness

Toxicity testing plays a central role in California's three Water Quality Control Plans, which establish standards for all surface waters in the State. The toxicity standards set minimum survival rates for test species exposed to test waters for acute (short-term) and chronic (long-term) periods. Currently, the State and Regional Water Boards are investigating toxicity testing protocols for nonpoint sources of water pollution in three major agricultural regions: the Sacramento Valley, the San Joaquin Valley, and the Imperial Valley. The Sacramento Valley study identified rice field pesticides as a source of toxicity in agricultural discharges to the Sacramento River and Delta.

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Colorado

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	27,195 mi	84%	3%	4%	8%
Lakes	143,140 ac	85%	8%	7%	<1%
Wetlands	60 ac	100%	—	—	—

Causes and Sources of Water Quality Impairments

Metals are the most common pollutant identified in Colorado rivers not supporting designated uses. Agriculture and resource extraction are the leading sources impacting rivers. In lakes, nutrients and metals cause most impairments and major sources are agriculture, construction runoff, industrial discharges, and municipal discharges. Many of Colorado's shallow, unconfined aquifers are contaminated with nitrates and salts resulting from agricultural activities.

Programs to Correct Impairments

Water quality management in Colorado has evolved from a technology-based program into a program that relates specific control actions to water quality problems. Program goals focus on measurable improvements or maintenance of existing water quality. The State is giving more attention to nonpoint source pollution controls where it can be shown that stream standards will not be attained by additional point source controls at reasonable cost levels. Colorado's nonpoint source program provides education and supports watershed programs to restore water quality and demonstrate nonpoint source treatment techniques.

In 1990, the Colorado Legislature passed an agricultural chemicals ground water protection act (Senate Bill 126). The Act will be implemented by the Colorado Department of Agriculture with fees collected on fertilizer and agricultural chemical sales. The Department of Health will monitor ground water and the Colorado Extension Service will conduct education programs. If monitoring reveals ground water contamination, the Commissioner of Agriculture may designate an agricultural management area and initiate a tiered approach to solving the problem. The first tier consists of voluntary implementation of best management practices (BMPs). If BMP implementation fails to correct the ground water problem, mandatory rules and regulations may be developed.

Programs to Assess Water Quality and Program Effectiveness

In Colorado, 9,315 stream miles have been, or are being, routinely monitored. At least seven lakes have long-term monitoring programs that sample nutrients and other trophic state indicators.

Currently, Colorado lacks comprehensive data on ground water contamination. The Ground Water Unit is addressing the problem by developing a comprehensive ground water quality database that will contain data on organic and inorganic chemical concentrations, radionuclides, and agricultural chemicals. The State is collecting additional data on agricultural chemicals in ground water under several programs. In 1992, the State sampled 100 wells in the South Platte River Valley. Permanent wells will be established where ground water problems are identified, forming a statewide network. A Section 319 nonpoint source (NPS) grant supports additional ground water monitoring in agricultural areas. The program will provide background data and identify aquifers vulnerable to contamination by agricultural chemicals.

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Connecticut

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	893 mi	41%	20%	31%	8%
Lakes	43,407 ac	76%	11%	13%	—
Estuaries	600 mi^2	60%	<1%	39%	1%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 11% of river miles, 52% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Estuarine waters are primarily impacted by nutrients and indicator bacteria, with lesser impacts from conventional organic pollutants. The dominant sources of pollutants are: municipal sewage treatment plants, urban runoff, CSOs, in-place contaminants and agricultural activities. Rivers and streams are impacted by a combination of conventional organic and inorganic pollutants, toxics, indicator bacteria, nutrients, and associated dissolved oxygen problems. The dominant sources of pollutants are: municipal and industrial point sources, CSOs, in-place contaminants, and a variety of nonpoint sources. Lake water quality is primarily impacted by excessive nutrient loads associated with noxious plant growth and priority organics. The dominant sources of pollutants are: nonpoint sources, in-place contaminants, and municipal sewage treatment plants.

Programs to Correct Impairments

The State Clean Water Fund was created to address the costs of municipal sewage treatment plant upgrading and CSO abatement. The State NPDES program is streamlining and addressing discharge toxicity issues in accordance with revisions to State water quality standards. The State is designating significant resources to and has expanded the Clean Water Fund to include nonpoint source pollution control strategies.

Programs to Assess Water Quality and Program Effectiveness

Physical/chemical monitoring is conducted both in cooperation with the USGS ambient monitoring program and with specific State programs including: intensive surveys, ambient toxicity monitoring, and specific water quality surveys as needed. Ambient biological monitoring is conducted to assess biological community viability, and bioaccumulation monitoring is conducted for a variety of pollutants. The State participates in the Long Island Sound Study monitoring water quality trends and finfish population. In addition, the State compiles water quality data from other State agencies, local authorities, and water supply utilities.

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Delaware

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	802 mi	11%	1%	6%	82%
Lakes	2,805 ac	22%	8%	32%	38%
Estuaries	29 mi^2	—	—	—	100%
Oceans	25 mi	100%	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 25% of river miles, 73% of lake acres, 35% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Bacteria, nutrients, and toxics impact surface water quality in Delaware. Bacteria concentrations exceed swimming criteria at 93% of assessed rivers, 63% of assessed lake waters, and 70% of estuarine waters (excluding the Delaware River and Bay). Inadequately treated sewage from onsite systems and municipal treatment plants are of most concern. Industrial point sources are the major source of elevated zinc and copper concentrations. Nutrient contamination impairs 77% of rivers, 67% of lake waters, and 100% of estuarine waters (excluding the Delaware River and Bay). Primary sources of nutrients include agricultural runoff, municipal wastewater treatment plants, food processing plant discharges, and urban runoff.

Programs to Correct Impairments

The Delaware Department of Natural Resources and Environmental Control (DNREC) adopted a watershed approach for assessing and managing water quality. The watershed approach enables the DNREC to evaluate all pollutant sources impacting a waterbody and to determine the most effective and efficient methods for protecting water quality or abating existing problems. In 1991, DNERC also initiated the Sediment Control and Stormwater Management Program to prevent existing flooding and water quality problems from worsening. The four components of the program are:
(1) sediment control and stormwater management plan approval;
(2) inspections during construction;
(3) post-construction inspection of permanent stormwater facilities; and
(4) education and training.

Programs to Assess Water Quality and Program Effectiveness

The DNREC will conduct intensive surveys in the priority watersheds targeted for initial implementation of the watershed approach. The surveys integrate water quality sampling with hydrodynamic and hydrologic studies to determine pollutant mass loadings and transport.

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Delaware River Basin Commission

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	206 mi	—	100%	—	—
Lakes	NA	NA	NA	NA	NA
Estuaries	216 mi²	—	100%	—	—
Oceans	NA	NA	NA	NA	NA
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles and 28% of estuary square miles.
NA = Not applicable.
— None or not reported.

Causes and Sources of Water Quality Impairments

Fish consumption use is not supported on 5.6 miles of the Delaware River and 22 square miles of the Delaware Estuary due to a fish advisory restricting consumption of fish contaminated with chlordane and PCBs. Forty-two square miles of Delaware Bay do not support shellfishing use because elevated concentrations of pathogen indicators restrict harvests. An area of acute toxicity also extends from the Bucks/Philadelphia County boundary downstream to the mouth of the Schuylkill River.

Programs to Correct Impairments

In 1991, the Commission initiated a special study to develop a comprehensive combined sewer overflow (CSO) assessment and control strategy for the Delaware Estuary. Combined sewers remain one of the last largely uncontrolled sources of water pollutants in the estuary. The 2-year study will determine critical flows, loadings, and impacts from the four CSOs discharging into the estuary. The study will also evaluate and model CSO functional designs and real-time operations. Surrounding land use patterns will be determined to estimate nonpoint source wasteloads. The study will estimate conventional and nonconventional pollutant impacts with several hydraulic and surface water quality models. Upon completion of the model studies, the Commission will evaluate alternative control strategies.

Programs to Assess Water Quality and Program Effectiveness

The Commission and the cooperating States initiated the Delaware Estuary Toxics Management Program in 1989 to control toxic substances discharged from point sources. During 1990, the cooperators established a toxics database to track the occurrence and magnitude of toxic pollutants in wastewater discharges, ambient waters, and sediments. The cooperators will use the database to establish water quality criteria for toxics.

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District of Columbia

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	39 mi	—	—	9%	91%
Lakes	238 ac	—	—	—	100%
Estuaries	6 mi²	—	—	—	100%
Wetlands	—	—	—	—	—

*Totals represent 21% of river miles, 100% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Elevated fecal coliform bacteria concentrations impair contact recreation uses in most district waters. Metals are a concern, especially in the District's smaller streams. Low dissolved oxygen concentrations resulting from organic enrichment impair most of the Anacostia River. Oil and grease, high pH, and priority organics also degrade District waters. The principal source of pollutants is urban runoff from storm sewers, combined sewer overflows, and surface runoff. Wastewater treatment plant effluent discharges are a major source of nutrients in the Potomac Estuary.

Programs to Correct Impairments

The District contracted the Metropolitan Washington Council of Governments (MWCOG) to study the feasibility of charging a fee when developers obtain a stormwater management waiver. Current stormwater regulations require all new development projects to control stormwater runoff with best management practices (BMPs). However, the District finds it difficult to apply traditional BMPs to sites undergoing development or redevelopment in the central city. Most traditional BMPs require more land than is available in the City. As a result, the District waives stormwater regulations at many sites under development. The study will investigate fees and recommend stormwater retrofit projects the District might implement with fees collected in lieu of stormwater management plans.

Programs to Assess Water Quality and Program Effectiveness

During the 1990-1992 reporting period, the District performed a small-scale rapid bioassessment of its tributaries and a land use monitoring project to assess nonpoint source pollutant loadings. The District also performed field sampling of toxics in sediments and planned to monitor effects of urban best management practices in 1992.

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Florida

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	7,933 mi	64%	3%	23%	10%
Lakes	957,120 ac	31%	1%	56%	12%
Estuaries	2,730 mi²	62%	1%	32%	6%
Oceans	902 mi	95%	—	4%	1%
Wetlands	—	—	—	—	—

*Totals represent 15% of river miles, 46% of lake acres, 64% of estuary square miles, and 11% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Many of the problems in Florida's surface waters can be attributed to industrial discharges and sources associated with residential development. Other important sources include agricultural runoff, domestic wastewater, and hydrologic modifications (including dam construction, channelization, dredging, and draining). Major sources of ground water contamination are underground storage tanks, agricultural activities, landfills, and septic tanks. Three agricultural chemicals (aldicarb, alachlor, and ethylene dibromide) have caused local and regional contamination problems. Other pollutants of concern include nitrates, petroleum products, and hazardous wastes.

Programs to Correct Impairments

In addition to controlling discharges with standard permit programs, Florida is pursuing reuse of wastewater discharges, primarily for irrigation use, and the use of wetlands for advanced treatment of wastewater plant discharges. Florida's Stormwater rule is the core of Florida's nonpoint source program. Regulations require all new developments to retain the first inch of runoff water in ponds to remove, theoretically, 80% to 90% of the sediment carried in the runoff. However, these rules are difficult to monitor and enforce.

Programs to Assess Water Quality and Program Effectiveness

During the reporting period, Florida planned to revise its biocriteria and initiated projects to develop freshwater macroinvertebrate sampling protocols and to refine the delineation of ecoregions in Florida. The State will conduct biological and chemical sampling at proposed ecoregion reference sites during wet and dry periods to determine the best quality invertebrate community present for the representative habitat and water chemistry.

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Georgia

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	4,054 mi	29%	—	32%	39%
Lakes	394,802 ac	90%	—	7%	2%
Estuaries	854 mi²	53%	—	—	47%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 6% of river miles, 94% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Pathogens and metals are major causes of impairments in rivers, lakes, and estuaries. Pesticides and pH also affect many lakes, and low concentrations of dissolved oxygen persist in estuarine waters. Industrial and municipal point sources, urban runoff, storm sewers, and industrial nonpoint sources generate most pollutants.

Programs to Correct Impairments

The Georgia Environmental Protection Division (EPD) pays significant attention to compliance and enforcement activities. During the reporting period, EPD issued 139 orders to municipalities for violations of NPDES permit requirements, collected $456,744 in related civil penalties, and imposed sewer connection bans on 42 municipalities. During the same period, DER issued 65 legal orders to industries for improperly treated discharges and collected $412,440 in related penalties. EPD issued 17 additional orders to private discharges and assessed their fines at $28,050. In addition, EPD issued 12 orders to resolve erosion and sedimentation problems and fined violators $41,000. Another 12 orders and fines of $65,000 resulted from investigations of hazardous spills.

Programs to Assess Water Quality and Program Effectiveness

During the reporting period, EPD added 16 sampling stations to the fixed station trend monitoring network, raising the number of sites to 145 stations. EPD conducted 26 intensive surveys of rivers, lakes, and estuaries and performed more than 600 compliance inspections of wastewater plant discharges. The State also performs aquatic toxicity testing to identify discharges that may require additional controls to eliminate toxic effects.

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Gila River Indian Community

For a copy of the Gila River Indian Community 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	196 mi	—	—	31%	69%
Lakes	153 ac	—	—	18%	82%
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles and 100% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

The Water Quality Planning Office suspects that rangeland management, agriculture, and upstream mining are the source of turbidity and siltation, salinity, and metals loading in the Gila River. Pathogens from onsite sewage disposal were detected in ground water and are the primary public health concern in the community. Other concerns include salinity and pesticides from large-scale agriculture and the limited potential for fuel and solvent leaks.

Programs to Correct Impairments

The Community's Water Quality Planning Office initiated a water quality control program by applying for Federal funding of a Wellhead Protection Strategy study. The proposed Wellhead Protection Strategy would identify the Community's most vulnerable water supplies and define a point source control program for wellhead protection areas. Point source controls will eliminate discharges that could reach ground water or provide incentives for rapid mitigation in cases where ground water is contaminated. The community needs funding to address existing pollution and potential degradation resulting from growth in the adjacent Phoenix metropolitan area and a planned large-scale expansion of agricultural activity on Community lands.

Programs to Assess Water Quality and Program Effectiveness

The Gila River Indian Community currently participates in a small-scale joint surface water monitoring effort with the Arizona Department of Environmental Quality (ADEQ). The program collects grab samples during runoff events in the Gila River to assess potential sulfate impacts from upstream mining operations. To assess overall water quality, the Community needs to establish quarterly sampling at sites on the Gila River, Thawnc Lake, and other ponds and ephemeral streams. The Community's Water Quality Planning Office has developed a ground water monitoring program consisting of 35 wells. Sampling from this program will establish the first comprehensive and reliable data set on ground water quality for the Community.

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Hawaii

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	105 mi	52%	48%	—	—
Lakes	—	—	—	—	—
Estuaries	874 mi²	86%	12%	<1%	2%
Oceans	773 mi	81%	5%	3%	10%
Wetlands	51,802 ac	70%	30%	—	—

*Totals represent 42% of river miles, 100% of estuary square miles, 99% of ocean miles, and 100% of wetlands acres.

— None or not reported.

Causes and Sources of Water Quality Impairments

Degradation of Hawaii's waters occurs mainly in urban, populated areas. Nonpoint sources such as agricultural, industrial and urban runoff generate the largest amount of damage to the water quality of streams, rivers, estuaries and coastal waters. Impacts from nonpoint sources are especially high during the wet seasons when runoff increases significantly. Pesticide percolation is considered to be the most important source of ground water contamination.

Programs to Correct Impairments

In order to control soil erosion and sediment, county governments are required to enact ordinances which set erosion control standards for various types of soil and land uses. These ordinances also include criteria, techniques, and methods for control of erosion and sediment problems caused by land-disturbing activities. The State would like to enact ordinances that require the rating of pesticides on their potential to migrate through soil and into ground water. The use of pesticides that pose a threat to ground water quality would be prohibited. Until more stringent ordinances can be enacted, the State recommends using alternatives to pesticides, such as natural predators of pests or other biological controls. Also encouraged is the use of low-toxicity, degradable, nonpersistent chemicals for home gardens, landscaping, and golf courses.

Programs to Assess Water Quality and Program Effectiveness

The State and EPA jointly monitor priority pollutants in water, sediment, fish, and shellfish samples collected at sites with a high potential for toxic contamination as well as at recreationally important areas. The State is also concerned about the uncertainty associated with bacterial indicators of human fecal contamination.

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Idaho

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	12,987 mi	5%	3%	66%	26%
Lakes	418,529 ac	—	57%	9%	34%
Wetlands	—	—	—	—	—

*Totals represent 11% of river miles and 81% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Point sources impact only 7% of Idaho's surface waters, but nonpoint sources impair 57% of the State's surface waters. Agriculture, including grazing, has the greatest impact on rivers and streams, followed by road construction and maintenance, forest practices, and mining. The extent of impacts by these activities varies by region. Urban runoff, land disposal, and hydrologic modification also impact lakes.

Fine sediments, channel alteration, nutrients, elevated temperatures, acid mine drainage, vegetation removal, streambank destabilization, low dissolved oxygen concentrations, and organic loading impair aquatic life in Idaho's waters. Recreational uses are impaired by bacteria and hydrologic modification. Bacteria, radionuclides, inorganic compounds, volatile organic compounds, and turbidity impair drinking water supply uses.

Programs to Correct Impairments

The Idaho Forest Practices Act contains approved best management practices (BMPs) for controlling water quality impacts from forest practices. These mandatory BMPs are approved in the State Water Quality Standards. New staff positions recently increased forestry BMP inspection, education, and enforcement activities.

Programs to Assess Water Quality and Program Effectiveness

The BMP Feedback Loop features onsite and in-stream monitoring to evaluate the effectiveness of implemented agricultural BMPs. The BMPs are modified through a public participation process if monitoring indicates that BMPs are not protecting beneficial uses. The Forest Practices Water Quality Management Plan also sponsors monitoring to determine the effectiveness of forestry BMPs.

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Illinois

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	13,980 mi	42%	2%	54%	1%
Lakes	206,081 ac	1%	8%	50%	41%
Great Lakes	63 mi	—	100%	—	—
Wetlands	—	—	—	—	—

*Totals represent 40% of river miles, 67% of lake acres, and 100% of Great Lakes shore miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Nutrients, siltation, organic enrichment and dissolved oxygen deficiencies, habitat/flow alteration, ammonia, metals, and suspended solids cause most impairments in Illinois. The sources of pollution most impacting Illinois waters include agriculture (primarily row crop production), in-place contaminants deposited on sediments, hydrologic/habitat modification, resource extraction, urban runoff, atmospheric depositions, and municipal point sources.

Programs to Correct Impairments

Illinois Environmental Protection Agency (IEPA) documents such as *Surface Water Monitoring Strategy*, *Water Pollution Control Program Plan – FY92*, and the *Illinois Water Quality Management Plan* (WQMP) detail the numerous surface water pollution control and monitoring programs of the agency for both point and nonpoint source control programs. Point source control program activities include Monitoring, Planning, Permitting, Financial Assistance Administration, Compliance Assurance, and Program Management. Current nonpoint source programs are built on the original recommendations of the WQMP, which includes, but is not limited to, the *State Nonpoint Source Management Program Report* and the *State Nonpoint Source Assessment Report*.

Programs to Assess Water Quality and Program Effectiveness

The IEPA conducts a wide variety of surface water monitoring programs that are designed to assess water quality and program effectiveness. Surface water monitoring programs include a Toxicity Testing Program, Ambient Water Quality Monitoring Network (streams), Pesticide Monitoring Subnetwork, Industrial Solvents Subnetwork, Facility-Related Stream Survey Program, Intensive River Basin Surveys Program, Ambient Lake Monitoring Program, Volunteer Lake Monitoring Program, Lake Water Quality Assessment Grant Program, Lake Michigan Survey Program, and the Fish Contaminant Monitoring Program.

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Indiana

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	6,849 mi	70%	6%	5%	19%
Lakes	102,096 ac	100%	—	<1%	<1%
Great Lakes	43 mi	—	—	100%	—
Wetlands	—	—	—	—	—

[a]Totals represent 19% of river miles, 71% of lake acres, and 100% of Great Lakes shore miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

The major causes of use impairment are bacteria, organic enrichment, pesticides, priority organic compounds, and ammonia. The sources of substances most often contributing to nonsupport of uses are industrial and municipal point sources, combined sewer overflows, and agricultural nonpoint sources. Impacts due to nonpoint sources are considered major. Nitrates, volatile organic chemicals, and heavy metals are most commonly detected in drinking water wells. The most commonly reported sources of ground water contaminants include hazardous material spills, underground storage tanks, and waste disposal activities.

Programs to Correct Impairments

Indiana's T-by-2000 program is a State-funded initiative aimed at reducing erosion on each acre of land to its tolerable (T) limit (at which crop productivity is not impaired) and controlling all offsite sedimentation using best practical technology. The program sponsors soil conservation education, agricultural and urban erosion control technical assistance, cropland erosion control cost-sharing, and lake enhancement projects.

Programs to Assess Water Quality and Program Effectiveness

Until EPA issues sediment criteria, Indiana will continue to identify areas of toxic concern by comparing sediment data with maximum background concentrations of toxic pollutants. The State derived background concentrations of toxicants from sediment samples collected at 86 background sites located upstream of known point source discharges. Toxicant concentrations exceeding 100 times the background concentrations merit high concern. A contaminant concentration of 10 to 100 times the background concentration merits medium concern. During the 1990-1992 reporting cycle, pesticides, PCBs, and metals in fish and sediment were detected at medium to high levels of concern in 35% of the monitored stream miles. Only 3% of the monitored inland lakes exhibited toxic levels of concern in sediments.

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Iowa

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	9,983 mi	—	5%	91%	4%
Lakes	48,730 ac	3%	48%	47%	2%
Wetlands	26,489 ac	4%	31%	52%	14%

*Totals represent 12% of river miles, 60% of lake acres, and 72% of wetlands acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

The failure of assessed waterbodies of all types to fully support their designated uses is attributed primarily to sediment and nutrients from nonpoint sources of pollution. Point sources, however, impact approximately 5% of the stream miles assessed and toxics impair the Red Rock Reservoir.

Programs to Correct Impairments

Iowa's Resources Enhancement and Protection (REAP) Program represents a major new initiative to protect and enhance Iowa's natural resources. The REAP fund supports various conservation activities, including soil and water enhancements. The Iowa Division of Soil Conservation (DSC) and the County Soil and Conservation Districts implement the Water Protection Program and the Water Protection Practices Program with REAP funding. In 1991, the REAP Act provided almost $2 million for Water Protection Program projects and Water Protection Practices. The DSC adopted rules for administering the Water Protection Practices Program in 1990, which include the following provisions:

- Districts must designate high-priority watersheds or water quality problems targeted for funding and the State Soil Conservation Committee must approve the priority designations
- Cost-share (up to 75%) will be available for best management practices ignored by previous programs, such as planting critical areas, grass strips, field borders, filter strips, and pasture and hay lands.

The Prairie Pothole Joint Venture program is reversing the previous trend of wetlands destruction in Iowa. The program purchases and restores wetlands with funds provided by State agencies, Federal agencies, and county and private organizations. During 1990 and 1991, the program purchased almost 5,000 acres of wetlands and surrounding uplands and restored almost 1,300 acres of wetlands in 288 basins.

Programs to Assess Water Quality and Program Effectiveness

Since the 1970s, Iowa's Department of Natural Resources (DNR) has collected data from fixed-station water quality monitoring sites (sampled monthly or quarterly), from DNR-sponsored special studies, and from monitoring programs conducted by other agencies. The State's surface water monitoring strategy was revised in 1990, but no major changes were made in DNR's monitoring network.

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Kansas

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Topeka, KS 66620
(913) 296-5575

1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable
Rivers	17,103 mi	3%	—	2%	45%	50%
Lakes	172,129 ac	<1%	2%	92%	5%	—
Wetlands	34,256 ac	—	—	100%	—	—

*Totals represent 13% of river miles, 100% of lake acres, and 100% of wetlands acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Pathogens, metals, salinity, and suspended solids are the major causes of use impairment in Kansas streams. These contaminants enter streams via agricultural runoff, sewage treatment plant discharges, and other point sources. Agricultural activities generate most of the pesticides and nutrients degrading lake water quality. Flow alterations resulting from agricultural activities and hydromodifications are responsible for impairments in assessed wetlands. The most significant sources of ground water contamination are underground storage tanks and oil and gas operations (excluding injection wells).

Programs to Correct Impairments

Kansas' Nonpoint Source Pollution Control Program assumes that nonpoint source (NPS) pollution threatens all of Kansas' water resources and that NPS controls must be implemented to reverse existing damage and prevent future water quality degradation. The program consists of four components. The **Certification Unit** reviews and certifies local NPS Pollution Management Plans and Project Plans and reviews Federal, State, and local projects for consistency with State water quality standards and the NPS Pollution Control Program. The **Local Environmental Protection Unit** provides funding to local governments to prepare and implement Local Environmental Protection Plans, which include a subdivision and wastewater management plan, public water supply plan, and an NPS control plan. The **Technical Assistance Unit** develops and administers demonstration projects, helps local health departments and conservation districts prepare plans, and maintains a Catalog of NPS Control Practices. The **Information and Education Unit** produces several newsletters, fact sheets, and displays.

Programs to Assess Water Quality and Program Effectiveness

In 1990, the Kansas Department of Health and Environment added NPS assessment sites to the ambient stream chemistry network. NPS monitoring sites now constitute 58% of the 277 sampling stations in the network.

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Kentucky

For a copy of the Kentucky 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	9,737 mi	67%	1%	10%	22%
Lakes	214,962 ac	47%	44%	6%	3%
Wetlands	—	—	—	—	—

*Totals represent 11% of river miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Fecal coliforms cause most impairments of swimming use in rivers, while siltation and organic enrichment impair aquatic life use in rivers. The sources impairing the largest number of stream miles include municipal wastewater treatment plants, agricultural activities, and resource extraction. Nutrients, primarily from agricultural runoff and municipal discharges, were the greatest cause of impairment in lakes. Iron and manganese also impaired domestic water supply use in many lakes. The Commonwealth considers underground storage tanks, septic tanks, abandoned hazardous waste sites, agricultural activities, and landfills to be the leading sources of ground water contamination.

Programs to Correct Impairments

In 1988, the Commonwealth of Kentucky integrated whole-effluent toxicity (WET) limits with traditional chemical limits in discharge permits issued to industrial facilities and municipal wastewater treatment plants. The Commonwealth set WET limits for both acute and chronic toxicity based on case-by-case evaluations of the discharge type and volume, and the characteristics of the receiving waterbody. By the end of 1991, 77 municipal and 35 industrial discharge permits required WET monitoring. Initially, these facilities submit monthly WET test results for 1 year after which tests are performed quarterly. A facility must undertake a toxicity reduction evaluation following two consecutive failures of a single concentration "screen" test. As a result of the program, five dischargers are changing plant operations, five dischargers are making plant improvements, and four dischargers are constructing new treatment plants to reduce effluent toxicity.

Programs to Assess Water Quality and Program Effectiveness

Kentucky implemented several long-term studies to determine nonpoint source impacts and demonstrate water quality improvements from best management practices, including a joint project with the State of Tennessee to correct mine drainage problems in the Bear Creek watershed.

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Louisiana

For a copy of the Louisiana 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable
Rivers	9,089 mi	26%	21%	37%	16%	—
Lakes	612,288 ac	42%	7%	51%	<1%	<1%
Estuaries	4,943 mi²	29%	53%	17%	<1%	—
Oceans	—	—	—	—	—	—
Wetlands	—	—	—	—	—	

*Totals represent 14% of river miles, 57% of lake acres, and 65% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

The most frequently cited pollutants causing impairments are pathogen indicators, nutrients, organic enrichment and low dissolved oxygen concentrations, and oil and grease. Most estuaries are impaired by high bacterial counts that force the State to close oyster harvesting areas. The most commonly cited sources of pollutants impacting the assessed waterbodies are agricultural runoff, discharges and spills from petroleum activities, urban runoff, industrial point sources, and inadequately treated sewage discharges from municipalities. Although the quality of the State's major ground water aquifer remains excellent, the State is concerned about threats to shallow aquifers and the water-bearing zones that contribute significantly to the deeper aquifers.

Programs to Correct Impairments

In 1989, the Louisiana State Legislature created the Lake Pontchartrain Basin Foundation, a nonprofit organization that brings together scientists, citizens, and politicians to reverse the shoreline erosion, loss of marshes, and reduction in fisheries accelerated by urban runoff and shell dredging. To date, the Foundation has sponsored educational projects with funding from the Greater New Orleans Expressway Commission and private donations.

Programs to Assess Water Quality and Program Effectiveness

The State's water pollution control program relies heavily on strong water quality standards. During 1989 and 1991, the State adopted numerical criteria for toxic substances including several priority organics and metals. Currently, the State is revising its bacteriological criteria and is considering biological criteria for all waters.

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Maine

For a copy of the Maine 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	31,672 mi	98%	—	1%	1%
Lakes	958,389 ac	73%	6%	21%	—
Estuaries	1,633 mi²	90%	—	2%	8%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles, 97% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

In Maine, priority pollutants (most notably dioxin) cause the most significant nonattainment in major rivers. In other riverine waters, oxygen deficits due to organic enrichment and bacteria are the most significant causes of impairment. Nonpoint sources generate most of the organic enrichment while municipal point sources, onsite wastewater treatment, and untreated discharges are the primary sources of pathogenic indicators. The most significant cause of nonattainment in Maine lakes is organic enrichment from nonpoint sources of pollution, such as urban runoff, agriculture, and silviculture. Pathogenic indicators from municipal point sources are the most significant cause of nonattainment in estuarine and coastal waters. The greatest threat to Maine's ground water is leaking underground storage tanks.

Programs to Correct Impairments

The State issued fish consumption advisories for major rivers due to elevated concentrations of dioxin detected in fish tissue samples. Maine is working with the Kraft pulp and paper mills to reduce dioxin concentrations in their discharges. As a result, Maine restored the fully supporting status of 20 river miles that were previously contaminated by dioxin.

Programs to Assess Water Quality and Program Effectiveness

The Maine Department of Environmental Protection (DEP) is concerned about possible mercury contamination from nonpoint sources. Occasionally, samples of older lake trout caught in inland waters lacking point sources exceed FDA standards for mercury. The DEP plans additional ambient fish tissue sampling during the next 2 years.

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Maryland

For a copy of the Maryland 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	17,000 mi	92%	—	7%	<1%
Lakes	21,001 ac	77%	4%	19%	<1%
Estuaries	2,522 mi²	—	4%	93%	3%
Oceans	—	99%	1%	—	—
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles, 27% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Overall, Maryland's surface waters are in good condition, but recreational bathing, shellfish harvesting, and consumption of certain fish species are restricted or prohibited in some areas. The most serious water quality problem in Maryland is the continuing accumulation of nutrients in estuaries and lakes. Excess nutrients from agricultural, urban, and natural runoff, as well as point sources, result in algal blooms and low dissolved oxygen concentrations in lakes and tidal embayments. The impacts affect water supplies, recreational activities, and limit habitat for aquatic plants and animals.

Locally high sediment levels affect all of the State's surface waters. Sources of sediment include agricultural and urban runoff, construction activities, natural erosion, dredging, forestry, and mining operations. Other State concerns include high bacteria levels found in all water types, toxic contaminants in sediments and fish tissues in selected urban areas, and acidic waters from acid mine drainage in western Maryland.

Programs to Correct Impairments

In 1989, the State issued a fish consumption advisory in a portion of the Potomac River in western Maryland due to elevated concentrations of dioxin identified in several fish species. The Kraft-process paper mill identified as the source of the dioxin changed its treatment process, reductions in dioxin levels in fish tissue samples were observed, and this advisory was modified to address only two fish species. A Targeted Watershed Program was implemented at several sites to demonstrate how an interagency approach can be used to identify and solve water pollution problems. Nonpoint source pollution control programs affect most of the State's citizens to some degree and range from shoreline protection and development regulations to implementation of agricultural and construction BMPs to educational efforts. Efforts to improve wastewater treatment plant performance through capital improvements and enhanced operator training have resulted in very high levels of compliance (greater than 95%) at major wastewater facilities in Maryland during the past 2 years.

Programs to Assess Water Quality and Program Effectiveness

Maryland's diverse and extensive water quality and aquatic resource monitoring programs are reviewed periodically and revised to incorporate newer technologies and sampling strategies. The Chesapeake Bay Monitoring Program monitors water quality, sediment, and aquatic resources intensively to document nutrient trends in the Bay and calculate pollutant loads from significant river systems. In 1990, the State initiated a biological assessment program using EPA-sanctioned rapid bioassessment protocols at almost 400 stream sites throughout the State. The State also modified its fish tissue and shellfish monitoring programs to enhance efficiency and respond to the analytical needs of each program.

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Massachusetts

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	1,571 mi	39%	—	17%	44%
Lakes[b]	21,247 ac	38%	—	55%	7%
Estuaries	223 mi²	30%	—	10%	60%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

[a]Totals represent 18% of river miles, 14% of lake acres, and 100% of estuary square miles.
[b]Excludes Quabbin Reservoir which covers 53% of the State's lake surface area. The entire Quabbin Reservoir does not support its designated uses because of a fish consumption advisory based on elevated mercury levels in fish tissues.
— None or not reported.

Causes and Sources of Water Quality Impairments

Pathogens impair the most miles of rivers and streams, followed by priority organics, and nutrients. Urban runoff/storm sewers are the predominant source of contamination in rivers and streams, followed by septic systems and in-place contaminants. Major causes of nonattainment in lakes include excessive aquatic plant growth, nutrients, organic enrichment, and exotic species. The major sources of lake water quality impairments are unknown. Stormwater runoff and combined sewer overflows generate the pathogenic contamination that impairs most estuarine waters. Estuaries also suffer from unionized ammonia and low dissolved oxygen concentrations. Organic pollutants appear most often in contaminated public ground water supplies.

Programs to Correct Impairments

Recent State legislation will provide funds for a revolving loan program to cities and towns for the correction of combined sewer overflows and the construction of wastewater treatment facilities. Local sources of funding to repay the loans and to finance nonfundable projects will be increased through higher use fees and other financial arrangements. DEP has established a Nonpoint Source Program. Currently, 14 demonstration projects are being funded with Section 319 funds in the State. DEP is developing a watershed based planning approach for regulation and monitoring of water quality.

Programs to Assess Water Quality and Program Effectiveness

DEP has ongoing surface water quality and assessment programs including wastewater discharge evaluations, river monitoring, lake monitoring, and coastal monitoring. In addition to water chemistry, there is a biomonitoring program including macroinvertebrate analysis, bioaccumulation studies, and toxicity testing. DEP has a joint surface water discharge permit program with EPA. The permits contain effluent limits for various parameters and monitoring requirements necessary to achieve compliance with water quality standards.

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Michigan

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened[b]	Partially Supporting[b]	Not Supporting
Rivers	22,590 mi	94%	—	—	6%
Lakes	490,455 ac	95%	—	—	5%
Great Lakes	3,288 mi	—	—	—	100%
Wetlands	—	—	—	—	—

[a]Totals represent 40% of river miles, 51% of lake acres, and 100% of Great Lakes shore miles.
[b]Michigan assesses its waters as either fully supporting their designated uses or not supporting their designated uses. Michigan does not recognize threatened and partially supporting categories of use support.
— None or not reported.

Causes and Sources of Water Quality Impairments

Priority organics caused impairments in more river miles than any other cause, followed by heavy metals and siltation/sedimentation. The State identified agriculture-related nonpoint sources as the most common source of river impairments. Heavy metals, priority organics, and dissolved oxygen depletion had the greatest impact on inland lakes. Point sources were the leading source of impairment in lakes. All Michigan waters in the Great Lakes failed to support designated uses because of elevated PCB concentrations in water and fish tissue samples. Sources of contamination include atmospheric deposition and in-place contamination (e.g., sediments contaminated by discontinued industrial discharges). The largest number of ground water contamination incidents are associated with underground storage tanks, surface discharges, and landfills.

Programs to Correct Impairments

The Watershed Demonstration Program is the major focus of nonpoint source control efforts in Michigan. The program facilitates interagency cooperation to improve water quality in specific watersheds and ensures that limited resources are directed to the highest priority areas. Most of the funded watershed projects combine streambank stabilization techniques with soil erosion controls and animal waste best management practices to reduce sedimentation and nutrient loading in waterbodies.

Programs to Assess Water Quality and Program Effectiveness

Michigan is pursuing a sediment assessment protocol that combines biological field surveys with chemical and physical analysis of sediments and sediment toxicity testing. The State will not incorporate sediment bioassay tests into an assessment program until further work validates toxicity test results in the field and defines the relationship between laboratory test results and instream responses.

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Minnesota

For a copy of the Minnesota 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	4,634 mi	23%	—	25%	52%
Lakes	2,882,818 ac	11%	6%	76%	7%
Great Lakes	272 mi	—	—	—	100%
Wetlands	—	—	—	—	—

[a]Totals represent 5% of river miles, 88% of lake acres, and 100% of Great Lakes shore miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Minnesota most frequently cites metals, nutrients, and fecal material from nonpoint sources as the causes of impairment in rivers. Pollution in lakes is primarily due to nutrients from agricultural runoff and mercury from atmospheric deposition. Portions of Lake Superior suffer from persistent toxic substances. Data indicate that human activities have introduced volatile organic compounds, pesticides, and nitrate into several important ground water aquifers.

Programs to Correct Impairments

The Minnesota Pollution Control Agency (MPCA) is moving toward integrating surface water monitoring, planning, and management on a watershed basis. Such an approach will focus on interconnections throughout the whole watershed and deal with water pollution problems in a comprehensive manner. Minnesota also intends to strengthen wetland preservation through local implementation of the Wetland Conservation Act of 1991. The Act advocates "no net loss" in the quantity, quality, and biological diversity of Minnesota's existing wetlands. The Act requires developers to avoid impacts where it is prudent and feasible, or replace wetland values where impacts cannot be avoided. The Act also creates a compensation program for permanent easements on high-quality wetlands and provides property tax incentives to landowners enrolling wetlands in preservation banks for 8 years. The State also plans to establish a cost-share program to create and restore wetlands.

Programs to Assess Water Quality and Program Effectiveness

The State tries to locate the source of fish tissue contamination by monitoring sediments in areas where fish tissue samples reveal elevated toxic concentrations. The State would like to pair sediment sampling with routine monitoring performed by dischargers where a toxicity problem is detected. Currently, several municipal wastewater dischargers monitor sediments for pollutants that tend to bioaccumulate.

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Mississippi

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	35,854 mi	6%	4%	88%	2%
Lakes	326,844 ac	47%	18%	35%	<1%
Estuaries	18 mi²	5%	68%	26%	—
Oceans	81 mi	—	12%	88%	—
Wetlands	—	—	—	—	—

*Totals represent 43% of river miles, 65% of lake acres, 14% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Nutrients, pathogens, pesticides, and solids cause major impacts to rivers and streams; pesticides and nutrients cause major impacts on assessed lakes; and metals cause the only significant major impact on estuaries. Agriculture impacts the majority of impaired river miles, followed by industrial and municipal point sources. Major impacts on lakes are also due to agricultural nonpoint sources. Septic tanks contribute to moderate impairments on lakes. Industrial point sources cause major impairments in estuaries. Municipal point sources, urban runoff, and septic tanks cause moderate impairments in estuarine waters and coastal waters.

Programs to Correct Impairments

Currently, Mississippi is implementing 10 nonpoint source (NPS) control projects with funds from Section 319 of the Clean Water Act. The projects provide technical assistance, public education, and agrichemical monitoring and demonstrate the effectiveness of slotted board risers, animal waste spray irrigation systems, constructed wetlands, and other best management practices.

Programs to Assess Water Quality and Program Effectiveness

The Mississippi Office of Pollution Control (OPC) implements an ambient biological integrity program that features annual ambient fish tissue sampling and macroinvertebrate sampling in freshwater and periphyton sampling in estuarine waters. The OPC collects three fish species at selected primary stations and analyzes composite samples for the presence of 27 organic compounds and 7 heavy metals. The OPC protocols include habitat assessment and sampling of every habitat that could be a home for macroinvertebrates. Staff count the number of individuals of each macroinvertebrate species collected to rate species richness and trophic community structure at each site.

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Missouri

For a copy of the Missouri 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	21,015 mi	53%	—	46%	1%
Lakes	287,543 ac	53%	35%	2%	10%
Wetlands	—	—	—	—	—

*Totals represent 18% of river miles and 100% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Siltation, habitat alteration, and water loss cause most impairments in rivers and streams. Channelization has degraded aquatic life habitat in 17 percent of Missouri's streams and the State does not have a program to prevent additional projects to straighten streams. Agriculture is the predominant source of river impairments. Pesticides from agricultural activities cause most lake impairments in the State. Urban runoff and hydrologic/habitat alterations also impair lakes.

Programs to Correct Impairments

The Nonpoint Source (NPS) program staff were very active during 1990 and 1991. The NPS staff generated four new pieces of legislation, participated in 11 public information and education projects, 11 watershed implementation projects, and 8 technical assistance programs. The NPS program focus areas include animal waste management, dead bird composting, inventory and water quality monitoring of NPSs, and fertilizer and pesticide management. The most successful nonpoint source program to date reclaims abandoned coal mine lands. Reclamation projects reduced the number of stream miles seriously impaired by coal mine drainage from 100 miles to 42 miles by October 1991.

Programs to Assess Water Quality and Program Effectiveness

The Missouri Department of Natural Resources (DNR) discontinued ambient chemical monitoring primarily for financial reasons. As a result, some important streams with long historical records are no longer monitored. In contrast, the ambient fish tissue monitoring network grew in recent years. At present, the EPA and Missouri DNR sample fish from 25 sites for a wide variety of toxicants. The Missouri Department of Conservation also analyzes a smaller number of toxicants in approximately 170 fish collected at 60 sites. The expansion of the ambient fish sampling program enables the Missouri Department of Health to specify individual species and waterbody segments affected by fish consumption advisories. Currently, the State recommends limiting consumption of fish caught in 19 waterbodies.

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Montana

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	64,677 mi	74%	5%	19%	2%
Lakes	979,433 ac	38%	14%	46%	2%
Wetlands	—	—	—	—	—

*Totals represent 36% of river miles and 100% of lake acres.

— None or not reported.

Causes and Sources of Water Quality Impairments

Flow alteration, suspended solids, and siltation cause most impairments in rivers and streams. Agricultural sources (crop production and rangeland), streambank destabilization, silviculture, flow modification, and construction impact the most stream miles. Metals, flow alteration, nutrients, suspended solids, noxious aquatic plants, and organic enrichment impair the most lake acres. Agricultural activities and flow regulation are the leading sources of lake impairments. Natural arsenic contamination in much of the State's water remains a concern, and the State is concerned about elevated concentrations of selenium, salts, and other trace elements and pesticides entering wetlands from agricultural and irrigation practices.

Programs to Correct Impairments

The Montana Department of Health and Environmental Sciences, Water Quality Bureau, received an EPA grant for more than $433,000 to fund a Statewide interagency wetlands program. The program's six components will (1) collect existing interagency data and establish a database; (2) monitor 20 water-quality-limited wetlands and 40 least-impacted wetlands and develop wetland biocriteria; (3) develop wetland education programs; (4) implement river corridor management projects; (5) revise the Department of Transportation's wetland protection and mitigation program, develop a system to track wetlands losses and mitigation banking, and monitor mitigation projects to determine effectiveness; and (6) print a Statewide classification and management document for riparian and wetland sites.

Programs to Assess Water Quality and Program Effectiveness

Successful long-term trend analysis has been limited to the Clark Fork River Basin and Flathead Lake. The Clark Fork River has shown improvement during the last several years. Copper concentrations have declined in the headwater reaches and phosphorus concentrations have declined in the lower reaches of the river. Unfortunately, water quality in Flathead Lake has declined as evidenced by increased algal growth.

The State is implementing studies under the Clean Lakes Program that will develop a nutrient balance and determine primary productivity status for Flathead Lake and Swan Lake. A third study will investigate methylmercury and PCBs in fish tissue and sediments as well as trophic status in 20 of the most heavily fished lakes in Montana.

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Nebraska

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	8,061 mi	26%	2%	49%	23%
Lakes	132,948 ac	26%	2%	43%	29%
Wetlands	—	—	—	—	—

*Totals represent 10% of river miles and 87% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Nebraska identified fecal bacteria, pesticides, and flow alteration as major causes of river impairments. Organic enrichment, ammonia, and metals cause moderate or minor impairments. Agriculture, natural sources, and point sources affected the most river miles. Metals, pathogens, suspended solids, and nutrients were the leading cause of impairment in lakes. Municipal point sources and agriculture were the leading sources of lake impairments. Major sources of ground water contamination included agricultural activities, leaking underground storage tanks, septic systems, waste disposal, and industrial facilities. Nitrate contamination, primarily from overfertilization of irrigated land, is the most widespread ground water concern in the State.

Programs to Correct Impairments

The Special Protection Area (SPA) Program authorizes local Natural Resource Districts (NRDs) to regulate activities that may generate nonpoint source contamination in designated ground waters. Designated SPA areas suffer from documented nonpoint source contamination or face a threat from nonpoint sources of pollution. The Nebraska Department of Environmental Conservation (NDEC) conducts detailed studies of proposed SPA sites. The predesignation studies usually include ground water sampling, coring of the vadose zone, and collection of existing data on geology, soils, and land use. At the close of 1991, NDEC had examined eight proposed SPA sites and designated two SPA sites encompassing 482 square miles.

Programs to Assess Water Quality and Program Effectiveness

The Nebraska Department of Health annually monitors nitrate concentrations in samples representing all 1,426 public ground water supplies in the State.

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Nevada

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable
Rivers	1,427 mi	23%	—	23%	50%	3%
Lakes	213,257 ac	62%	—	12%	26%	
Wetlands	36,169 ac	—	—	33%	67%	

*Totals represent 1% of river miles, 38% of lake acres, and 26% of wetlands acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Agricultural practices (specifically irrigation, grazing, and flow regulation) generate the large sediment and nutrient loads impacting the waters of Nevada. Urban drainage systems add nutrients, heavy metals, and organic substances to the load. The State is eliminating point sources where possible and their adverse effects on water quality have been greatly reduced. However, the Las Vegas wastewater treatment plant and low flows resulting from natural drought conditions also impair waters in the State.

Programs to Correct Impairments

The Nevada Nonpoint Source (NPS) Base Program (initiated in 1991) enhances the Nevada NPS Program with new activities that address technical transfer and technical outreach. The new Base Program utilizes existing staff and one new hire to administer new projects.

In 1990, DEP issued two stormwater discharge permits to control runoff from two major urban areas in the State. The first permit was issued jointly to the Cities of Reno and Sparks, Washoe County, and the Nevada Department of Transportation (NDOT). The second permit was issued to the cities of Las Vegas, North Las Vegas, and Henderson, the NDOT, and the Clark County Regional Flood Control District. The permits require monitoring, land use planning, and zoning to address upstream stormwater issues. Wet weather sampling began in 1991.

Programs to Assess Water Quality and Program Effectiveness

As a long-term goal, DEP recommends increased staffing and funding to develop a ground water monitoring network and database. Current activities are fragmented, sporadic, and site-specific. The State would use the monitoring data to assess existing water quality in Nevada's aquifers and inventory sources of known or potential threats to ground water quality.

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New Hampshire

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	10,841 mi	98%	—	1%	1%
Lakes	153,580 ac	85%	6%	6%	3%
Estuaries	28 mi²	34%	—	—	66%
Oceans	18 mi	100%	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles, 100% of lake acres, 100% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Elevated bacteria levels, organic enrichment and depressed oxygen concentrations, nutrients, and siltation cause occasional problems in rivers and streams. The sources of these contaminants are primarily "unknown." Excessive noxious aquatic plants and nutrients from industrial and municipal discharges and "unknown" sources are the main cause of nonattainment of designated uses in reservoirs. Elevated bacteria levels from small point sources and nonpoint sources restrict shellfishing in the coastal bays and estuaries. The major sources of ground water contamination are leaky underground storage tanks, uncontrolled hazardous waste sites, and municipal landfills.

Programs to Correct Impairments

The State drafted a Clean Water Strategy to address the remaining water quality standard violations. The plan proposes to confirm the presence of violations with additional sampling and detect causes and sources with field investigations. The State will take compliance actions to eliminate the sources on a priority basis. Plan implementation relies on EPA funding.

Programs to Assess Water Quality and Program Effectiveness

All point source discharge permits require (or will require) effluent testing for acute toxicity. Some permits will also require chronic toxicity testing depending on the flow limitations of the receiving waters. Some dischargers must also sample surface water toxicity at upstream sites. Approximately 80 percent of the industrial dischargers and 90 percent of the municipal dischargers have been screened for acute toxicity. The State has not detected evidence of in-stream acute toxicity.

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New Jersey

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	1,515 mi	—	73%	15%	12%
Lakes	—	—	—	—	—
Estuaries	614 mi²	72%	—	20%	8%
Oceans	146 mi	73%	—	—	27%
Wetlands	—	—	—	—	—

*Totals represent 23% of river miles, 100% of estuary square miles, and 100% of ocean miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Fecal coliform bacteria, nutrients, depressed dissolved oxygen concentrations, siltation, road salts, and oil and grease cause most water quality impairments in rivers and streams. The most common pollution problems in lakes include nutrients, siltation, depressed dissolved oxygen concentrations, and excess primary productivity. The State cites nonpoint sources (such as stormwater outfalls, construction, urban and agricultural runoff) as the principal source of contaminants in surface waters. However, very little monitoring data exist to quantify the effect of individual nonpoint sources. The most common pollutants detected during ground water pollution investigations include volatile organic compounds, metals, base neutrals, acid extractables, PCBs, and pesticides. Underground storage tanks are most often cited as the source of ground water contamination, followed by landfills, surface spills, and industrial/commercial septic systems.

Programs to Correct Impairments

The New Jersey Department of Environmental Protection and Energy (NJDEPE) developed the Sewage Infrastructure Improvement Act (SIIA) program to address stormwater drainage and combined sewer overflows in the coastal zone. The program provides funds to municipalities to inventory and map their sewer lines, stormwater systems, cross-connections, and interconnections. The municipalities will use the data to develop municipal nonpoint source abatement measures and plans.

Programs to Assess Water Quality and Program Effectiveness

The New Jersey Cooperative Coastal Monitoring Program concluded that 70% of New Jersey's 62 ocean beach closures between 1987 and 1991 could be prevented through implementation of the SIIA program.

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New Mexico

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	3,589 mi	9%	1%	82%	8%
Lakes	143,718 ac	<1%	9%	91%	<1%
Wetlands	—	—	—	—	—

*Totals represent 3% of river miles and 95% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Siltation, metals, and habitat alterations in the riparian zone cause most impairments in rivers and streams. Agricultural sources impair more stream miles and lake acres than any other identified source. Hydrologic modification and recreation impair rivers to a lesser extent. Recreation, spills and silviculture impair significant areas of lakes. The leading causes of impairment in lakes are mercury contamination in fish tissues, siltation, metals, and habitat alterations along shorelines.

Programs to Correct Impairments

New Mexico's ground water protection regulations consist of (1) ground water quality standards and (2) requirements for ground water discharge plans. The ground water discharge plans establish baseline concentrations of contaminants that cannot be exceeded after the discharger begins disposal practices. The dischargers prepare the plans, which must be approved by the New Mexico Environment Department or the Oil Conservation Division. The State approves most plans for a 5-year period, after which the discharger must renew the plan. With enforceable numeric standards, the State ground water discharge plans function like a discharge permit. As of 1991, New Mexico had adopted numeric ground water quality standards for 47 contaminants and narrative criteria for 87 toxic pollutants in ground waters that could serve a beneficial use. The ground water rules apply to wastewater discharges on the surface of the ground as well as subsurface discharges. In addition to municipal sewage plants and industrial facilities, ground water discharge plans regulate dairies, mineral extraction operations, sludge and septage disposal sites, hydrocarbon cleanup operations, and large private sewage treatment systems for trailer parks.

Programs to Assess Water Quality and Program Effectiveness

The ground water discharge plans also specify monitoring schedules to detect standard violations or document compliance with standards.

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New York

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	51,729 mi	93%	3%	6%	<1%
Lakes	730,387 ac	44%	3%	53%	3%
Great Lakes	577 mi	15%	—	85%	—
Estuaries	1,530 mi²	72%	<1%	11%	17%
Oceans	120 mi	50%	—	48%	2%
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles, 100% of lake acres, 100% of Great Lakes shore miles, 100% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Agriculture and hydrologic/habitat modifications are major sources of water quality impairment in New York's rivers, lakes, and reservoirs. Agricultural sources contribute nutrients and silt, which cause turbidity and excessive weed and algae growth. Hydrologic/habitat modifications include activities that alter stream beds or shorelines, such as dredging, filling, and impoundments. Urban runoff is the major nonpoint source of impairment in New York's bays and estuaries. Urban runoff is a source of silt, pathogen indicators, bacteria, petroleum products, heavy metals, and oxygen-demanding substances. Pathogen indicators from urban runoff, point sources, boats, water fowl, and onsite disposal systems caused the State to close 200,000 acres (16 percent) of the shellfish beds in the New York City-Long Island region.

Programs to Correct Impairments

In 1991, New York revised its surface water quality standards and adopted methodologies for developing toxic standards for human health and aquatic life. To date, the State has adopted standards and/or guidance values for nearly 250 toxic substances or groups of toxic substances. These standards and guidance values are the basis for setting effluent limits for discharge permits.

Programs to Assess Water Quality and Program Effectiveness

In 1990 and 1988, the NY State Division of Environmental Conservation (NYSDEC) sampled PCB and aroclor in Hudson River striped bass. The data indicated a spatial decline in average PCB concentrations with increasing distance from the Albany-Troy area. The study also found an overall decline in fish tissue concentrations of total PCB, Aroclor 1254, and Aroclor 1016 between 1980 and 1990.

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North Carolina

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	35,060 mi	37%	34%	24%	5%
Lakes	304,542 ac	70%	21%	9%	<1%
Estuaries	3,122 mi²	87%	4%	9%	<1%
Oceans	—	—	—	—	—
Wetlands	10,307,000 ac	51%	—	25%	24%

*Totals represent 93% of river miles, 100% of lake acres, 100% of estuary square miles, and 100% of wetlands acres.

— None or not reported.

Causes and Sources of Water Quality Impairments

Siltation causes most use impairment in rivers and streams. Agriculture is the leading source of water quality degradation in rivers and streams, followed by urban runoff/storm sewers, and point sources. Excessive nutrient enrichment is the major cause of use impairment in North Carolina lakes. Municipal wastewater treatment plants are the leading source of nutrients in lakes. Gasoline and diesel fuel from leaking underground tanks is the primary cause of ground water contamination.

Programs to Correct Impairments

North Carolina has a number of strong programs to not only correct, but also to prevent, water quality impairments. Several of these include

- A newly initiated Basinwide Management Program that addresses both point and nonpoint source pollution on a watershed basis. This program will cover every basin in the State on a 5-year cycle.
- A Water Supply Protection Program requiring development within water supply watersheds to control stormwater quantity and quality through density restrictions or stormwater treatment devices.
- A substantial Agricultural Cost Share Program ($8 million per year) to reduce sediment, nutrients, pesticides, etc., which contribute to impairment of State waters.
- Recently enacted Animal Waste Management Rules, which mandate Best Management Practices for new and existing confined animal feeding operations.
- An innovative nutrient management strategy involving nutrient trading between point and nonpoint sources in the nutrient-sensitive waters of the Tar-Pamlico River Basin. This strategy provides point sources with the option of meeting nutrient reduction goals either through in-plant reductions or through the funding of agricultural BMPs within the basin.

Programs to Assess Water Quality and Program Effectiveness

North Carolina integrates a wide variety of information to address multiple needs of the water quality program. Data collected from a statewide fixed station chemical/physical monitoring network (AMS) provides baseline long-term information. Intensive water quality characterization studies augment baseline data in predictive modeling for assimilative capacity and wasteload allocation. These surveys include time of travel work, physical/chemical collections, long-term BOD analysis, and in situ sediment oxygen demand measurements. Numerous assessment tools are used in evaluating existing conditions of water quality and biological integrity in-stream. These include macroinvertebrate surveys, fish community structure analyses, phytoplankton analyses, fish tissue analyses, aquatic toxicity tests, and limnological review of lakes and watersheds incorporating many of these tools.

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North Dakota

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	9,172 mi	2%	73%	25%	0%
Lakes	611,074 ac	2%	36%	26%	36%
Wetlands	—	—	—	—	—

*Totals represent 77% of river miles and 99% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Nutrients and siltation, primarily from agricultural runoff, caused most impairments in the State's surface waters. Loss of streamside vegetation, wetlands drainage, and flow regulation also impaired streams. The recent drought, compounded by water management policies for the two mainstem Missouri River reservoirs in the State, Lake Sakakawea and Lake Oahe, impaired approximately 36 percent of the assessed lake acres. The policy implemented during the drought required the State to maintain downstream Missouri River uses (such as municipal water supply and navigation uses) by releasing reservoir waters at the expense of lake uses (such as fishing, recreation, and wildlife habitat). Five percent of the assessed lake acres partially supported designated uses due to periodic fish kills resulting from low dissolved oxygen concentrations caused by the decomposition of organic matter. Major sources of pollution to the State's lakes are agricultural runoff and internal nutrient cycling from sediments. Drainage continued to be the greatest threat to wetlands in the State. However, nonpoint source pollution problems, such as siltation and pesticide contamination are a growing concern as significant threats to wetlands in the State. Chemical spills from petroleum storage facilities and agricultural chemical storage facilities are the primary sources of ground water contamination.

Programs to Correct Impairments

During the past 3 years, the State directed a majority of its Section 319 funds to local projects addressing NPS pollution from agriculture lands, the dominant land use in North Dakota. Given the complexity of the agricultural industry, the Division of Water Quality has to work closely with the U.S. Department of Agriculture (USDA), as well as with local project sponsors to secure sufficient funds to adequately address agriculture-related pollution at specific project watersheds. Funded projects demonstrate the effectiveness of reduced cropland tillage, proper grazing use, livestock waste management, low energy precision application (LEPA) irrigation, as well as nutrient and pesticide management as effective strategies for NPS pollution control and abatement. Several projects also provide funds to demonstrate proper procedures for sealing abandoned wells.

Programs to Assess Water Quality and Program Effectiveness

North Dakota's Division of Water Quality administers a diverse program to assess water quality. Program monitoring and assessment activities include the State's ambient stream water quality monitoring network, which includes 61 monitoring sites on 31 rivers and streams, the lake water quality assessment project, the ground water monitoring program, monitoring in support of Section 319, NPS pollution projects, and biological monitoring including instream bioassay and fish flesh analysis. In March 1991, the State issued its first fish consumption advisory for sections of the Missouri River, the Red River, and 10 lakes. The advisory affects 509 miles of rivers and 339,370 acres of lakes where fish sampling revealed elevated concentrations of mercury in fish tissues.

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Ohio

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	7,903 mi	33%	7%	21%	39%
Lakes	78,527 ac	<1%	8%	85%	7%
Great Lakes	236 mi	—	—	100%	—
Wetlands	—	—	—	—	—

[a]Totals represent 27% of river miles, 66% of lake acres, and 100% of Great Lakes shore miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Organic enrichment affects 30 percent of the assessed river miles, followed by sediment (affecting 9 percent), and habitat modification (affecting 8 percent). Point sources are the leading source of pollutants impairing rivers, followed by habitat modification, agriculture, and mining. Agricultural runoff, discharges from wastewater treatment plants and industries, failing septic systems, stormwater runoff, and habitat modifications are the leading sources depleting oxygen, elevating nutrients, and causing siltation in Ohio's lakes. The Great Lakes shoreline is impaired by a fish consumption advisory and exceedences of copper and cadmium criteria in the water column.

Programs to Correct Impairments

Ohio EPA is shifting from a regulatory approach that controls individual pollutants to an ecosystem approach that tackles habitat degradation on shore as well as in the water. Long-term solutions include land use setbacks and preservation of stream hydrology.

Programs to Assess Water Quality and Program Effectiveness

Ohio EPA adopted biocriteria (direct measures of fish and macroinvertebrate population and community characteristics) in February 1990. The State measures biological community health by comparing observed ecological characteristics with the characteristics at least-impacted reference sites for a given ecoregion and stream type. Biological monitoring enables the State to detect aquatic life effects that would not be revealed by measuring chemical and physical parameters alone. Trend analysis of comprehensive data collected over the past 12 years indicates substantial improvements in river quality, especially in rivers where organic enrichment loadings have declined and dissolved oxygen levels have increased. The State attributes much of the water quality improvements to wastewater treatment plant upgrades performed since 1972.

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Ohio River Valley Water Sanitation Commission (ORSANCO)

For a copy of the ORSANCO 1992 305(b) report, contact:

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	981 mi	0%	0%	51%	49%
Lakes	NA	NA	NA	NA	NA
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles.
— None or not reported.
NA = Not applicable.

Causes and Sources of Water Quality Impairments

Priority organics, metals, pesticides, siltation, and pathogens impair the mainstem of the Ohio River. Priority organics, such as benzene and chloroform, exceed the 10-6 Cancer Risk Criteria Level in 10 to 90 percent of the daily samples. Urban runoff, storm sewers, combined sewer overflows, unknown sources, agriculture, and industrial point sources impair large stretches of the river, and the relative contribution of nonpoint sources appears to be increasing.

Programs to Correct Impairments

The Ohio River Valley Sanitation Commission (ORSANCO) relies on its member States (Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia) to administer point source permit programs. However, the Commission reviews point source permits drafted by the States to ensure that Commission standards will not be violated. The Commission's Pollution Control Standards (adopted in 1990) include criteria for human health pollutants and industrial waste treatment requirements. The Commission recently began to define its role in controlling nonpoint source pollution. The Commission went on record advocating a technology-based approach for controlling nonpoint sources. The Commission will prioritize the control of pollution resulting from resource extraction activities, followed by urban runoff. However, the Commission's role in managing nonpoint source pollution remains undefined.

Programs to Assess Water Quality and Program Effectiveness

ORSANCO's monitoring program includes ambient sampling, daily organics monitoring, fish tissue analysis, fish population studies, bacterial monitoring, and intensive surveys. Following detections of copper in samples collected from intakes, the Monitoring Strategy Subcommittee undertook a complete review and assessment of the ambient monitoring system. The Subcommittee will review field operations, sample handling and analysis, data review and validation, data uses, and reporting procedures. The review should ensure that valid data are generated and distributed to decision makers.

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Oklahoma

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	7,045 mi	8%	50%	31%	11%
Lakes	605,892 ac	16%	38%	40%	6%
Wetlands	120 ac	—	100%	—	—

*Totals represent 8% of river miles, 58% of lake acres, and <1% of wetlands acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Turbidity, siltation, pesticides, and nutrients, primarily from agricultural sources, cause the most widespread impairments in rivers, streams, and lakes. Other significant sources include domestic and industrial wastewater discharges, construction runoff, urban runoff, and oil field activities.

Programs to Correct Impairments

In 1990, the Oklahoma Conservation Commission (OCC) received an EPA 319 grant to implement a 3-year demonstration project for "Control of Erosion Related Pollution from Mixed Agricultural Activities." The OCC will implement the demonstration project at three watersheds in western Oklahoma. Two of the watersheds suffer from excessive nutrient and sediment loads; the third watershed is impaired by bacteria, followed by sediment and nutrients. Local conservation districts and the OCC will select best management practices (BMPs) to remedy the problems in each watershed and recruit agricultural operators to implement the BMPs. The OCC set a project goal at 70 percent participation by local landowners. The project also includes background monitoring and post-implementation monitoring to assess BMP effectiveness.

Programs to Assess Water Quality and Program Effectiveness

In 1991, the State initiated a 3-year sampling program to identify ground water wells potentially at risk from agricultural impacts. The State conducted background surveys to identify areas most likely to be contaminated by agricultural impacts, such as animal waste, fertilizer, and pesticides. In 1991, the State sampled 67 wells and analyzed the samples for nitrate-nitrogen and specific pesticides used in the vicinity of each well. Four of the samples contained nitrate-nitrogen above the recommended limit of 20 mg/L for noncommunity water supplies. None of the samples contained significant concentrations of pesticides. Ultimately, the State will sample 200 wells under the program.

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Oregon

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	29,109 mi	43%	—	30%	27%
Lakes	504,928 ac	74%	—	12%	14%
Estuaries	60 mi²	7%	—	63%	31%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 32% of river miles, 82% of lake acres, and 30% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Habitat alterations, flow alterations, elevated temperatures, and siltation affect the largest number of stream miles. Rangeland, agriculture, forestry, and recreational activities impair the most stream miles. Nutrients and pH affect lakes, and pathogens and toxics impair estuarine waters.

Programs to Correct Impairments

The Groundwater Protection Act requires statewide ground water monitoring, domestic well testing, public education activities, and implementation of Best Management Practices (BMPs). The Oregon Department of Environmental Quality (DEQ) implements the Groundwater Quality Protection Rules through existing programs such as the National Pollutant Discharge Elimination System (NPDES) permit program for point sources and the Environmental Cleanup Program. The ground water rules minimize wastewater discharges by requiring facilities to adopt "highest and best methods" that prevent pollutants from entering ground water. The rules also require that facilities develop ground water management plans and monitor ground water quality. In addition, the DEQ reviews new facility plans to ensure that facility design, construction, and operation will not degrade ground water.

Programs to Assess Water Quality and Program Effectiveness

In 1991, the State adopted new narrative biocriteria and focused on using biological monitoring to detect the effects of nonpoint sources. In 1991, the State monitored macroinvertebrates at 45 sites to determine the effects of grazing and forest management practices on water quality. The biological monitoring program includes macroinvertebrate assessments, fish enzyme studies, fish tissue analysis for toxic chemicals, fish health observations, periphyton growth studies, and toxicity testing.

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Pennsylvania

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1992 Water Quality Assessment[a]

Waterbody Type	Waters Assessed[b]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	24,751 mi	81%	—	8%	11%
Lakes	—	—	—	—	—
Great Lakes	—	—	—	—	—
Wetlands	—	—	—	—	—

[a] Source: 1993 305(b) Update.
[b] Totals represent 45% of river miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Abandoned mine drainage is the leading source of surface water quality degradation. The pollutants responsible for degradation due to mining are low pH, metals, and turbidity. Other sources of surface water degradation include agriculture and municipal and industrial point sources. These sources generate nutrients, turbidity, and metals. The major source of ground water contamination is leaking underground storage tanks. Other sources of ground water contamination include coal mining, bulk storage tanks, chemical plants, and oil and gas exploration. Contamination is from both organic and inorganic chemicals.

Programs to Correct Impairments

Current efforts to address mining-related problems include: requiring abatement or load reduction when sites are remined, reconstruction of abandoned mines that are a threat to public health, and research programs. The Department of Environmental Resources is also pursuing legislative changes to provide incentives for remining and reclamation. Agriculture problems are addressed primarily through individual conservation plans using Best Management Practices (BMPs) and education programs. Several of the State's agencies are jointly developing a single, integrated document that encompasses all the planning issues related to agriculture — such as erosion/sediment control, manure management, and integrated pest management. A permitting program modifies land disposal problems, and stormwater rules require every county to prepare a stormwater management plan that identifies problems and suggests BMPs to address the problems.

Programs to Assess Water Quality and Program Effectiveness

Currently there are 168 fixed-monitoring stations on rivers, streams, and Lake Erie scheduled to be visited monthly for stream discharge and physical/chemical analysis and annually for biological evaluation of stream bottom life.

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Puerto Rico

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	5,375 mi	5%	11%	18%	66%
Lakes	10,587 ac	15%	22%	29%	33%
Estuaries[b]	184 mi	5%	8%	18%	69%
Oceans	428 mi	44%	42%	8%	5%
Wetlands	—	—	—	—	—

[a]Totals represent 100% of river miles, 100% of lake acres, 100% of estuary square miles, and 100% of ocean miles.
[b]Puerto Rico reports linear miles of estuaries supporting designated uses rather than square miles of estuaries supporting designated uses.
— None or not reported.

Causes and Sources of Water Quality Impairments

The principal causes of impairment in rivers are pathogen indicators, nutrients, dissolved oxygen, and metals primarily from land disposal activities, agriculture, and urban runoff. Impairment in lakes and lagoons is caused by pathogen indicators, nutrients, dissolved oxygen, and other inorganics, the sources of which include land disposal, urban runoff, and agriculture. In estuaries, urban runoff, storm sewer discharges, and land disposal are primary sources of impairment caused by unknown toxicity, metals, organic enrichment, and pathogen indicators. Pathogen indicators are the primary cause of impairment in oceans with metals, chlorine, and unknown toxicity also contributing. Sources of ocean impairment include land disposal and municipal point sources.

Programs to Correct Impairments

In addition to traditional point source controls, Puerto Rico promotes water quality through various nonpoint source programs. Two of the more prominent programs attempt to control contamination from livestock enterprises and erosion from construction and mining operations. Livestock enterprises are required to implement animal fecal waste management systems and other Best Management Practices (BMPs). Construction or extraction activities that meet certain requirements are required to file a sediment and erosion control plan that establishes the control measures necessary to minimize erosion.

Programs to Assess Water Quality and Program Effectiveness

Monitoring of both surface and ground waters was performed in five priority watersheds to evaluate the effectiveness of BMPs. Inspections of 200 livestock enterprises were performed in five priority watersheds. Inspections will also be performed on cropland and agricultural activities within the priority watersheds to evaluate implementation of BMPs.

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Rhode Island

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	664 mi	31%	42%	5%	22%
Lakes	16 749 ac	8%	71%	18%	3%
Estuaries	193 mi²	73%	7%	11%	9%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 86% of river miles, 100% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Metals, especially copper and lead, are the most significant causes of nonsupport in rivers and streams, followed by priority organics, pathogen indicators, low dissolved oxygen concentrations, and nutrients. Nutrients, metals, eutrophication-related low dissolved oxygen concentrations, and pH impair lakes. In estuaries and coastal waters, the major causes of impairment include pathogen indicators, heavy metals, nutrients, and eutrophication-related low dissolved oxygen concentrations. Major sources of pollutants in rivers and estuaries include industrial discharges, municipal discharges, combined sewer overflows, urban runoff, highway runoff, septic systems, and contaminated sediments. In lakes, septic systems and runoff are the leading sources of impairment.

Programs to Correct Impairments

Since 1990, the NPS management program has documented freshwater wetland water quality problems, evaluated the State's freshwater wetland regulations, and proposed revisions to the regulations. The NPS program also reviewed the existing regulatory framework for stormwater runoff and developed Best Management Practice (BMP) performance standards and applicability criteria for a guidance manual issued to State and municipal staff. The NPS program also oversaw creation of the Site Plan Review Program by the Rhode Island Conservation Districts. The program assists municipalities reviewing site plans for compliance with soil erosion and sediment controls.

Programs to Assess Water Quality and Program Effectiveness

The Rhode Island Department of Environmental Management and the Narragansett Bay Project developed the Citizen's Volunteer Monitoring Program Coordination Project to promote and coordinate all volunteer monitoring groups at the State level. The project supports a Statewide Coordinator to educate volunteers and ensure data quality.

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South Carolina

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Full-Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	3,954 mi	72%	—	16%	12%
Lakes	382,028 ac	80%	—	14%	6%
Estuaries	427 mi²	73%	—	24%	3%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 40% of river miles, 73% of lake acres, and 20% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Organic enrichment, pathogens, and pH cause most stream impairments in South Carolina. Agriculture, unknown sources, municipal point sources, and urban runoff/storm sewers are the leading sources of impairments in rivers and streams. Organic enrichment and low dissolved oxygen concentrations are the leading source of impairment in lakes and estuaries. Unknown sources generate most lake impairments, followed by agriculture and industrial point sources. Unknown sources also generate most estuarine impairments, followed by urban runoff/storm sewers and industrial point sources. Leaking underground storage tanks account for most ground water contamination incidents in the State.

Programs to Correct Impairments

The South Carolina Department of Health and Environmental Control (DHEC) initiated the Watershed Water Quality Management Strategy to integrate protection activities on a basin and watershed scale. The Strategy integrates monitoring, assessment, problem identification and prioritization, water quality modeling, permitting, and planning activities to develop management plans and implementation strategies for entire watersheds. On a 5-year rotation, DHEC will develop or revise a water quality management strategy for one of five delineated hydrologic basins per year. Each year, DHEC staff can focus monitoring efforts on the targeted basin rather than randomly selecting monitoring sites throughout the State. The watershed approach encourages DHEC to evaluate both point and nonpoint source impacts and consolidate management solutions.

Programs to Assess Water Quality and Program Effectiveness

Biological monitoring includes identification and enumeration of phytoplankton, aquatic macroinvertebrates, and fish. Biological sampling stations are located in headwater reaches of selected impoundments, in major waterbodies subject to possible pollution, and critical waters used for water supplies, recreation, and fish and wildlife propagation.

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South Dakota

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	3,604 mi	17%	—	26%	57%
Lakes	683,458 ac	—	81%	5%	14%
Wetlands	—	—	—	—	—

*Totals represent 36% of river miles and 98% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Agricultural nonpoint sources and livestock operations are the primary sources of suspended solids and pathogens causing impairments in rivers and streams. River impairments also result from natural pollutant sources, such as the erosive soils naturally occurring in western South Dakota. Elevated stream pH is another important cause of impairment, but the source could not be identified. Runoff from agricultural lands, carrying sediment and nutrients, remains the major source of lake pollution. Petroleum products, fertilizers, and pesticides are the most frequently identified contaminants in ground water.

Programs to Correct Impairments

The land treatment phase of the Oakwoods-Poinsett Rural Clean Water Program (RCWP) implemented best management practices (BMPs) to reduce total nitrogen, pesticides, animal wastes, and water- and sediment-borne contaminants entering ground water and surface waters. The project identified and prioritized three critical areas for BMP implementation based on aquifer vulnerability and sediment delivery. The RCWP contracted with landowners to implement BMPs (conservation tillage, fertilizer management, pesticide management, and animal waste management) on 81 percent of the critical area with highest priority and 60 percent of all three critical areas. The RCWP provided 75 percent cost share assistance through the Agricultural Stabilization and Conservation Service.

Programs to Assess Water Quality and Program Effectiveness

The Comprehensive Monitoring and Evaluation (CM&E) phase of the Oakwoods-Poinsett RCWP monitored the effects of BMP implementation on ground water and surface water quality. The CM&E phase included three monitoring studies: (1) ground water monitoring, (2) the Oakwood Lakes System Study, and (3) the Agricultural Chemical Leaching Study in the vadose zone. Ground water monitoring was conducted at five farmed fields with BMPs, one farmed field without BMPs, and one unfarmed site. Event-based sampling techniques were developed for monitoring ground water and the vadose zone.

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Tennessee

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	10,823 mi	47%	16%	27%	9%
Lakes	539,326 ac	78%	1%	9%	12%
Wetlands	—	—	—	—	—

*Totals represent 57% of river miles and 100% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

No single cause or source of water quality impairment is dominant, but siltation, organic enrichment/dissolved oxygen, and suspended solids affect many river miles. Principal sources of river impairment are agriculture, hydromodification, and land development/construction. Although agriculture impacts approximately 25 percent of the State's river miles, it is not necessarily dominant. Impairment of Tennessee's lakes is from organic enrichment/dissolved oxygen, priority organics, flow alteration, and siltation. Sources of lake impairment include in-place contaminants, upstream impoundments, land development/construction, and agriculture. The largest single source of lake impacts is in-place contaminants, which has resulted in the majority of the State's fish consumption advisories.

Programs to Correct Impairments

New regulatory and planning tools such as Total Maximum Daily Loading studies, updated water quality standards, and the Stormwater Program are being used to adress pollution sources. Tennessee has been very progressive in its use of the Federal 401 Certification and the State Aquatic Resource Alteration Permit (ARAP) program to protect wetlands, regulate construction runoff, and oversee activities such as gravel dredging and channelization of streams. Future tools envisioned include watershed planning for NPDES permitting activities, biocriteria, sediment criteria, and increased ability to require BMPs for nonpoint sources not currently being regulated. Tennessee's ground water criteria, wellhead protection program, and an aquifer mapping program are currently under development.

Programs to Assess Water Quality and Program Effectiveness

Overall program effectiveness will ultimately be gaged by streams and lakes that are not currently fully supporting designated uses being brought into compliance with water quality standards. The recent updating of the STORET system and the newest Waterbody System (WBS) will be used to track support of designated uses and improved water quality.

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Texas

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable
Rivers	14,107 mi	74%	—	10%	17%	—
Lakes	1,504,539 ac	89%	—	<1%	11%	—
Estuaries	1,991 m^2	66%	—	8%	23%	3%
Oceans	—	—	—	—	—	—
Wetlands	—	—	—	—	—	—

*Totals represent 7% of river miles, 49% of lake acres, and 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Use impairments in Texas streams and rivers result primarily from treated domestic wastewater discharges that reduce dissolved oxygen concentrations and elevate fecal coliform densities. Use impairments in reservoirs stem from natural sources and municipal wastewater treatment plant discharges resulting in elevated salinity, total dissolved solids, and fecal coliform densities. Industrial and municipal point sources generate most of the fecal coliform bacteria and toxic contaminants causing use impairments in bays. Most ground water contamination incidents are related to point source activities, such as petroleum storage tanks and industrial waste disposal.

Programs to Correct Impairments

The Texas Water Commission (TWC) wrote new rules that created the Program for Assessment of Water Quality by Watershed and River Basin. The rules realign water quality programs by regional river authorities and require the TWC to move toward simultaneously issuing all wastewater discharge permits in a basin. The watershed program encourages public participation in the development of regional assessments.

Programs to Assess Water Quality and Program Effectiveness

The TWC, Texas Parks and Wildlife Department, and EPA Region 6 are cooperatively conducting the Texas Ecoregion Project. The project will evaluate regional variability of physical, chemical, and biological characteristics of Texas streams. The project will determine the potential for developing regional water quality standards and biological criteria, verify Texas ecoregions, and refine use assessment procedures.

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Utah

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	7,557 mi	57%	—	16%	27%
Lakes	450,078 ac	61%	—	32%	7%
Wetlands	—	—	—	—	—

*Totals represent 64% of river miles and 93% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Metals impair aquatic life support use and total dissolved solids impair agricultural uses of streams and rivers. The primary source of these pollutants is nonpoint source runoff. Agricultural practices such as grazing and irrigation increase sediment and nutrient loading in streams. Nutrient concentrations, especially phosphorus, exceed State indicator levels in most rivers, streams, lakes, and reservoirs sampled. However, the State does not consider nutrient levels when determining use support in rivers and streams because the effects of nutrients are difficult to assess without concurrent biological sampling or visual evaluations of aquatic plant growth. The State does consider nutrients the leading cause of impairment in lakes, followed by low dissolved oxygen and suspended solids. The major sources of lake pollutants are nonpoint sources, agricultural practices, industrial and municipal point sources, drawdown of reservoirs, and natural background level sources. Irrigation, urbanization, and infiltration of leachate from landfills, mine tailings, and mill tailings degrade ground water.

Programs to Correct Impairments

Utah's Watershed Program is implementing NPS controls in five priority watersheds, restoring stream channels and wetlands, and identifying sources of salts and sediments entering the Colorado River. The priority watershed projects will demonstrate the water quality benefits derived from NPS controls. The State routinely relies on the Soil Conservation Service to provide technical expertise to cooperators in priority watersheds. The Jordan River Wetland Project will demonstrate river restoration techniques in an urban area. The Colorado River project will focus on rangelands loading salts and sediment into the River.

Programs to Assess Water Quality and Program Effectiveness

Utah's interagency monitoring program will undertake additional habitat monitoring in addition to chemical sampling to document water quality improvements resulting from nonpoint source management. Sampling will focus on watersheds implementing best management practices.

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Vermont

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	5,264 mi	59%	22%	15%	4%
Lakes/Ponds	52,851 ac	37%	33%	20%	10%
Lake Champlain	174,175 ac	—	—	46%	54%
Wetlands	—	—	—	—	—

*Totals represent 100% of river miles and 99% of lake/pond acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

As in 1990, agriculture impairs the greatest number of river miles, primarily via nutrient runoff from nonirrigated crop production, animal management areas, and pasture land. Siltation, nutrients, thermal modification, and organic enrichment cause the most extensive impairments in rivers and streams. Unspecified sources generate flow alterations, nutrients, and algae, the leading causes of impairments in lakes and ponds (excluding Lake Champlain). Flow regulation, streambank destabilization, and agriculture are the most significant identified nonpoint sources of pollution in lakes. All of Vermont's portion of Lake Champlain is impaired by phosphorus concentrations that exceed the State's lake-specific criteria. Fish consumption advisories for priority organics, PCBs, and mercury also threaten the entire lake. Leading sources of ground water contamination include leaking underground storage tanks and leachate from landfills and hazardous waste sites.

Programs to Correct Impairments

In 1991, Vermont received EPA Section 319 funding to implement erosion controls in targeted watersheds, demonstrate agricultural milkhouse waste treatment BMPs, enforce domestic discharge rules, and coordinate NPS projects with other States.

Programs to Assess Water Quality and Program Effectiveness

Diagnostic studies on three lakes suggested that watershed monitoring programs are the only reliable method for identifying nonpoint sources impairing lakes. The diagnostic studies identified sources that contradicted professional evaluations made prior to watershed monitoring. For example, monitoring revealed that internal phosphorus loading was the major source of pollution in Lake Morey. Prior to monitoring, the State suspected that poorly sited septic systems were the primary source of nutrients in the lake. Vermont will expand lake monitoring with an EPA Clean Lakes grant.

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Virginia

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed[a]	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	17,958 mi	80%	—	14%	6%
Lakes	90,762 ac	93%	—	7%	<1%
Estuaries	3,080 mi²	78%	—	20%	2%
Oceans	120 mi	100%	—	—	—
Wetlands	—	—	—	—	—

[a]Totals represent 33% of river miles, 56% of lake acres, 100% of estuary square miles, and 100% of ocean miles.

— None or not reported.

Causes and Sources of Water Quality Impairments

Elevated densities of fecal coliform bacteria, primarily from agricultural runoff, are the most common cause of impairment in Virginia's rivers and streams, followed by metals. Nutrients and pH are the most common causes of nonsupport in lakes. The most prevalent sources of lake impairments are agriculture, silviculture, and urban runoff/storm sewers. Nutrients are the dominant cause of impairment in estuaries, followed by Kepone and suspended solids. Municipal and industrial point sources, in-place contamination, agriculture, runoff/storm sewers, and atmospheric deposition affect the most estuarine waters in Virginia.

Programs to Correct Impairments

The Virginia Water Control Board (now the Department of Environmental Quality) encourages wastewater treatment plants to implement biological nutrient removal (BNR), a new cost-effective technology. The Hampton Roads Sanitation District (HRSD)-York River Sewage Treatment Plant conducted a full-scale demonstration of the BNR process during 1988 and 1989, with a grant from the Water Control Board. The HRSD was granted a public domain patent for the BNR process, ensuring that it will be freely available to other municipalities and industrial dischargers.

Programs to Assess Water Quality and Program Effectiveness

Virginia contracts the U.S. Geological Survey (USGS) and two universities to monitor the Chesapeake Bay and its tributaries. The USGS samples nutrients at the fall lines of five tributaries. The USGS increases sampling frequency during storm events to capture increased nutrient and sediment loadings into the tidal portion of the watershed. Virginia will estimate nutrient loads to the Bay with the nutrient data collected by the USGS. The universities sample chemical and biological parameters at 27 stations in the mainstem of the Chesapeake Bay. The State will characterize spatial and temporal patterns of nutrients, organic materials, and plant pigments in the Bay and its tributaries.

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Virgin Islands

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	—	—	—	—	—
Lakes	—	—	—	—	—
Estuaries	6 mi²	50%	17%	17%	16%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 100% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Conventional pollutants pose the greatest threat to marine and estuarine environments. Sewage discharges are frequent and result from both mechanical breakdowns and unpermitted discharges. Nonpoint source contamination is primarily from construction projects and urban runoff from roads and landfills. This runoff leads to increased turbidity and nutrient levels. Wastes from marine vessels is another significant source of impaired water quality. Water quality standards for fecal coliform are often exceeded and low dissolved oxygen levels are found where there are large numbers of live-aboard vessels and low flushing rates of waters.

Programs to Correct Impairments

Discharge permits are the principal regulatory tool for reducing pollutant release into territorial waters. Currently, a bill is pending that would disallow any marine vessel from discharging pollutants into the territorial waters. Effective nonpoint source control is, for all purposes, nonexistent, but the Territory is developing programs to combat soil erosion and urban runoff. For example, new development projects must provide for vegetated buffers, wetlands, catch basins, porous pavements, and similar systems for the detention, retention, treatment, and percolation of runoff. The Coastal Zone Management Act also requires that the Territory develop management plans for 18 of the most sensitive areas in the Territory. Unfortunately many delays have prevented development of these plans.

Programs to Assess Water Quality and Program Effectiveness

Toxicity testing, stormwater limits, and biological monitoring are required by some permits. All point sources must self-monitor and submit results to DPNR and EPA. DPNR conducts compliance inspection on all permittees and compliance monitoring on all major permittees.

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	5,639 mi	29%	7%	19%	46%
Lakes	80,696 ac	46%	5%	22%	27%
Estuaries	1,093 mi²	24%	13%	9%	54%
Oceans	—	—	—	—	—
Wetlands	—	—	—	—	—

*Totals represent 14% of river miles, 13% of lake acres, and 37% of estuary square miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Low levels of dissolved oxygen, often naturally occurring, are the major cause of impairment of designated uses in estuaries. Bacterial contamination, primarily from agricultural runoff, onsite wastewater disposal, and municipal wastewater treatment plants also causes impairments in estuaries. Major causes of impairment in lakes include nutrients, pesticides, siltation, flow alteration, and low dissolved oxygen. Agricultural production is the predominant source of impairment in lakes. Other sources include urban runoff, land disposal, septic tanks, and natural sources. In rivers and streams agriculture is the major source of water quality degradation, followed by industrial point sources and hydro-habitat modification. Causes of water quality impairment from these sources include thermal modification, pathogen indicators, metals, and priority organics.

Programs to Correct Impairments

Washington provides financial incentives to encourage compliance with permit requirements, the principal vehicle for regulating point source discharges. The State also has extensive experience developing, funding, and implementing nonpoint source pollution prevention and control programs since the early 1970s. The State has developed nonpoint source control plans with Best Management Practices (BMPs) for forest practices, dairy waste, irrigated agriculture, dryland agriculture, and urban stormwater. The State is now focusing attention is watershed planning. Efforts are currently geared toward prioritizing watersheds and developing comprehensive plans for the priority watersheds.

Programs to Assess Water Quality and Program Effectiveness

Washington implements an aggressive program to monitor the quality of lakes, estuaries, and rivers and streams. The program makes use of fixed-station monitoring to track spatial and temporal water quality changes so as to ascertain the effectiveness of various water quality programs and be able to identify desirable adjustments to the programs.

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West Virginia

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Causes and Sources of Water Quality Impairments

Metals, siltation, and pH are the leading causes of impairment in rivers and lakes. Coal mining impairs the most stream and river miles, followed by pasture land and road construction and maintenance. Coal mining is the dominant source of impairment in lakes, followed by industrial point sources and agriculture.

1992 Water Quality Assessment

Waterbody Type	Waters Assessed	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	5,287 mi	14%	7%	63%	16%
Lakes	21,522 ac	27%	8%	57%	8%
Wetlands	—	—	—	—	—

*Totals represent 16% of river miles and 100% of lake acres.
— None or not reported.

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	11,336 mi	82%	1%	12%	5%
Lakes	211,734 ac	21%	21%	25%	33%
Great Lakes	840 mi	—	—	100%	—
Wetlands	—	—	—	—	—

*Totals represent 20% of river miles, 22% of lake acres, and 100% of Great Lakes shore miles.
— None or not reported.

Causes and Sources of Water Quality Impairments

Siltation, habitat alterations, and nutrients cause most impairments in Wisconsin's rivers and streams. Unspecified nonpoint sources, agriculture, and habitat modification are the leading sources of river impairments. Most lake impairments are due to aquatic weeds, metals, and nutrients. Fish contamination impairs all 840 miles of Wisconsin's Great Lakes shoreline. The Wisconsin Department of Natural Resources blames historical point source discharges for introducing most of the priority organics, pesticides, and metals currently detected in fish samples. Other significant sources include atmospheric deposition and contaminated sediments.

Programs to Correct Impairments

The WDNR is currently developing a strategic plan, Water 2010, to guide the State's water-related activities for the next 20 years. River basin water quality management plans lay the foundation for the Water 2010 strategic plan. The basin plans, updated every 5 years, identify planning goals, summarize the condition of the waters in each river basin, identify water quality improvements and persistent pollution problems, and recommend remedial or preventive actions needed to protect water quality. The river basin plans also contain watershed rankings used to select priority watershed projects for funding under the Wisconsin Nonpoint Source Water Pollution Abatement Program. The nonpoint source program provides funds to individual landowners and communities to implement priority watershed projects.

Programs to Assess Water Quality and Program Effectiveness

Under the Great Lakes Coastal Sediment Study, WDNR is evaluating procedures for assessing sediment toxicity. The staff established reference concentrations for toxics measured in samples collected from coastal streams and harbors above contaminated areas. The study will evaluate contaminant bioacummulative potential of coastal sediments by placing caged fathead minnows over sediments previously sampled for laboratory tests. Sediment samples will be collected from the cage sites for bulk chemistry analysis.

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1992 Water Quality Assessment

Waterbody Type	Waters Assessed*	Fully Supporting	Threatened	Partially Supporting	Not Supporting
Rivers	6,013 mi	13%	20%	59%	8%
Lakes	125,422 ac	26%	1%	50%	23%
Wetlands	—	—	—	—	—

*Totals represent 26% of river miles and 43% of lake acres.
— None or not reported.

Causes and Sources of Water Quality Impairments

Sediment and siltation, nutrients, total dissolved solids and salinity, flow alteration, and low dissolved oxygen concentrations are the top five causes of water quality impairment in Wyoming streams. The top five sources, based on the number of miles impacted, are rangeland, natural sources, irrigated cropland, pasture land, and highway, bridge, and road construction. In lakes, low dissolved oxygen concentrations, nutrients, sediment and silt, other inorganics, and metals cause the most extensive impairments. The top five sources of impairment in lakes include natural sources, rangeland, irrigated cropland, flow regulation, and municipal discharges.

Programs to Correct Impairments

In 1991, the Governor appointed a citizen-based Nonpoint Source Task Force to modify the Wyoming Nonpoint Source Plan and oversee nonpoint source project funding and implementation. Since its formation, all project proposals undergo Task Force review. Currently funded projects will demonstrate best management practices for cropland production and road construction, riparian restoration, and education programs.

Programs to Assess Water Quality and Program Effectiveness

Nonpoint source assessment is a high priority in Wyoming due to the complexities of accounting for natural background levels of sedimentation. The State intends to incorporate volunteer monitoring and biological assessment in the routine monitoring program to gather additional data needed to distinguish natural sedimentation and nonpoint source inputs. Currently, the State is designating reference stream sites representative of relatively undisturbed sites in specific ecoregions. Biological parameters such as species composition, species abundance, and relative habitat condition will be examined at these candidate streams.

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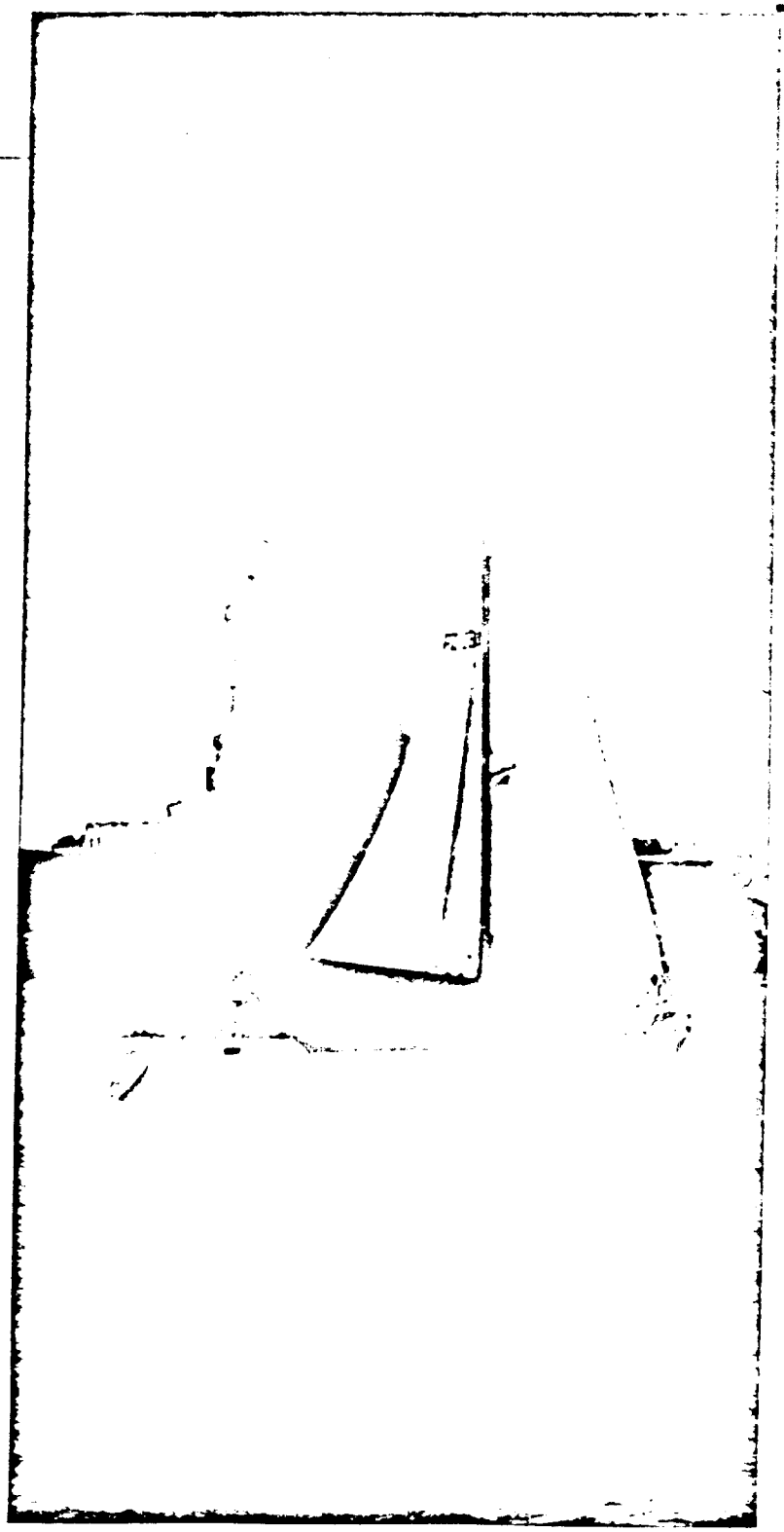

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State Recommendations

In their 1992 reports, 30 States and Territories discussed recommended program actions needed to make additional progress toward the Clean Water Act's goal of fishable and swimmable waters. These recommendations encompass a range of actions at the congressional, Federal, State, and local levels and are often expressed in terms of State objectives or continuing needs. It should be emphasized that the recommendations discussed here were reported by the States themselves in 1992; this discussion does not attempt to assess their merits. Nor should this discussion be construed as an EPA or Administration endorsement of any State recommendations. Many of the State recommendations for action do, however, coincide with current EPA program concerns and priorities.

A recurring theme in almost all State recommendations is the need for continued, and in many cases additional, funding to implement ever-expanding State water quality protection responsibilities. For example, Mississippi's 305(b) report includes the following:

> Additional resources are needed to evaluate and regulate the environmental risk from the release of toxic chemicals, to develop the storm water permitting and regulatory program, to implement a statewide nonpoint control program, to expand and strengthen our wetlands protection efforts, to implement and manage the State's Wellhead Protection Program, to expand the Ambient Surface Water Monitoring Program, to develop narrative and numeric biological criteria, to expand our laboratory's analytical capability, to develop Total Maximum Daily Loads, and to develop and implement a citizen volunteer monitoring program. Without additional funding and staffing, most of these concerns cannot be adequately addressed, if at all.

In general, the most frequently reported State recommendations fall into eight major categories. These areas of concern are nonpoint source abatement, toxic identification and control, water quality monitoring, ground water conservation, wetlands protection, pollutant source discharge permitting, municipal facilities, and water quality criteria and standards. Other concerns less frequently reported include data management/coordination, sewer overflow treatment, and education to increase public awareness.

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Nonpoint Source Abatement

Recommendations most often cited by the States concern the identification, prevention, and control of nonpoint sources (NPSs) of pollution. Most commonly, States cite the need for additional funding for development of better monitoring and assessment methods to detect nonpoint sources, assess their impacts, and determine the effectiveness of NPS controls. States listed regulation of urban runoff and increased monitoring as NPS areas needing additional financial support. (Note that much of urban runoff is discharged in a conveyance that is legally considered a point source and is subject to National Pollutant Discharge Elimination System [NPDES] stormwater requirements.) Many States indicate that increased monitoring will enhance the ability to identify and eventually control nonpoint sources of pollution. Montana's 305(b) states:

> To adequately measure the effectiveness of the state's nonpoint source control program and other water pollution control programs would require a greatly expanded monitoring and assessment effort.

A number of States cite increased public education on the nature of NPS pollution and NPS controls as a mechanism for encouraging BMP implementation and NPS program funding. Several States suggest EPA should take specific actions with respect to NPS programs ranging from issuing total maximum daily loading limits for NPS pollutants and recommending adoption of more stringent nutrient standards to developing numeric criteria for NPS pollutants.

Identification and Control of Toxic Substances

The States strongly recommend expanding efforts to gather data on toxic pollutants and to develop or implement State toxic control programs. Specific recommendations for data collection on toxics emphasize two areas: bioaccumulation of toxics in fish and shellfish tissue and sediment contamination. The States cite a need for the Federal government to provide national guidance on bioaccumulation of toxics in fish tissue. Several States requested funding to initiate or expand their current fish tissue monitoring programs. With respect to sediment contamination, there were recommendations for the EPA to actively pursue development of a nationwide in-place pollutant program designed to provide both technical guidance and dedicated Federal financial support for expansion of sediment monitoring programs and remediation efforts. In addition, States cite the need for EPA to refine and/or develop national sediment criteria for toxics, particularly heavy metals.

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Water Quality Monitoring

Beyond expressing a general need to expand water quality monitoring activities and evaluate them to be certain they are providing needed data, a prominent theme of State monitoring recommendations is to increase the emphasis on instream biological monitoring as an indicator of pollution and pollution abatement. Specifically, several States recommend the expanded use of volunteer monitoring programs in which volunteers are trained to make observations of aquatic and terrestrial conditions and perform water quality sampling and analysis. Other monitoring recommendations include seeking increased EPA and State support to expand fish tissue and sediment toxics monitoring programs as well as lake and NPS monitoring efforts.

Future Ground Water Concerns

A number of special or future ground water concerns were mentioned by 33 States in their Section 305(b) reports. The most prevalent issues were

- Agricultural nonpoint source discharges, including nitrate and pesticide contamination and soil erosion problems (17 States)
- Funding and staff resources (15 States)
- Data management (12 States)
- Development and implementation of State and Federal regulations, including enforcement and legislative support for State ground water protection programs (12 States)
- Development and maintenance of State monitoring systems (11 States).

Nitrate and pesticide contamination of ground water are of particular concern in many States because of the extensive reliance on ground water for rural drinking water supplies. Potential adverse health effects associated with the consumption of nitrate- or pesticide-tainted water include methemoglobinemia (blue baby syndrome), cardiovascular disorders, hypertension, and cancer. In response to these concerns, one State suggested that Federal pesticide registration criteria should be developed to rate pesticides on their potential to migrate through soils and into ground water.

A number of States expressed concerns with regard to the continued ability to fund State and Federal ground water research and protection programs. The lack of a stable long-term source of funding for these programs and the Federal emphasis on expanding the role of State governments in ground water protection programs were of concern to many States. These States applauded the Federal focus on prevention of ground water contamination as a more effective

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and economical approach than a focus solely on remediation programs. However, they also expressed that, without adequate Federal funding, the development and implementation of these programs cannot be accomplished. Two States suggested better utilization of volunteers in reaching program goals. Also mentioned was the establishment of a cleanup fund financed by penalties or other enforcement actions and fees.

Data management concerns for many States included the lack of computerized databases to accommodate the growing body of ground water quality data. Monitoring produces large volumes of data, much of which remains on manual files in various State and local agencies where it is not readily accessible. Incompatibility between computer systems and lack of coordination between agencies was also cited as a problem. Many of the States recognized that they must continue to expand their monitoring efforts to include potential sources of contamination and to evaluate the relationship between surface water and ground water quality.

Although ground water has traditionally been considered a safe source of drinking water, research and monitoring have revealed problems in a number of States that may threaten the integrity of their ground water resources. Population growth and residential development compound the need for clean, safe ground water supplies. Many States see that the promotion of public awareness campaigns and improved ground water monitoring have placed ground water protection in the forefront of their environmental agenda.

Wetlands Protection

Several States called for increased Federal efforts in protecting valuable wetlands resources. Specific recommendations include the need for additional Federal appropriations to identify and quantify wetlands acreage and to strengthen existing State protection efforts. In addition, a number of States cited the need for additional Federal guidance in developing water quality standards and designated use classification for wetlands or, in lieu of that, the need for establishing national minimum water quality standards for wetlands to be incorporated into State regulations.

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Pollutant Source Discharge Permitting

Federal financial assistance has been requested by the States for increases in planning/review functions necessary to enact a more forceful and stricter NPDES permit program as stipulated by the Federal Government. Because new mandates require sludge management, toxicity biomonitoring, and storm water management to be implemented through the NPDES program, a heavier burden has been placed on State programs to comply with these revisions. Several States indicated the need to incorporate NPS into the NPDES permit program. The State of Oklahoma is currently developing a Total Maximum Daily Load process to be used in issuing NPS permits. Another recommendation made was to amend the Atomic Energy Act, which exempts certain pollutants, such as plutonium and enriched uranium, from regulation under the NPDES program. The EPA was specifically asked to change its NPDES enforcement policy from focusing on permit classification (dischargers are currently graded on volume of discharge) to uniform enforcement, regardless of discharge volume. It was suggested that enforcement efforts be based on compliance records, designated stream uses, water quality standards violations, and potential risk to environment or public health.

Municipal Facilities

Continued funding for the maintenance, upgrade, and construction of municipal sewage treatment facilities remains a leading recommendation of the States. Several States expressed concerns about the State Revolving Fund Program, which replaces the Construction Grants Program terminated in 1990. The State Revolving Fund Program transfers funding responsibility for wastewater treatment construction from the Federal Government to the States. Several States voiced concerns that adequate money is not available to provide a smooth transition from the Construction Grants Program to the State Revolving Fund Program. Several States expressed concerns about acquiring the matching funds required to initiate State Revolving Fund Programs in their States.

Two other municipal concerns that were cited by many States involved pretreatment and combined sewer overflow (CSO) mitigation problems. States feel EPA should put more pressure on municipalities to implement and enforce their approved pretreatment programs. Federal funding is urged to support inspections, audits of industrial uses, enforcement, and more research on the effectiveness of pretreatment in reducing toxics in effluent. Special appropriations are also suggested for CSO mitigation projects, and, because of excessive costs, States recommend Federal assistance be provided to implement the projects expeditiously.

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States' water quality standards consist of:

- *Criteria for specific pollutants established by the States and approved by EPA*
- *Designated uses*
- *Antidegradation policy*

Water Quality Criteria and Standards

The States' ability to assess water quality conditions depends heavily on criteria for specific pollutants established by the States and approved by the EPA. When these criteria are violated, designated uses may not be met. Together with an antidegradation policy, the criteria and the uses they protect form the State's water quality standards. A number of States recommend updating their standards by taking such actions as strengthening numerical criteria for toxics (particularly priority organics and heavy metals), adopting new standards for NPS pollutants and wetlands protection, or developing more specific classifications such as nutrient-sensitive or high-quality waters. Federal leadership is urged in finalizing criteria for sediment contamination and continuing to refine and develop criteria for substances causing risks to human health with specific emphasis on fish and shellfish consumption advisories. EPA is also encouraged to promote greater interstate consistency in all water quality standards.

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Part III

Water Quality Management Programs

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The Watershed Protection Approach

Background

Since the 1990 Report to Congress, EPA and many States have moved toward a more geographically oriented approach to water quality management. They share a growing consensus that the Nation's nonpoint source and habitat degradation problems can be solved best at the basin or watershed level.

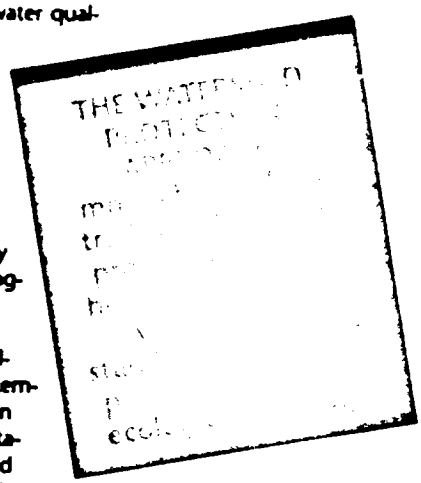
In 1991, EPA highlighted the Watershed Protection Approach (WPA), a framework for focusing efforts on carefully chosen watersheds. The WPA is not a new government program, but rather a means of pulling together the resources and expertise of existing local, State, and Federal programs. A State that is using the WPA

- Targets those watersheds where pollution poses the greatest risk to human health, ecological resources, or desirable uses of the water, and where a successful outcome is likely

- Involves all parties with a stake in the watershed in the analysis of problems and the implementation of solutions

- Draws on the full range of methods and tools available, integrating them into a coordinated, multi-organizational attack on the problems.

The WPA draws on existing EPA authorities, as well as State and local requirements, and voluntary actions to resolve all significant water quality problems in a watershed. The WPA emphasizes the goal of monitoring or restoring ecological integrity in watersheds in addition to the more traditional goals of protecting human health and meeting water quality standards. Restoring ecological integrity means more than controlling chemical pollutants in the water column; other factors–flow, temperature, bank and riparian buffer condition, sedimentation, existence of riffles and pools in the stream–must be considered.



The Total Maximum Daily Load (TMDL) process, as established by Section 303(d) of the Clean Water Act, is a key element of the Watershed Protection Approach. TMDLs provide a flexible tool to address any stressor that precludes the attainment of water quality standards. A TMDL calculates allowable loadings from the contributing point and nonpoint sources to a given waterbody and provides a quantitative target for the pollution reduction necessary to meet water quality standards. States develop and implement TMDLs for impaired or threatened waterbodies.

NOTE

Under the WPA, a "watershed" is a hydrogeologic area defined for best management purposes. A watershed can be a river basin, a county-sized watershed, or a small supply watershed.

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EPA's recent efforts to fully implement Section 303(d) revolve around tackling more challenging problems and moving toward integrated water-quality-based controls on point and nonpoint sources, geographic targeting, and watershed-scale assessments and protection.

The WPA fosters a high level of interprogram coordination within a State. Historically, each individual program deals with a particular problem, and each sets its own priorities. In a typical State, the National Pollutant Discharge Elimination System (NPDES) program issues discharge permits for point sources, the Section 319 program deals with nonpoint source controls, the ground water program protects wellheads and aquifers, and the fisheries program monitors fish populations and contamination by toxics. The WPA seeks to establish common priorities so that all available resources and talent can be brought to bear on targeted areas.

Implementation

WPA projects are being implemented at three levels—State, local, and regional. Some States, such as North Carolina and South Carolina, have incorporated elements of the WPA by shifting program activities to a basinwide planning approach. These States concurrently conduct most major program activities such as NPDES permitting, nonpoint source management, TMDL development, and monitoring within a basin (Figure 10-1). A management plan is developed for each basin every 5 years. Both of these States made the switch to basinwide planning without major organizational changes or increased resources.

Wisconsin's Priority Watershed Program focuses on watersheds rather than large basins. Wisconsin targets several of the State's 330

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watersheds each year and begins nonpoint source planning, monitoring, and other efforts; full implementation of a watershed plan takes about 10 years.

On the local level, the U.S. Department of Agriculture and other agencies have sponsored watershed projects for many years. In other cases, a local government agency provides the impetus for a project and a special management agency may be formed. Successful projects involve a high degree of local participation through advisory committees, volunteer monitoring, and other activities. The Anacostia River Restoration Program is an example of a progressive urban watershed project (see highlight). The State of Washington also provides technical expertise to local committees for preparation of watershed action plans (see Puget Sound highlight).

At the regional level, large watershed projects often involve multiple States and Federal jurisdictions. The Great Lakes and National Estuary Programs (described in Chapter 11) are examples of WPA-type projects at the regional level. In addition, the EPA Regions are implementing a series of WPA projects in their States.

Figure 10 1

Neuse River Basin

The Neuse River Basin, North Carolina, featuring the upper Contentnea Creek watershed. The State will update the Neuse River Basin Plan, conduct monitoring, and revise NPDES permits concurrently throughout the basin every 5 years.

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The Anacostia River Restoration Project

This project illustrates many of the principles being encouraged under EPA's Watershed Protection Approach.

Background

The Anacostia River is a tributary to the Potomac River and has a watershed of about 150 square miles. The watershed has a variety of pollution and habitat modification problems. Starting in the 1930s, construction projects along the Capitol Mall and Washington's central business district transferred much of the surface drainage of the Tiber River to the Anacostia. This creates a substantial combined sewer overflow (CSO) problem on the lower, tidal portions of the River. In addition, approximately 75% of the Anacostia watershed's forest cover has been removed for urban development and agriculture, resulting in high stormwater flows and pollutant loadings.

From an early date, the Anacostia was targeted by Maryland as a Critical Area under the Chesapeake Bay program. With impetus from this program, the Anacostia Restoration Agreement was signed in 1987. The four principal signatories are the State of Maryland, Maryland's Montgomery and Prince George's Counties, and the District of Columbia.

Stakeholders

The Anacostia River Restoration Committee consists of representatives from the signatory agencies:

- District of Columbia Department of Public Works
- District of Columbia Department of Consumer and Regulatory Affairs
- Prince George's County Department of Environmental Regulation
- Montgomery County Department of Environmental Programs
- Maryland Department of Natural Resources
- Maryland Department of the Environment.

Other stakeholders and participants include

- U.S. Army Corps of Engineers
- Washington Suburban Sanitary Commission
- National Park Service
- Interstate Commission on the Potomac River Basin
- Metropolitan Council of Governments
- U.S. Department of Agriculture
- U.S. Environmental Protection Agency
- Izaac Walton League
- Anacostia Watershed Society
- Alliance for Chesapeake Bay.

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Subwatershed Action Plans

With more than 60 groups and government programs involved, the key to restoring the Anacostia River is the creation of detailed Subwatershed Plans (SWAPs). SWAPs are blueprints for restoration activities within a portion of the Anacostia Basin. SWAPs address high-priority needs in each subwatershed while targeting attention on goals that will benefit the entire basin.

Each SWAP consists of eight elements:

- an analysis of existing water quality information
- specific goals to guide restoration efforts
- an inventory of stormwater retrofit and stream restoration opportunities
- a priority ranking of restoration projects based on feasibility, cost, and ability to meet goals
- long-term agreements to implement and monitor priority restoration projects
- plans to increase wetlands and forest cover
- lists of additional actions that could protect the subwatershed
- a long-term monitoring program to assess progress in achieving water quality and habitat improvements.

SWAPs have been defined for nine subwatersheds and three more SWAPs are under development.

Implementation of Controls

Implementation measures in the Anacostia Basin generally fall into two categories: stormwater retrofits and stream restoration projects. Stormwater retrofits usually control storm surges with wet or dry detention structures. Promising restoration measures include the establishment of stream buffer zones, streambank stabilization, wetlands reclamation, riparian reforestation, and modification of fish barriers. Coordination with open space agencies, such as the National Park Service and city parks, helps target restoration efforts to streamsides with the most potential to restore aquatic resources and enhance natural processes that trap pollutants.

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Puget Sound Watershed Planning*

Developing an Action Plan

Local watershed management committees form the backbone of efforts to protect the State of Washington's Puget Sound from nonpoint sources. Local committees seeking funding for watershed projects in the Puget Sound basin are required to prepare action plans for control of nonpoint sources. The Puget Sound Water Quality Authority's Nonpoint Rule requires watershed management committees to include, at a minimum, the following elements in their action plans:

- A watershed characterization, including information such as watershed maps, geographic and biological information, and sources of data on the watershed
- A water quality assessment identifying nonpoint sources of pollution and evaluating water quality, beneficial uses, and the biological "health" of the watershed
- A problem definition indicating the extent of existing and potential water quality problems and effects on beneficial uses from nonpoint sources in the watershed
- Goals and objectives for prevention and correction of these nonpoint pollution concerns
- Specific source control programs to address the problems identified and justification for the management actions proposed in each of these programs. Source control programs can apply to stormwater, erosion, agriculture, onsite sewage disposal systems, forest practices, boats and marinas, and other nonpoint sources.

*Source: Puget Sound Water Quality Authority, 1989.

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HIGHLIGHTS

- An implementation strategy identifying specific actions required, the responsibilities of each implementing agency or entity, and project milestones, costs, and funding sources.

Interagency Technical Assistance Teams

The Washington Department of Ecology (DOE) formed the Interagency Technical Assistance Team to support local watershed committees. The Interagency Technical Assistance Team provides a central pool of experts that local committees can utilize. The team consists of representatives from over 20 State agencies with expertise in

- Forestry best management practices
- Technical transfer to the agricultural community
- Surface water quality monitoring and assessment
- Ground water protection
- Stormwater management
- Shellfish protection
- Public involvement strategies
- Wildlife management
- Habitat protection.

In addition, a Puget Sound Cooperative River Basin Study Team was formed with representatives from the Soil Conservation Service, the Forest Service, the Washington Department of Fisheries, and DOE. This team helps evaluate land use water quality problems within watersheds through field and literature investigations, provides management alternatives, and produces reports and maps based on watershed information.

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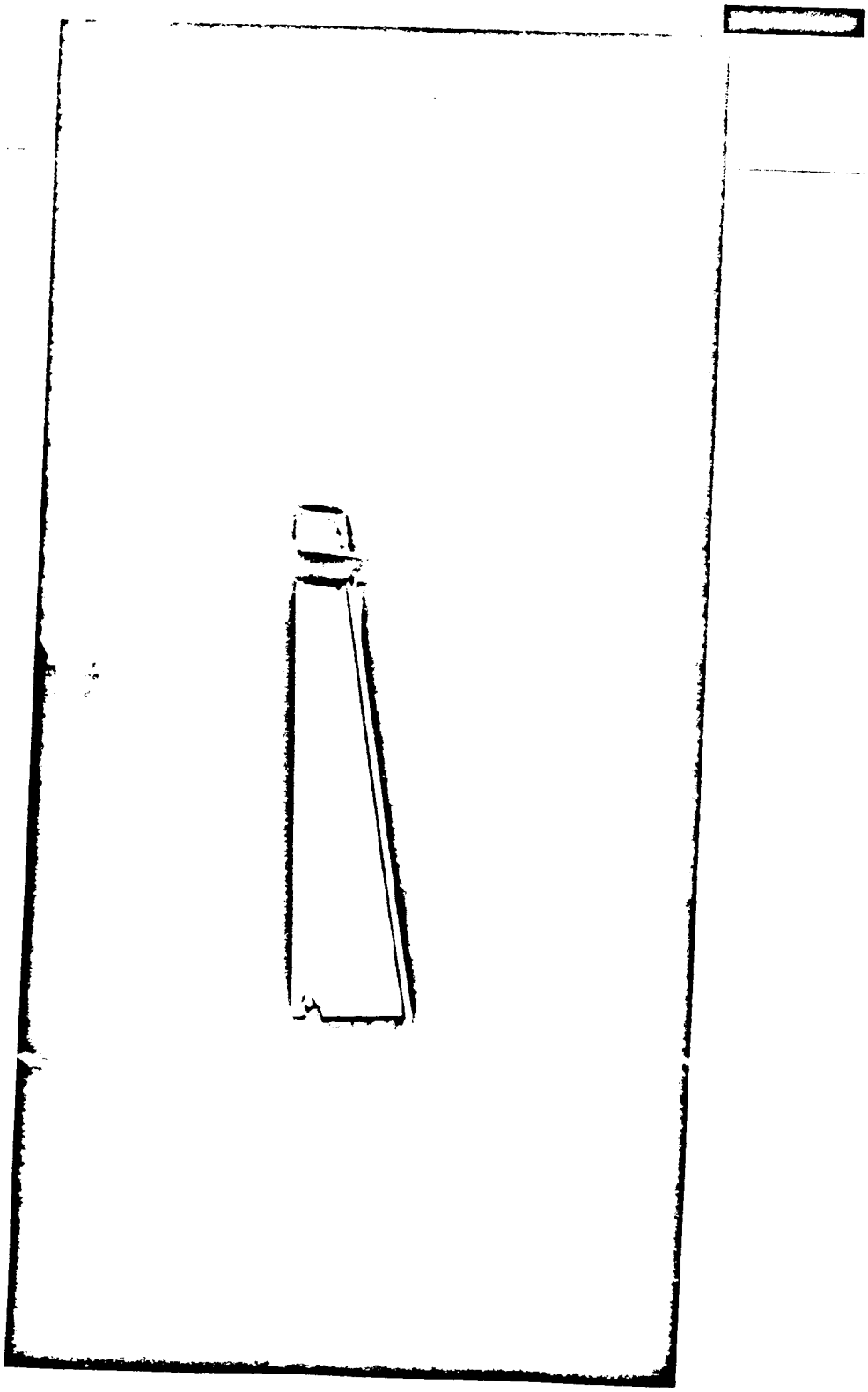

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Geographically Targeted Programs

Introduction

The programs described in this chapter (the Great Waterbodies Program, the Great Waters Program, and the National Estuary Program) embody a watershed protection approach at different scales. The Great Waterbodies Program and the Great Waters Program target entire drainage basins, such as the Gulf of Mexico, which drains two-thirds of the continental United States and a large portion of Mexico. The National Estuary Program (NEP) targets clusters of watersheds that drain into a specific estuary, such as Galveston Bay. NEP sites may be nested within a larger basin targeted by the Great Waterbodies or Great Waters Programs, such as the Gulf of Mexico.

Although scales differ, these programs share a common ecosystem approach to solving water quality problems. The ecosystem approach recognizes that all components of the environment are interconnected and that pollution released in one area can cause problems in another. This concept requires all responsible parties to recognize and reduce impacts. Therefore, managing pollution on the ecosystem level requires building institutional frameworks that involve all affected parties, such as agricultural interests, environmental advocacy organizations, industry, government agencies, and private citizens. Consensus is a key to managing pollution on the ecosystem level.

The ecosystem approach also encourages pollution prevention and efforts to avoid actions that can even indirectly lead to contamination of the waterbody. Although such ecosystem perspectives are hardly new, they are more often applied to much smaller units such as watersheds.

The Great Waterbodies Program

Background

The Great Waterbodies Program manages water quality protection in the three largest watersheds targeted by EPA: the Gulf of Mexico, the Great Lakes, and the Chesapeake Bay.

The Gulf of Mexico

Background

The Gulf of Mexico is fed by rivers draining a vast area in five countries. The Gulf's watershed, which covers almost 2 million square miles, is far larger than the Chesapeake Bay or Great Lakes

INVOLVEMENT OF ALL AFFECTED PARTIES is the most important issue

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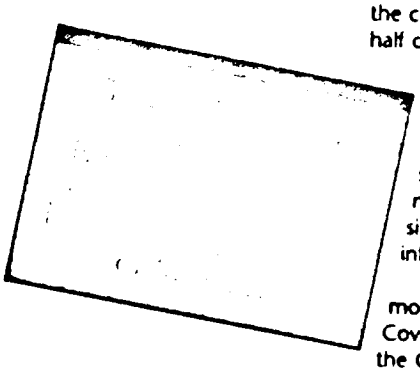

watersheds. It includes two-thirds of the continental United States, one-half of Mexico, and parts of Canada, Guatemala, and Cuba. Over 1.1 million square miles of the Gulf's watershed are in the Mississippi River drainage system, making the Mississippi the single largest freshwater riverine influence on the Gulf.

The Gulf of Mexico is enormously productive and diverse. Covering 600,000 square miles, the Gulf provides habitat for over 75% of U.S. migratory waterfowl. Its commercial fisheries annually produce nearly 2 billion pounds of fish, oysters, shrimp, and crabs, and almost 90% of U.S. offshore oil and gas comes from Gulf waters. Four of our Nation's busiest ports border its shores, and many nations of the world fish its waters. As a recreational resource, the Gulf and adjacent estuaries provide a playground for sport fishing, diving, water skiing, sailing, swimming, sunbathing, beachcombing, or just plain relaxing.

However, the health and vitality of the Gulf have been declining in recent years, caused in part by increasing populations along its coast and the growing demand upon its resources and in part by the accumulation of years of careless depletion, abuse, and neglect of its environment. These problems in the Gulf have reduced its ability to regenerate naturally. The result has been alarming damage and destruction of the Gulf's ecosystem and habitats, particularly wetlands and seagrasses. These losses stem from: marine debris, toxic substances and pesticides, coastal and shoreline erosion, nutrient enrichment, freshwater inflow, nonpoint source runoff, and contaminants from inefficient or nonexistent septic systems. The effects are seen in decreasing populations of waterfowl and marine wildlife, increasing degradation and loss of wetlands and other habitat, and growing threats to human health from environmental pollution.

The Gulf of Mexico Program

In response to signs of serious long-term environmental damage throughout the Gulf's coastal and marine ecosystem, the Gulf of Mexico Program (GMP) was established in August 1988 with EPA as the lead Federal agency. The Program Office is located at Stennis Space Center in Mississippi. Its main purpose is to develop and help implement a strategy to protect, restore, and maintain the health and productivity of the Gulf. The GMP is a grass roots program that serves as a catalyst to promote sharing of information, pooling of resources, and coordination of efforts to restore and reclaim wetlands and wildlife habitat, clean up existing pollution, and prevent future contamination and destruction of Gulf resources.

In addition to providing funds, the GMP mobilizes Federal, State, and local government; business and industry; academia; and the community at large through programs of public awareness, information dissemination, forum discussions, citizen committees, and technology application. A Policy Review Board and a newly formed Management Committee determine the scope and focus of GMP activities. The

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program also receives input from a Technical Advisory Committee and a Citizen's Advisory Committee. The GMP Office and 10 technical Issue Committees coordinate the collection, integration, and reporting of pertinent data and information.

The Issue Committees are responsible for documenting environmental problems and management goals, available government and private resources, and potential solutions relating to specific issue areas. The Issue Committees are composed of individuals from Federal, State, and local agencies and from industry, science, education, business, citizen groups, and private organizations. These committees cover a broad range of issues, including habitat degradation, public health, freshwater inflow, marine debris, coastal and shoreline erosion, nutrient enrichment, toxics and pesticides, and living aquatic resources. They develop and present their findings in GMP documents called Action Agendas, which describe strategies to build upon programs already under way and to develop new cooperative mechanisms with other public and private organizations. The Action Agendas also provide strategies to monitor and assess the effectiveness of ongoing efforts and to communicate information to individuals and agencies that can best use it. Two additional committees provide operational support for public education and outreach and data and information transfer activities for the entire GMP.

Partnership for Action

On December 10, 1992, EPA; the Governors of Alabama, Florida, Louisiana, Mississippi, and Texas; the Chair of the Citizens Advisory Committee; and representatives of 10 other Federal agencies signed a Gulf of Mexico Program Partnership for Action agreement for protecting, restoring, and enhancing the Gulf of Mexico and adjacent lands. The partnership document includes vision and goal statements and nine 5-year challenges for the GMP. The goals established for the Gulf of Mexico Program are to protect, restore, and enhance the coastal and marine waters of the Gulf of Mexico and its natural coastal habitats, to sustain living resources, to protect human health and the food supply, and to ensure the recreational use of Gulf shores, beaches, and waters in ways consistent with the economic well-being of the region.

The nine environmental challenges commit the signatory agencies to pledge their efforts, over the next 5 years, to obtain the knowledge and resources to

- Significantly reduce the rate of loss of coastal wetlands
- Achieve an increase in Gulf Coast seagrass beds
- Enhance the sustainability of Gulf commercial and recreational fisheries
- Protect human health and the food supply by reducing inputs of nutrients, toxic substances, and pathogens to the Gulf
- Increase Gulf shellfish beds available for safe harvesting by 10%
- Ensure that all Gulf beaches are safe for swimming and recreational uses
- Reduce by at least 10% the amount of trash on beaches

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- Improve and expand coastal habitats that support migratory birds, fish, and other living resources
- Expand public education/outreach tailored for each Gulf Coast county or parish.

The GMP structure has been streamlined to better meet the needs of the new 5-year environmental challenges. In addition, EPA is restructuring its management scheme for the GMP to increase Regional involvement in the program as it moves to implement environmental protection and restoration activities.

Take-Action Projects

During 1992, the GMP launched important environmental projects in each of the five Gulf States to demonstrate that GMP strategies and methods could achieve positive results quickly. Called "Take-Action Projects," they primarily address habitat protection and restoration and public health. They are designed for Gulf-wide application to help restore the environment.

Water Quality

In Louisiana, Florida, and Alabama, several Take-Action Projects deal with pollution and contaminants from inadequate treatment of human waste–a main cause of damage to Gulf coastal ecosystems and a major concern to public health officials and to the tourism and seafood industries.

- An innovative wastewater treatment system is being monitored in a pilot project near the Port Fourchon/Bay Marchand area of Lafourche Parish, Louisiana. The *upwelling injection* system filters human wastewater through a sand/soil bed to remove fecal coliforms and enteric viruses–the primary pollutants and contaminants in human waste. The system uses inexpensive, easy to install equipment that has potential use throughout the Gulf's system of rivers and bayous. Monitoring and mathematical modeling will be used to evaluate the improvement of environmental conditions in nearby oyster beds.

- A Take-Action Project is under way in Florida's Suwannee Sound and Appalachicola National Estuarine Research Reserve to upgrade existing septic systems that pollute coastal waters. Contamination from fecal coliforms has required suspension of oyster harvesting and threatened to close beaches. Health officials are monitoring improvements to oyster habitat and recreational uses of coastal waters.

- The use of peat moss as a medium for filtration and biological treatment of household wastewater is being demonstrated in Weeks Bay, Alabama. Use of this raw material and renewable resource as a sewage treatment medium is intended to reduce fecal coliforms in nearby oyster-producing waters.

Pollution Prevention

The State of Mississippi has developed a common sense publication entitled *The Gulf of Mexico Citizens Pollution Prevention Handbook*. Written in nontechnical language, the handbook describes the Gulf of Mexico and explains why it is a valuable resource to our Nation's economy and quality of

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life. This take-action guide provides a detailed listing of contacts for more information, and it explains specific ways that everyone in the Gulf region can be actively involved in restoring and preserving the environmental quality of the Gulf.

Habitat Protection

Based on a Texas program called Coastal Preserves, a GMP Take-Action Project called Eco-reserves strives to protect coastal tracts that have been identified as important to the Gulf ecosystem. In some cases, areas may be preserved as wilderness. In others, they would be conserved–that is, carefully monitored and managed to maintain their vitality as wildlife and marine life habitat while being used for hunting, fishing, resource extraction, recreation, or other development. Ideally, these tracts would be under the management and protection of a government agency or established environmental organization.

To promote the concept Gulf-wide, the GMP sponsored an Eco-reserves Workshop in New Orleans to share information about the need to protect such areas; to discuss the resources available to help manage, preserve, or conserve them; and to develop a strategy for generating Gulf-wide support and funding for protecting the most valuable of these tracts.

- Adopting this concept, Mississippi set aside a donated portion of the Graveline Bayou Estuary and placed it under the protection and management of the State's Bureau of Marine Resources.

- Protection of oyster habitat is the goal of a Take-Action Project in Alabama. Oyster beds and reef systems in the shallow waters of Mobile Bay, often harmed unintentionally by boaters and fishermen, have been marked with buoys and signs to help boaters and fishermen avoid damaging them in the future.

Habitat Restoration

The degradation (and in many cases, complete disappearance) of wildlife and marine life habitats is one of the most serious environmental problems of the Gulf ecosystem. Restoration of these habitats is the focus of numerous GMP Take-Action Projects throughout the Gulf Region. Wetlands, reefs, seagrasses, and the quality of the water in these habitats are among the most significant concerns receiving immediate attention.

Seagrass Beds

One of several Take-Action Projects in Alabama's Mobile Bay is an innovative program to restore damaged or destroyed seagrass beds – a major habitat for fish, shrimp, and crabs. A new approach being developed is less costly and labor intensive than current methods of transplanting from existing seagrass beds. Seagrasses are germinated from the seeds of wild plants, grown in the natural environment within protected mesh-covered trays, then planted in designated areas where seagrass beds are in decline or are known to have once existed. Low in cost and requiring very little equipment or technical knowledge, this program lends itself extremely well to hands-on participation by concerned citizens and can be easily implemented Gulf-wide.

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Salt Marsh Wetland

Another Take-Action Project in Alabama's Mobile Bay is the restoration of a salt marsh wetland on an abandoned site near the Dauphin Island Sea Lab. A wildlife habitat before the Civil War, this marsh wetland was filled in and used for a number of land uses including grave sites and large septic tank reservoirs. The objective of this project is to accelerate the natural reclamation process of tidal action and provide a model for future manmade marsh and wetlands areas. A team of scientists is carefully monitoring the marsh reconstruction (from initial sloping of the land and planting of marsh and wetlands flora, to rebuilding of the adjacent dune system) and will conduct a long-term evaluation of the habitat's health and development. This "living marsh" will also serve as an outdoor exhibit for the nearby *Estuarium* – a marine sciences museum intended to educate the public about the marine flora and fauna found in the surrounding area.

Oyster Bed

In Louisiana, Florida, and Alabama, the number of oyster reefs that have been closed to harvesting operations has steadily increased in recent years due to bacterial contamination from inadequately treated human waste. The solution is a series of Take-Action Projects to install upgraded septic systems or innovative sewage treatment systems in areas affecting the oyster beds. In a few short years, these low-cost, easy-to-install systems are expected to revitalize oyster habitats and help rebuild associated commercial operations.

- In Louisiana, the Nation's number one producer of oysters, a take-action project in cooperation with the National Estuary Program targets 240,000 acres of the Barataria-Terrebonne Estuary that contains 68% of the State's private oyster leases–an area increasingly closed to harvesting. Likewise, the oyster-producing areas near Suwannee Sound and Appalachicola Bay (Florida) and Weeks Bay (Alabama) will benefit from similar projects to improve sewage treatment systems.

- Another Take-Action Project in Alabama's Mobile Bay aims to restore and create oyster habitat with a certain type of Mexican coral taken from dead reef deposits found inland and used to form new living reefs for young oysters to grow on. This first-of-its-kind application of such coral will shorten the time it takes for oyster reefs to form. If successful, it could have far-reaching impacts in reef restoration Gulf-wide.

The Great Lakes Basin

Background: Water Quality in the Great Lakes

During the past two decades, the United States and Canada have corrected many of the nutrient enrichment problems in the Great Lakes region that attracted national attention in the 1960s. Since 1970, phosphorus detergent restrictions, municipal sewage treatment plant construction and upgrades, and agricultural practices that reduce runoff have cut the annual phosphorus load into the Great Lakes in half. The decline in phosphorus loadings is most evident in Lake Erie, which receives more effluent from sewage

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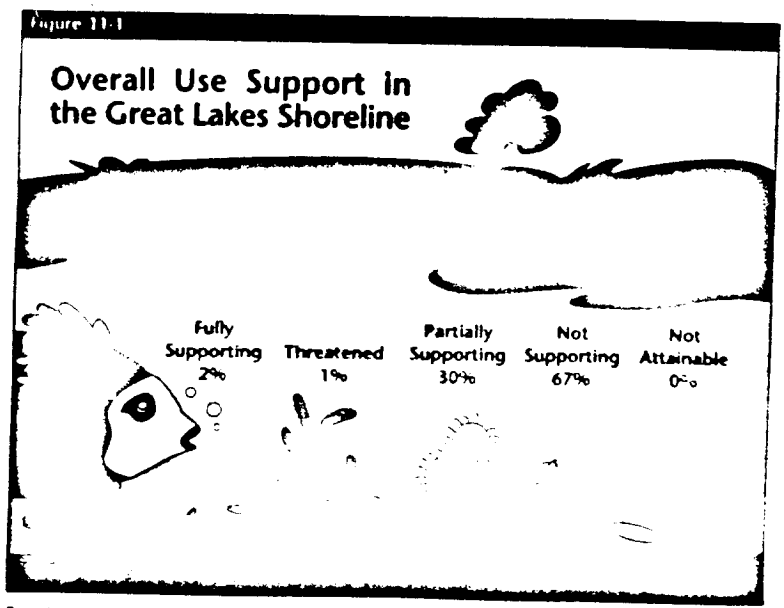
treatment plants and sediment from agricultural lands than the other Great Lakes. Lake Erie also experienced a concurrent decline in phytoplankton biomass, an indicator of trophic condition and nutrient enrichment. The decline in phytoplankton biomass provides evidence that the phosphorus controls implemented in the early 1970s have reversed Lake Erie's severe nutrient enrichment problems of the 1960s.

Despite dramatic declines in the occurrence of algal blooms, fish kills, and "dead" zones depleted of oxygen, less visible problems continue to degrade water quality in the Great Lakes. The States report that toxic contamination is the most prevalent and persistent water pollution problem in the Great Lakes. The eight States bordering the Lakes have issued advisories to restrict consumption of fish caught along their entire shorelines because concentrations of mercury, PCBs, pesticides, and dioxins in fish tissues exceed standards set to protect human health. As a result, virtually all of the waters along the Great Lakes shoreline fail to fully support fish consumption use, and therefore fail to fully support overall designated uses (Figure 11-1).

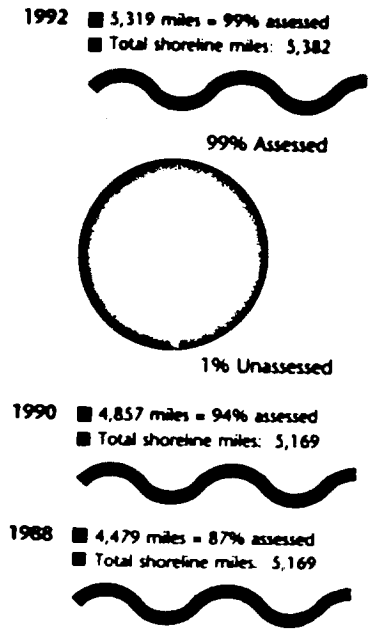
Although fish consumption use is impaired throughout the Lakes, more than 96% of the Great Lakes shoreline fully supports recreational uses, drinking water supply use, and agricultural use (Figure 11-2). The individual use support data submitted by the States indicate that the remaining problems on the Lakes have the greatest impact on fishing activities and aquatic life. Aquatic life impacts include depleted fish

Figure 11-1



Based on data contained in Appendix F, Table F-1.

Great Lakes Shoreline Miles Assessed by the States



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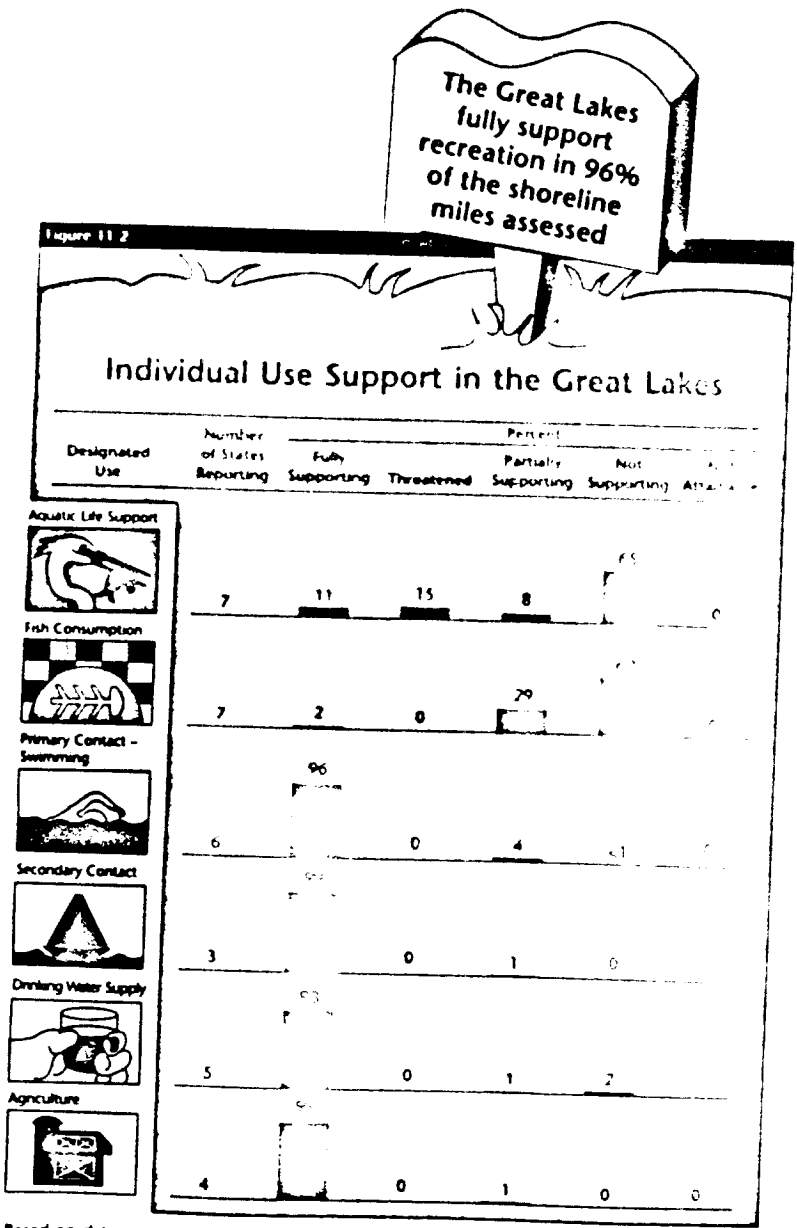

Based on data contained in Appendix F, Table F-2.

populations and reproduction problems in birds (Table 11-1 and box). Aquatic life impacts result from persistent toxic pollutant burdens in birds, habitat degradation and destruction, and competition and predation by nonnative species, such as the zebra mussel and the sea lamprey.

The States reported that priority organic chemicals, such as PCBs and dioxins, are the most prevalent cause of impairment in their Great Lakes waters (Figure 11-3). These toxic chemicals persist in fish tissues, wildlife tissues, and sediment. The States reported much lower incidences of metal contamination, depressed oxygen conditions, nutrient pollution, and siltation.

The States did not report extensively on sources of contamination in the Great Lakes (Figure 11-4). Therefore, the information on sources applies to only one-third of the Great Lakes shoreline. The States reported that atmospheric deposition contributes to the impairment of 50% of the impaired shoreline, followed by contaminated sediments (affecting 40%), land disposal (affecting 30%), and urban runoff and storm sewers (affecting 10%).

Building Institutional Frameworks for the Great Lakes

Rehabilitating the Great Lakes requires cooperation from numerous organizations because pollutants originate in both Canada and the United States and pollutants enter the Lakes via multiple media (i.e., air, ground water, and surface water). The International Joint

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Trends in PCB Contamination in the Great Lakes

Research conducted by the United States and Canada in the Great Lakes indicates that PCB concentrations in wildlife have declined dramatically since the EPA banned most uses of PCBs in 1976. However, the PCB concentrations in fish persist well above concentrations set to protect public health, and the persistent PCB burdens in some fish, mammals, and birds still may impair reproductive success. For example, concentrations of PCBs in Lake Michigan lake trout declined by about 90% since 1970, but remain at about 180 times the target goal of 0.014 parts per million. Similarly, body burdens of PCBs in a colony of Forster's terns near Green Bay, Wisconsin, declined by 66% while hatching success tripled between 1983 and 1988. However, the tern's offspring continued to suffer "wasting" and other fatal health problems, which may have resulted from the contaminant burdens in the adult birds.

Table 11-1: Effects of Toxic Contamination on Fish and Wildlife in the Great Lakes

Species	Population Decrease	Effects on Reproduction	Eggshell Thinning	Birth Defects	Behavioral Changes	Biochemical Changes	Mortality
Mink	X	X	NA	NE	NE	NE	X
Otter	X		NA	NE	NE	NE	?
Double-crested Cormorant	X	X	X	X		X	?
Black-crowned Night Heron	X	X	X	X		X	?
Bald Eagle	X	X	X	NE		NE	NE
Herring Gull		X	X	X	X	X	X
Ring-billed Gull				X		NE	X
Caspian Tern		X		X	NE	NE	
Common Tern		X	X	X		X	
Forster's Tern		X		X	X	X	
Snapping Turtle	NE	X	NA	X	NE	NE	NE
Lake Trout		X	NA			X	
Brown Bullhead			NA NA			X X	
White Sucker			NA	X		X	

X = Effects documented.
NA = Not applicable.
NE = Not examined.
? = Suspected because population declined.

NOTE: Unpublished records of gross birth defects exist for the double-crested cormorant, great blue heron, and the Virginia rail.

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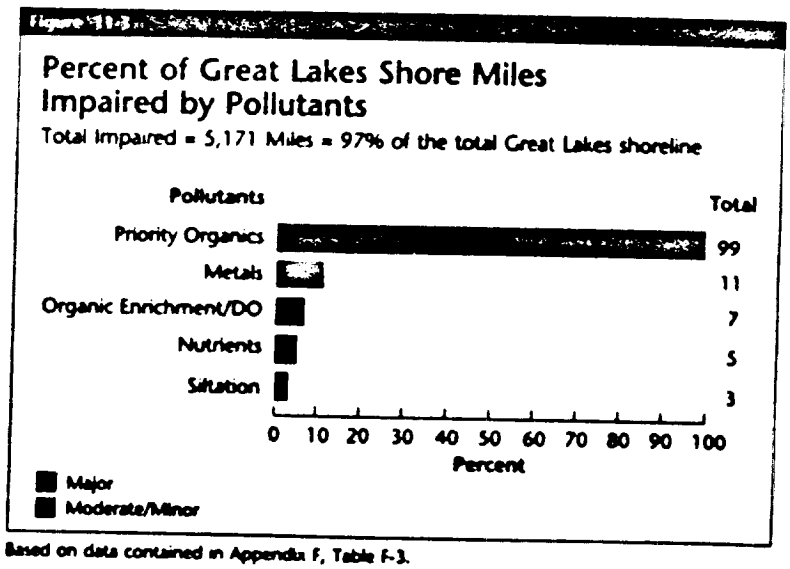
Commission (IJC), established by the 1909 Boundary Waters Treaty, lays the foundation of the institutional framework for managing the Great Lakes. Representatives from the Governments of the United States and Canada, the Province of Ontario, and the eight States bordering the Lakes sit on the IJC. The IJC is responsible for identifying actions needed to maintain the integrity of the Great Lakes ecosystem.

The EPA Great Lakes National Program Office (GLNPO) serves as a liaison and provides information to the Canadian members of the IJC and the Canadian counterparts to the EPA. The GLNPO also coordinates activities in the United States aimed at protecting and restoring the Lakes.

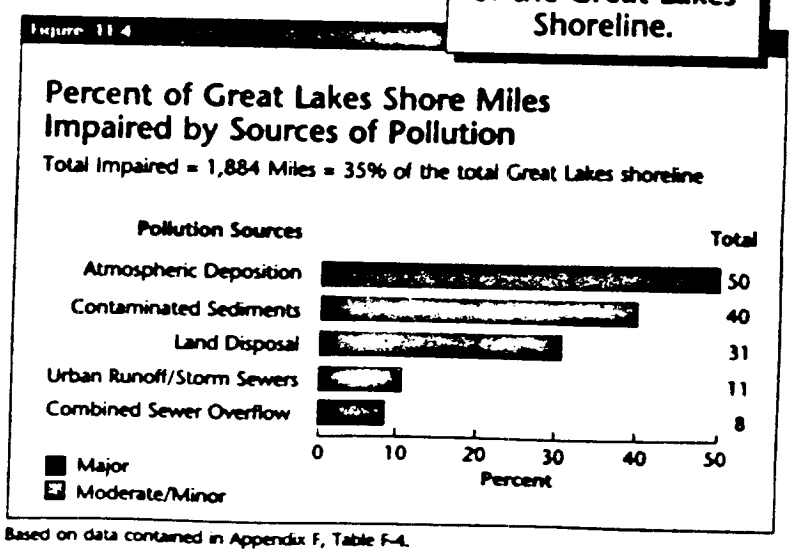
The Great Lakes Protection Fund was formed by the Great Lakes Governors in 1989. The mission of the Fund is to identify, demonstrate, and promote regional action to enhance the health of the Great Lakes ecosystem. It is the Nation's first multi-State environmental endowment. The Great Lakes States have pledged $100 million to its permanent endowment.

Public-private partnerships support the institutional framework for managing the Great Lakes water quality. Special boards, commissions, and committees composed of representatives from universities, environmental organizations, agricultural interests, industry, shipping interests, and government play vital roles in coordinating policy and management decisions. Some of these groups focus on local areas and issues, while others represent national organizations. To better coordinate their activities on the



Based on data contained in Appendix F, Table F-3.

Information on sources applies to ONLY 35% of the Great Lakes Shoreline.



Based on data contained in Appendix F, Table F-4.

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Great Lakes Basin, groups have begun to support umbrella organizations, such as Great Lakes United. Great Lakes United, started in 1982, represents more than 180 affiliated groups in the United States and Canada. One of its goals is to facilitate citizen involvement in decisionmaking processes.

The Great Lakes Commission is an independent organization binationally chartered that integrates environmental concerns with economic development concerns. The Commission's members are appointed by the States, Canadian Provinces, and Federal governments. The members issue reports on subjects such as the environmental impacts of transportation options in the Great Lakes Region. The reports provide data for decisionmaking by the government bodies with authority to manage the Lakes.

Private conservation groups are also working with government agencies to protect natural areas in the Great Lakes Basin. The GLNPO is funding 19 restoration and protection projects based, in part, on findings of the Great Legacy Project. The Great Legacy Project includes efforts by the Nature Conservancy of Canada and the United States and other conservation groups to pool natural heritage data from several public agencies and land trusts and to apply geographic targeting approaches to identify particularly high-quality resource areas.

The Great Lakes Water Quality Agreement

The 1978 Great Lakes Water Quality Agreement (GLWQA), as amended in 1987, established a commitment by the United States and Canada to restore and protect the Great Lakes. The Amendments to the Agreement stress two central concepts: (1) the ecosystem approach, and (2) the virtual elimination of persistent toxic substances.

CONSIDERABLE SUCCESS [illegible] toxic pollutants.

Although there has been considerable progress in addressing impacts from point and nonpoint loadings of conventional pollutants under the GLWQA, the Great Lakes are still highly vulnerable to toxic pollutants. The IJC released a set of recommendations identifying 11 "critical pollutants" for which management scrutiny is warranted throughout the Basin. These chemicals and possible sources are presented in Table 11-2.

The Great Lakes Water Quality Initiative

In June of 1989, EPA launched the Great Lakes Water Quality Initiative to provide a framework for Federal assistance in pursuing the goal of whole-system restoration based on an ecosystem perspective. The Initiative emphasizes areas in which EPA can provide State governments and other stakeholders with technical support. The Initiative envisions EPA making the following technical contributions:

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Chemical	Production and Release	Source
2,3,7,8-TCDD (dioxin) and 2,3,7,8-TCDF (furan)	Unintentional	Contaminant in herbicides used in agriculture, range, and forest management. Also produced as a byproduct of combustion of fossil fuels and waste incineration, and through production of pentachlorophenol (PCP) and pulp and paper production processes. 2,3,7,8-TCDD is the most toxic of 75 congeners (forms) of dioxin, and 2,3,7,8-TCDF is the most toxic of 135 congeners of furan.
Benzo[a]pyrene (b[a]p)	Unintentional	Product of incomplete combustion of fossil fuels and wood, including forest fires, grills (charcoal broiling), auto exhaust, and waste incineration. One of a large family of polynuclear aromatic hydrocarbons (PAHs).
DDT[a] and its breakdown products (including DDE)	Intentional	Insecticide, used heavily for mosquito control in tropical areas. Banned for use in the U.S. and Canada with some exceptions for gypsy moth control. Once used extensively in North America and worldwide.
Dieldrin[a]	Intentional	Insecticide used extensively at one time, especially on fruit.
Hexachlorobenzene (HCB)	Unintentional	Byproduct of combustion of fuels and waste incineration, and of manufacturing processes using chlorine. Found as a contaminant in chlorinated pesticides.
Alkylated lead	Intentional	Used as a fuel additive and in solder, pipes, and paint.
	Unintentional	Released through combustion of fuel, waste, and cigarettes, and from pipes, cans, and paint chips.
Mirex[b]	Intentional	Fire retardant; pesticide used to control fire ants. Breaks down to more toxic form, photomirex, in presence of sunlight. Present sources are residuals from manufacturing sites, spills, and land disposal.
Mercury	Intentional	Used in metallurgy, batteries, thermometers, electrical switches, and disinfectants.
	Unintentional	Byproduct of chlor-alkali, gold mining, paint, and electrical equipment manufacturing processes. Also occurs naturally in soils and sediments. Releases into the aquatic environment may be accelerated by sulfate deposition (i.e., acid rain) and leaching from landfills.
Polychlorinated biphenyls (PCB)[c]	Intentional	Insulating fluids used in electrical capacitors and transformers and in the production of hydraulic fluids, lubricants, and inks. Was previously used as a vehicle for pesticide dispersal. PCBs comprise a family of 209 congeners of varying toxicity.
	Unintentional	Primarily released to the environment through leakage, spills, and waste storage and disposal. Leaches from soil and sediment deposits.
Toxaphene[a]	Intentional	Insecticide used on cotton. Substitute for DDT. Use in Great Lakes Basin not documented, but the presence of toxaphene in the Great Lakes raised the issue of long-range transport, or atmospheric deposition.

[a] Use restricted in the United States and Canada.
[b] Banned for use in the United States and Canada.
[c] Manufacture and new uses prohibited in the United States and Canada.

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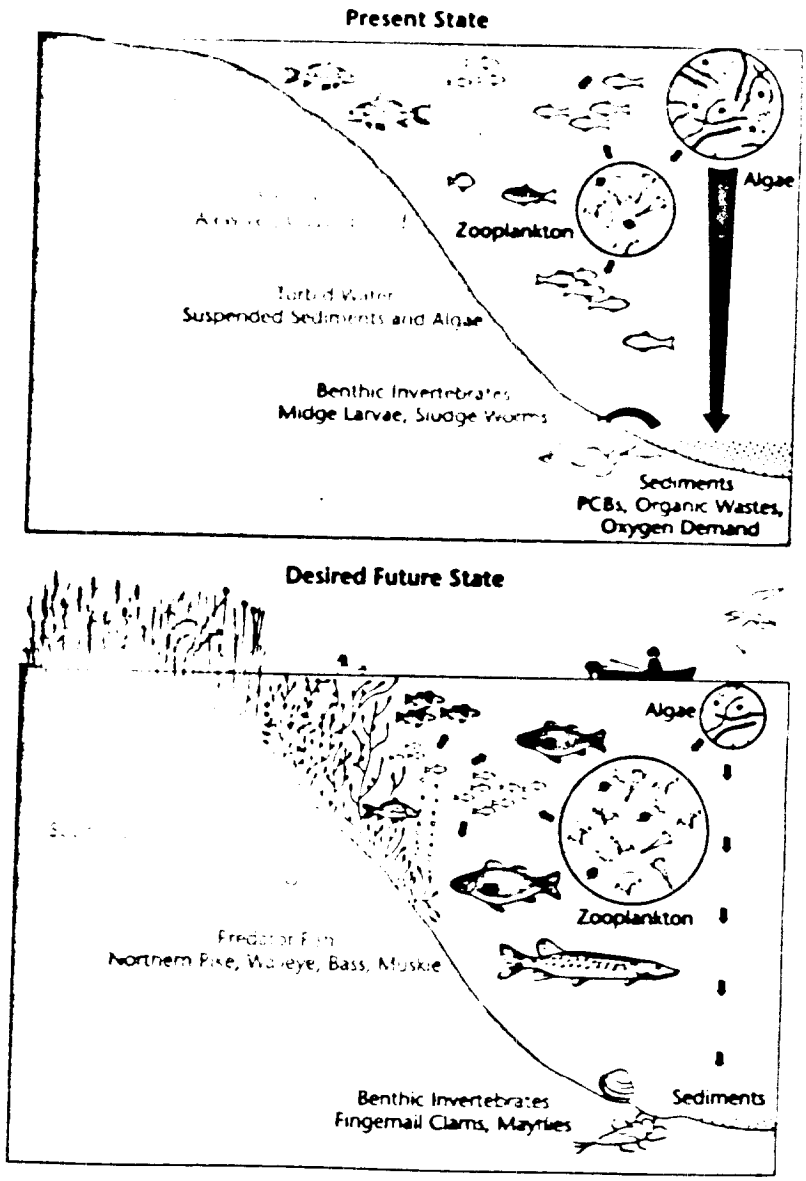
- Develop guidance for identifying areas affected by toxics
- Develop guidance for tracking the relative contributions of toxic and acidic pollutants from surface water and atmospheric sources
- Develop guidance for determining the relative roles of point and nonpoint source contributions to conventional and toxic pollutant burdens
- Suggest innovative approaches for the protection of critical habitat areas
- Support the development of special wildlife standards.

To help implement the goals of the Great Lakes Initiative, EPA Region 5 and the EPA GLNPO coordinate a Steering Committee, Technical Workgroup, and Public Participation Group. The States have played an active role in the development of draft criteria and policies. For example, Wisconsin took the lead in developing water quality standards criteria and wildlife criteria. This is clearly one of the most challenging aspects of the Great Lakes Initiative, since it involves attention to a variety of mammals, waterfowl, and raptors that use aquatic or wetlands habitats and are especially vulnerable to toxicants in their aquatic food supplies. Figure 11-5 illustrates the current status of an impaired Great Lakes watershed (the Lower Green Bay Ecosystem) and the desired future status of the ecosystem, which is the ultimate goal of the Great Lakes Initiative.

By August 1993, EPA had held public hearings on the Great Lakes

Figure 11-5

Present State and Desired Future State of the Lower Green Bay Ecosystem



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Initiative Guidance published in the *Federal Register* in the Spring of 1993. When issued in final form, the GLNPO will use this major guidance document to update the Great Lakes Five Year Strategy. The Strategy translates the general goals of the Great Lakes Water Quality Agreement into practical steps.

Remedial Action Plans for Areas of Concern

Implementing control measures for pollutants usually begins in smaller drainages and waterbodies. At the smallest geographic scale, the IJC identified 43 Areas of Concerns (AOCs), located primarily along river mouths or harbors. The United States and Canada designated all 43 AOCs, which face major toxics concerns. Thirty-five of the 43 AOCs report toxics concerns in ambient water, 41 of 43 report toxics in sediments, and 38 of 43 AOCs restrict consumption of fish harvested from local waters because of elevated toxic concentrations in fish tissues.

In 1985, the Great Lakes States and the Canadian Provinces agreed to develop and implement a Remedial Action Plan (RAP) for each AOC. A complete RAP encompasses the following stages and has a planning document associated with each milestone:

STAGE 1 – Summarizes available information and specifies the nature of the problem(s).

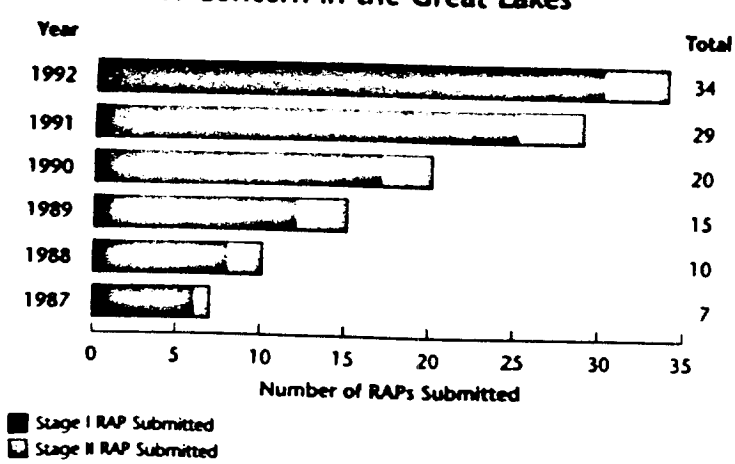
STAGE 2 – Specifies remedial and regulatory measures needed to restore beneficial uses.

STAGE 3 – Summarizes results as progress is achieved in implementing management plans.

Figure 11-6 summarizes the status of Stage 1 and Stage 2 RAP submittals through 1992.

Figure 11-6

Status of Remedial Action Plan (RAP) Development for Areas of Concern in the Great Lakes



Lakewide Management Plans

Lakewide Management Plans (LaMPs) are the next level of geographic integration envisioned in the Great Lakes Water Quality Agreement. The United States is preparing the LaMP for the Lake Michigan Basin, which is contained entirely in this country. Although impacts from nutrients and unionized ammonia toxicity persist, most of the problems in Lake Michigan stem from toxic contaminants

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already in the Lake system and ongoing toxic loadings from point and nonpoint sources.

Building on work in progress at the various AOCs, the Lake Michigan LaMP will look at the lake ecosystem as a whole and identify a set of critical pollutants. In some cases, this would be a subset of the range of pollutants being addressed at smaller geographic units such as the AOCs. In other cases, pollutants that are not of the highest concern in localized areas but are deemed critical to the entire Lake Michigan ecosystem may warrant scrutiny. As the set of critical pollutants is refined, the LaMP will propose a tiered concept for developing management actions.

The LaMPs for each Great Lake will also encourage pollution prevention approaches. Lake Superior provides perhaps the best opportunity to implement pollution prevention because it is the least impacted of the Great Lakes. Lake Superior has been spared much of the extreme ecological disruptions associated with industrial and municipal discharges, introduction of exotic species, and overharvesting of the fisheries that have had devastating impacts on the lower Great Lakes, especially Lakes Ontario and Erie.

In the Spring of 1992, the United States, Canada, and the States of Minnesota, Wisconsin, and Michigan formally agreed on a new regional agreement to protect Lake Superior from toxic pollution. The Binational Agreement seeks to expand authorities (where appropriate) to implement a goal of zero pollutant discharge of persistent toxic substances. As a first step, both the U.S. and the Canadian governments will work to freeze loadings of toxic discharges. The United States and Canada plan to issue a draft LaMP for Lake Superior by the end of October 1993.

Pollution Prevention Initiatives

The EPA GLNPO is working with EPA Regions 2, 3, and 5, the States, and their Canadian counterparts to promote pollution prevention as the most effective approach to achieve the GLWQA goal of virtually eliminating discharges of persistent toxic substances in the Great Lakes. In 1991, EPA and the States developed the Great Lakes Pollution Prevention Action Plan to highlight how EPA and the States will minimize the use, production, and release of toxic substances at the source. The Action Plan targets persistent bioaccumulative toxic substances for reduction or elimination.

At this time, the EPA is implementing the National 35/50 Program in the Great Lakes Basin. Under this program, EPA has received voluntary commitments from industry to reduce the emission of 17 priority pollutants by 50% by the end of 1995. The EPA is also working with utilities located within the Great Lakes Basin to accelerate the phaseout of transformers containing PCBs.

RAP[illegible] are the [illegible] coordi[illegible] elimin[illegible] problems in the Great Lakes Basin.

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The Chesapeake Bay Program

In 1975, the Chesapeake Bay became the Nation's first estuary to be targeted for protection and restoration when Congress, through the appropriations bill, directed EPA's Office of Research and Development to launch a study investigating the causes of the environmental declines experienced in the Bay. Section 117(a) of the Clean Water Act amendments of 1987 required the EPA Administrator to continue the ongoing Chesapeake Bay Program and maintain a Chesapeake Bay Program Office. This program would continue to collect and make available information about the Bay's environmental quality; coordinate Federal and State efforts to improve the Bay's water quality; and determine the impact of sediment deposition and natural and man-induced environmental changes in the Bay, especially nutrients, chlorine, acid precipitation, dissolved oxygen, and toxic pollutants, with particular attention to the impact on striped bass.

Building Institutional Frameworks

A system of committees, subcommittees, work groups, and task forces have evolved under the Chesapeake Executive Council, which acts as the coordinating body for implementation, establishes the policy direction, and provides oversight for the restoration and protection of the Bay and its living resources. On August 6, 1991, the Chesapeake Executive Council adopted four action steps, building on the original 1987 agreement, which defined the future priorities and direction of the Chesapeake Bay Program. These steps are: (1) to reevaluate and accelerate the nutrient reduction program; (2) to adopt pollution prevention; (3) to restore and enhance living resources and their habitat; and (4) to broaden participation in the Bay Program.

Baywide Nutrient Reduction Strategy

In 1987, the parties to the original Chesapeake Bay Agreement of 1983 signed a new Chesapeake Bay Agreement. The 1987 agreement set a specific goal–to achieve at least a 40% reduction of nitrogen and phosphorus entering the mainstem Chesapeake Bay by the year 2000. The agreement also included a provision that the goal be reevaluated in 1991 to determine whether it is, indeed, the reduction needed.

The Problem

Studies completed in the 1970s substantiated that increases in agricultural development, population growth, and sewage treatment plant flows were causing the Bay to become nutrient enriched. High levels of nutrients (primarily phosphorus and nitrogen) flow into the Bay causing excessive algae growth (see Figure 11-7). This condition involves a chain reaction and has two effects:

- In shallow areas, the excess algae shade underwater bay grasses, blocking the light the grasses need

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to grow. This degrades the habitat and causes the eventual loss of grass beds.

■ In deeper areas, when the algae die and sink to the bottom, their decomposition uses up available oxygen in the water. During the warm summer months, oxygen in the bottom waters can only be replenished slowly because little mixing with the high oxygen surface water occurs. Many bottom-living animals such as oysters, clams, and worms, which provide food for fish and crabs, cannot survive this prolonged period of low oxygen.

The Sources

Nutrients that enter the Chesapeake Bay originate from point sources (e.g., municipal and industrial wastewater), nonpoint sources (e.g., cropland, animal wastes, urban and suburban runoff), and atmospheric deposition (airborne contaminants). These sources span

Figure 11.7

Effects of Pollutants in the Chesapeake Bay

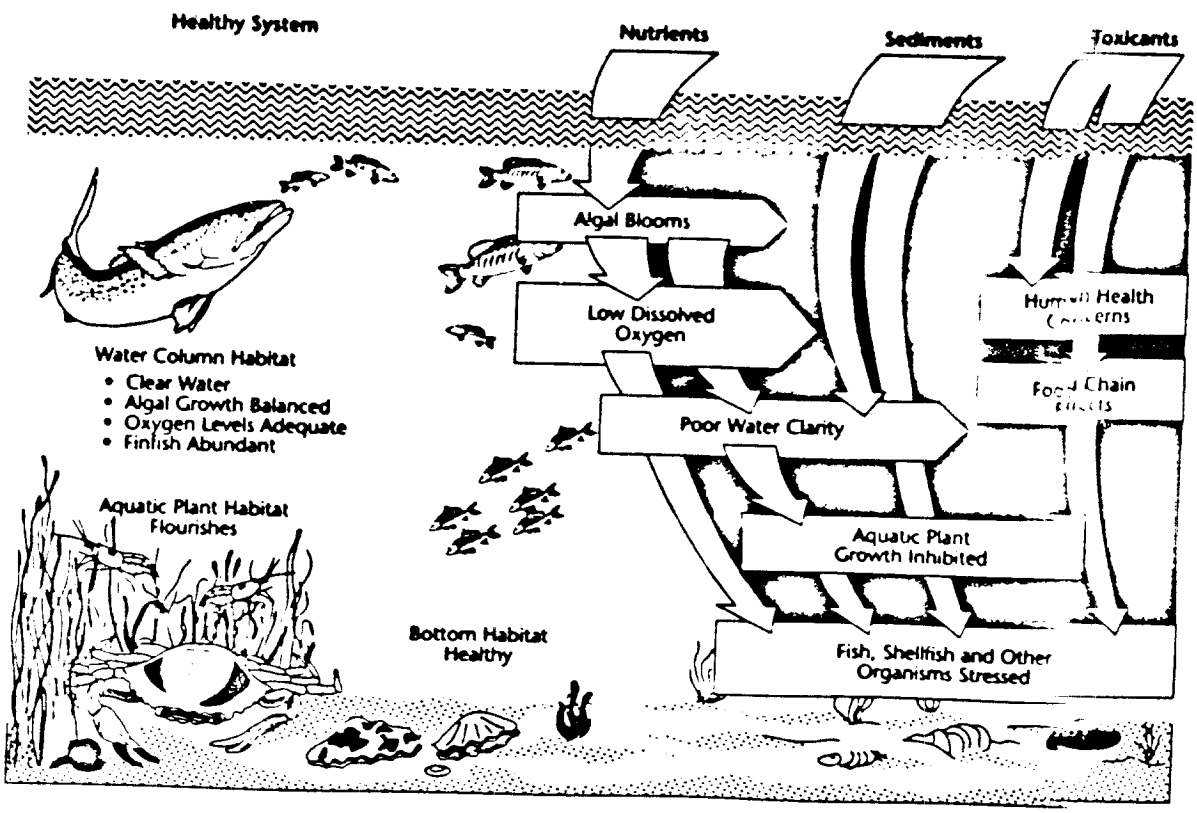

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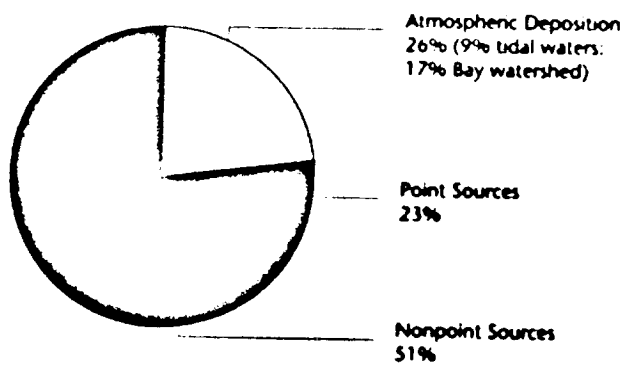
Figure 11-8

1985 Total Nitrogen Base Load Distribution in Chesapeake Bay

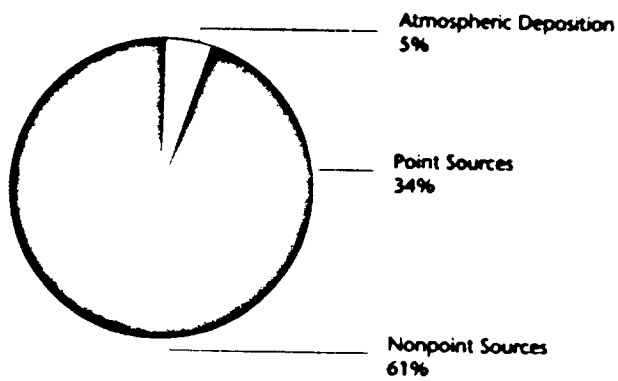


Total Load = 376 Million Pounds

Source: 1991 Watershed Model, September 30, 1992.

Figure 11-9

1985 Total Phosphorus Base Load Distribution in Chesapeake Bay



Total Load = 27 Million Pounds

Source: 1991 Watershed Model, September 30, 1992.

so vast an area that it is difficult to collect comprehensive data throughout the watershed. Therefore, a computer simulation of sources was used as the common mechanism for estimating both the 1985 base load and the load reductions that are necessary to improve dissolved oxygen conditions in the deep trench of the Bay.

To approximate long-term average conditions, the 1985 base load was calculated as a 4-year average to take into account the natural variations in runoff and river flow. Figure 11-8 shows that nonpoint sources contribute 51% to the total *nitrogen* load followed by atmospheric deposition (26%), and point sources (23%). Atmospheric loads of total nitrogen include nitrogen loads deposited on the tidal waters of the Bay (9%) and total nitrogen loads deposited on the watershed lands surrounding the Bay that wash into the Bay waters (17%). Figure 11-9 shows the same breakdown but for *phosphorus*. The percentage of contributions are 61% for nonpoint sources, 34% for point sources, and 5% for atmospheric deposition.

To calculate the controllable loads of nutrients to the Bay, the Program estimated the expected load if there were 100% forest cover and subtracted that from the 1985 base load (see Tables 11-3 and 11-4). The controllable fraction of nutrient loads is approximately 49% for nitrogen and 77% for phosphorus.

Point Source Nutrient Reduction

Municipal and industrial discharges are major sources of nutrient loads to the Bay system. Three elements of the Chesapeake Bay

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Program's point source control strategy are responsible for reductions in the nutrient loading:

- Upgrading wastewater treatment plants
- Improving compliance with permit requirements
- Pollution prevention actions such as prohibiting the sale of detergents containing phosphorus.

Phosphorus detergent restrictions sharply reduced the quantity of phosphorus entering municipal sewage treatment plants at the same time that population growth increased the total volume of water entering treatment facilities (Table 11-5). Plant operators also use fewer chemicals to remove phosphorus from their effluent and produce less sludge as a result of the phosphorus detergent restrictions.

Phosphorus load reduction has occurred at a faster pace than predicted. Annual discharges have dropped about 4.7 million pounds from 1985 to 1991, a reduction of 40% since 1985 (Figure 11-10). Wastewater treatment plant upgrades have also begun to have an effect on nitrogen loads.

The Chesapeake Bay Program has conducted pilot projects to assess the cost and effectiveness of an emerging technology known as biological nutrient removal. That technology is now used to reduce nitrogen and phosphorus loads from point sources in the Bay.

Furthermore, compliance has improved with permitted discharge limits. Since 1989 when the Chesapeake Executive Council made compliance a priority, the rate of

Nutrient Source[a]	1985 Base Load[b]	Forest Background Load[c]	Controllable Load[d]	Reduction (40% Controllable)
Nonpoint	254.6	153.9	100.7	40.3
Point	87.3	2.8	84.5	33.8
Atmospheric Deposition[e]	34.6	—	0	0
Total	376.5	156.7	185.2	74.1

[a] Nonpoint source loads include atmospheric deposition to the land (17%). Point source loads are reported as delivered to tidal waters.

[b] The 1985 Base Load is 1984-1987 output from the Watershed Model plus point source load discharged below the fall line.

[c] Forest Background Load simulated all land uses converted to forest. Includes atmospheric deposition on the land, rivers, and lakes that may be possible to control.

[d] Controllable Load equals Base Load minus Forest Background Load.

[e] Deposition to tidal waters only (9%). Deposition to land is included in nonpoint source load. Technical studies indicate that a large majority of this load is attributable to human activities, but that fraction is not estimated here.

Source: 1991 Watershed Model, September 30, 1992.

Nutrient Source[a]	1985 Base Load[b]	Forest Background Load[c]	Controllable Load[d]	Reduction (40% Controllable)
Nonpoint	16.50	4.35	12.15	4.86
Point	9.25	0.33	8.92	3.57
Atmospheric Deposition[e]	1.47	—	0	0
Total	27.22	4.68	21.07	8.43

[a] Nonpoint source loads include atmospheric deposition to the land. Point source loads are reported as delivered to tidal waters.

[b] The 1985 Base Load is 1984-1987 output from the Watershed Model plus point source load discharged below the fall line.

[c] Forest Background Load simulated all land uses converted to forest. Includes atmospheric deposition on the land, rivers, and lakes that may be possible to control.

[d] Controllable Load equals Base Load minus Forest Background Load.

[e] Deposition to tidal waters only. Technical studies indicate that a large majority of this load is attributable to human activities, but that fraction is not estimated here.

Source: 1991 Watershed Model, September 30, 1992.

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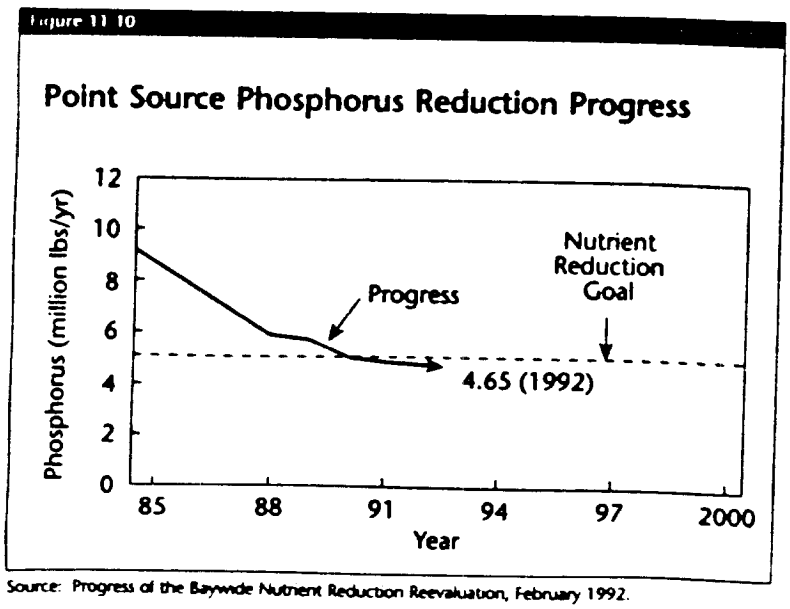
significant noncompliance has declined from a high of about 7% in 1989 to less than 4% in 1992. The percentage of significant noncompliance nationally has decreased from approximately 10% in 1989 to 9% in 1992.

State	Date Implemented	Reduction in Influent Phosphorus	Reduction in Effluent Phosphorus	Reduction in Sludge Production
Maryland	1985	30%	16%	28 dry tons/day
District of Columbia	1986	26%	—	14%
Virginia	1988	34%	50%	—
Pennsylvania (Susquehanna River Basin)	1990	25-33%	—	—

— Not reported.

Figure 11.10



Source: Progress of the Baywide Nutrient Reduction Reevaluation, February 1992.

Nonpoint Source Nutrient Reduction

The Chesapeake Bay Program's nonpoint source control program emphasizes controls on agriculture, paved surfaces, and construction in urban areas. The most important additional control measure is the practice of nutrient management in which animal wastes and fertilizers are applied to farmland in amounts carefully calculated to meet the needs of the crops. This practice reduces the runoff and leaching of nutrients that result from overuse of fertilizers.

Because it is not possible to monitor every nonpoint source, a model was developed to estimate the reduction of nutrient loadings. Implementation of nonpoint source control programs has resulted in a 12% and 8% reduction in controllable nonpoint source nitrogen and phosphorus, respectively. Portions of these decreases are reductions in nitrogen loads to ground water. Because nitrogen in ground water is released very slowly, the benefits to Bay water quality may not be seen for years.

Water Quality Trends and Characterization

Bay water quality monitoring data confirm the significant progress made in reducing phosphorus from nonpoint source and municipal point source loads, as well as the need for further progress toward reducing nitrogen loadings. These trends are as follows:

Phosphorus Trends

- Total phosphorus levels in the Chesapeake Bay decreased by 16% between 1984 and 1992.

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- Significant downward trends in phosphorus concentrations were observed in the upper middle mainstem (from the Susquehanna Flats to the Bay Bridge) and the lower mainstem (from the Rappahannock River south to the mouth of the Bay).

- Phosphorus concentrations declined in two upper tributaries (Patuxent and James) and increased in three tributaries (Gunpowder, Nanticoke, and Choptank).

Nitrogen Trends

- Total nitrogen levels in the mainstem of the Chesapeake Bay are essentially unchanged.

- Nitrogen concentrations increased in the upper reaches of several tributaries (Potomac, Rappahannock, York, James, Gunpowder, Northeast, Sassafras, Chester, and Choptank).

- Nitrogen concentrations increased significantly in Mobjack Bay, located between the Rappahannock and York Rivers).

Dissolved Oxygen Trends

- The volume of anoxic/hypoxic water in the mainstem has fluctuated widely over the last four decades, often reflecting patterns of freshwater inflow.

- The volume of anoxic waters has increased since 1950, based on available data.

Water Quality Characterization

- Numerous areas in the Bay's tributaries, as well as previously identified areas in the mainstem Bay, are impacted by low dissolved oxygen. These tributaries include the Patapsco, Magothy, Severn, South, West, Rhode, Patuxent, Potomac, Anacostia, Rappahannock, Your, Chester, and Little Choptank rivers, as well as Easter Bay.

- Submerged aquatic vegetation (SAV) is the best single indicator of the health of the Bay. Although water quality conditions in many tributaries are not currently suitable for survival and growth of SAV, the amount of SAV in the Bay has doubled during the past decade.

- There is no one single limiting nutrient in the Bay. Phosphorus tends to stimulate algae growth in freshwater areas of the Bay while nitrogen stimulates phytoplankton development in salt water areas. Reduced phosphorus loads will decrease algae growth in the tributaries and upper portions of the Bay, allowing for increased light penetration to underwater grasses. Reduced nitrogen loads will improve dissolved oxygen conditions in the upper and lower Bay by reducing the amount of decomposing algae available to settle to the saltier and denser bottom water that circulates back up the Bay.

Water Quality and Living Resource Objectives

The Bay Program's highest priority is to restore the Bay's living resources. One of the ways to do this is to improve water quality through nutrient reductions. These reductions will increase dissolved oxygen and improve water clarity. Submerged aquatic vegetation

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provides critical habitat for many of the Bay's organisms, but requires relatively clear water to grow and photosynthesize. The Chesapeake Bay Executive Council, which consists of the Governors of Maryland, Virginia, and Pennsylvania, the Administrator of the EPA, the Mayor of the District of Columbia, and the Chairman of the Chesapeake Bay Commission, set a goal to increase the amount of SAV from 70,000 acres to 114,000 acres. At the current rate of recovery, this acreage will be achieved by the year 2005. The Council also pledged to open hundreds of miles of Bay tributaries to spawning fish by removing some dams and creating fish passages.

The Great Waters Program

Section 112(m) of the Clean Air Act Amendments of 1990 requires that the EPA and the National Oceanic and Atmospheric Administration (NOAA) jointly conduct a program to identify the extent of atmospheric deposition of hazardous air pollutants (HAPs) into the Great Lakes, Chesapeake Bay, Lake Champlain, and selected coastal waters. EPA developed the Great Waters Program to comply with Section 112(m).

The Great Waters Program requires four monitoring networks:

- A Great Lakes monitoring network established one wet dry collection facility for each of the five Great Lakes. The facilities will collect data to help identify and track movement of HAPs into the Great Lakes ecosystem and determine overall HAP loadings from atmospheric deposition. EPA will ensure that the data collected are compatible with related databases. The information will support development of Remedial Action Plans (RAPs) for the 43 Areas of Concern designated by the United States and Canada and development of LaMPs.

- A Chesapeake Bay monitoring network has deposition monitoring stations within the Bay watershed, which extends into Virginia, Maryland, West Virginia, Delaware, and Pennsylvania. The monitoring program will help determine the relative contribution of atmospheric HAP loadings to total pollutant loadings into the Bay, investigate sources of HAPs, and evaluate the environmental effects of deposited HAPs on the Bay ecosystem based on biological sampling within individual watersheds.

- A Lake Champlain monitoring network should establish deposition monitoring stations in the Lake Champlain watershed straddling Vermont and New York. The Lake Champlain network will also investigate the contribution air deposition makes to overall pollutant loadings, the sources of deposited HAPs, and the environmental effects of atmospheric deposition in the Lake Champlain watershed.

- A coastal waters monitoring network should determine relative loadings of HAPs into National Estuary Program waters designated by EPA and National Estuarine Research Reserves designated by NOAA. The first step in this network is a screening study targeted for Galveston Bay in 1993-94.

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Beginning in 1993, Section 112 of the Clean Air Act Amendments also requires EPA to report program results to Congress biennially. The Great Waters Report to Congress should describe the relative contribution of deposited HAPs to total pollutant loadings, the environmental and human health effects of HAPs, the sources of HAPs, and water quality standards violations due to HAP deposition in designated Great Waters. Recommendations should also be proposed for additional regulatory revisions under any Federal laws needed to protect the Great Waters from hazardous pollutants, and EPA should promulgate any needed revisions under Section 112 of the Clean Air Act.

EPA assembled three teams to author scientific documents that will support preparation of the Great Waters Report to Congress. Each team analyzed available information on one of the following issues:

- Loading of toxicants from air relative to total loading from all routes
- Human and ecological exposure and effects
- Source identification.

Each team distributed a draft of its support document, and EPA's Office of Air Quality Planning and Standards (OAQPS) held a workshop to critique, discuss, and supplement their documents. Attendees included invited experts and the Great Waters Core Group, composed of representatives from EPA program offices, EPA laboratories, NOAA, and States. The teams recently incorporated workshop comments into the final drafts of their support documents.

Currently, EPA is synthesizing the supporting information into the Great Waters Report to Congress. The Report will describe the extent of our knowledge, the data needed to fill gaps, and conclusions based upon available information. EPA will develop a long-term strategy for future Great Waters work based on the research needs described in the support documents and policy needs identified by program participants.

The National Estuary Program

The National Estuary Program embodies the ecosystem approach by building coalitions, addressing multiple sources of contamination, pursuing habitat protection as a pollution control mechanism, and investigating cross-media transfer of pollutants from air and soil into estuarine waters.

Congress recognizes that estuaries are unique and endangered ecosystems and that traditional water pollution control programs alone cannot address the more complex issues associated with estuaries. These issues include protecting living resources and their habitats, controlling diffuse sources of pollutants, and managing estuaries as watershed ecosystems. Responding to the unmet needs of estuarine ecosystems, Congress established the National Estuary Program in 1987 under Section 320 of the Clean Water Act.

The NEP adopts a geographic, basin-wide approach to environmental management. A State governor nominates an estuary in the

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governor's State for participation in the program. The State must demonstrate a likelihood for success in protecting candidate estuaries and provide evidence of institutional, financial, and political commitment to solving estuarine problems.

If an estuary meets the NEP guidelines, the EPA Administrator convenes a management conference of representatives from interested Federal, Regional, State, and local governments; affected industries; scientific and academic institutions; and citizen organizations. The management conference defines program goals and objectives, identifies problems, and designs strategies to prevent and control pollution and manage natural resources in the estuarine basin. Each management conference develops and initiates implementation of a Comprehensive Conservation and Management Plan (CCMP) to restore and protect its estuary.

The NEP currently supports 21 estuary projects, including four sites added to the program in 1992:

- Albemarle-Pamlico Sounds in North Carolina
- Buzzards Bay in Massachusetts
- Long Island Sound in Connecticut and New York
- Narragansett Bay in Rhode Island
- Puget Sound in Washington State
- San Francisco Bay Estuary in California
- Santa Monica Bay in California
- Delaware Estuary in New Jersey, Pennsylvania, and Delaware
- Delaware Inland Bays in Delaware
- Galveston Bay in Texas
- New York-New Jersey Harbor in New York and New Jersey
- Sarasota Bay in Florida
- Indian River Lagoon in Florida
- Tampa Bay in Florida
- Barataria-Terrebonne Estuarine Complex in Louisiana
- Casco Bay in Maine
- Massachusetts Bay in Massachusetts
- Corpus Christi Bay in Texas
- Peconic Bay in New York
- San Juan Bay in Puerto Rico
- Tillamook Bay in Oregon.

These 21 estuaries are nationally significant in their economic value as well as in their ability to support living resources. The project sites also represent a broad range of environmental conditions in estuaries throughout the United States and its Territories.

The NEP integrates science and decisionmaking for the protection, restoration, and maintenance of estuaries. Through a characterization process, scientists from Federal, State, and local government agencies, academic institutions, and the private sector analyze an estuary's problems and their causes and work with estuary managers to suggest remedies. Because the NEP is not a research program, it relies heavily on past and current research of other agencies and institutions to support its work.

Appendix F, Table F-5, lists physical and economic characteristics of 17 NEP estuarine basins. The table also describes each estuary's susceptibility to pollution in terms of its ability to flush out and dilute pollutants. This information is being evaluated as part of a national survey of nutrient enrichment in estuaries, sponsored jointly by EPA and NOAA.

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Estuarine Problems

Each of the 21 estuaries in the NEP is unique, yet the estuaries share common threats and stressors. Each estuary faces expanding human activity near its shores that may degrade water quality and habitat. Eutrophication, toxic substances (including metals), pathogens, and changes to living resources and habitats top the list of problems being addressed by the NEP Management Conferences. Tables F-6, F-7, and F-8 in Appendix F, list the problems stressing 17 NEP sites.

Eutrophication

Nutrients enter waterways through sewage treatment plant discharges, stormwater runoff from lawns and agricultural lands, faulty septic tanks, and even ground water discharges. (For example, nitrates are believed to leach into ground water and discharge into the Delaware Inland Bays.) Algae and bacteria respond to elevated inputs of nutrients by rapidly reproducing. Decomposition of the algae consumes oxygen and causes hypoxia–low concentrations of dissolved oxygen.

■ The Long Island Sound Study Management Conference (which includes representatives from NOAA, State and County agencies in Connecticut and New York, and New York City) is focusing on sources of hypoxia in the basin surrounding the Sound. During recent summers, poor water circulation exacerbated hypoxia problems in parts of the Sound. The Long Island Sound Study identified nitrogen as the primary nutrient linked to hypoxia in the Sound and concluded that discharges from sewage treatment plants and runoff are the leading controllable sources of nitrogen loadings to the estuary.

■ The Delaware Inland Bays Management Conference is focusing on the Inland Bays' capacity to assimilate nutrients. First, the study identified critical information gaps and planned research projects to fill the gaps. Ongoing research projects target four goals: (1) determine ground water contributions of nutrients, (2) develop a mass balance model of nutrient cycling between ground water and the Inland Bays, (3) define nutrient transport processes in the Inland Bays' basin, and (4) develop a strategy for using living resources as indicators of water quality. The project coordinates public input and research conducted by Federal, State, academic, and private scientists in an attempt to characterize the estuary and develop a Comprehensive Conservation and Management Plan.

Toxic Substances

■ Metals in Massachusetts Bay illustrate the impact from sewage treatment plants, atmospheric deposition, and polluted tributaries. The Bay receives high metal loading from the Merrimack River. The Comprehensive Conservation and Management Plan for the Bay will have to address sources of metals contaminating the Merrimack River as well as sources discharging metals directly into the Bay.

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■ Sediment core samples collected at Narragansett Bay revealed that most metal concentrations peaked during the 1950s and have declined by an average of 60% since the 1950s. The study attributes declines in metal concentrations to improvements in sewage treatment.

■ The Casco Bay Estuary Project focuses on the extent of toxic contamination in Bay sediments. Heavy metal concentrations in Casco Bay sediments exceed concentrations in most NEP estuaries. The Casco Bay study detected heavy metals, PCBs, PAHs, pesticides, dioxins, and other organic compounds in the Casco Bay sediments. NOAA's flounder liver survey revealed heavy concentrations of lead, copper, zinc, silver, and PCBs in fish captured in Casco Bay.

Pathogens

Pathogens are bacteria and viruses that cause diseases. To protect public health, State agencies prohibit the harvest of shellfish in waters contaminated with pathogens or pathogen indicators, such as fecal coliforms. Waters contaminated with pathogens also pose a health risk to swimmers, surfers, and divers.

■ A growing network of shellfish farms on the Indian River Lagoon serves as a monitoring system to alert scientists and managers to water quality problems in the Lagoon, including the presence of pathogens.

■ Elevated counts of bacterial and viral indicators in two Santa Monica storm drains raised concern about the safety of swimming near storm drain outfalls. Additional sampling confirmed elevated bacterial indicator counts in the surf zone and in storm drain runoff. However, the data were inadequate to calculate health risks. The study recommended additional research to determine the source of fecal organisms and viruses in the storm drains and the dispersion of runoff along the shoreline.

Living Resources and Their Habitat

Overharvesting and loss of habitats have led to a decline of valuable species, an increase in populations of less desirable species, and a decrease in the diversity of living resources in estuaries. Land development in upland areas increases sedimentation in waterways; construction in wetlands destroys this valuable filter system and habitat for juvenile fish; bulkheading interferes with natural plant and animal shoreline interactions; and dredge and fill activities create turbid waters, destroy habitat, and interfere with circulation patterns. In Florida, ongoing estuary projects study the effects of habitat changes, rapid growth and development, and sewage treatment plant expansion on living resources.

■ The Florida Marine Research Institute is conducting cooperative studies of fish-habitat relationships in Tampa Bay with NOAA funding channeled through the Florida Department of Environmental Regulation. These studies examine fish community structure along the salinity gradient, fish density in seagrass beds and unvegetated habitats, and the use of microhabitats by economically valuable

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fish species. The State will enter the results of this research into a database for predicting the effects of future habitat modifications.

■ In Sarasota Bay, water quality trends indicate that nutrient and salinity levels and the alkalinity/acidity ratio have decreased over time. The decrease reflects a shift from agrarian to urban land use. On the eastern shore, submerged aquatic vegetation has declined, particularly in an area within transport range of a seawater treatment plant outfall. Although the total concentration of suspended solids is elevated, researchers cannot link increased biomass to decreased light resulting from the sewage plant discharges. Further studies are investigating another possible cause of the vegetation losses: the formation of insoluble calcium carbonate from the soluble bicarbonate present in the sewage plant effluent.

■ The Bay Study Group of the City of Tampa has conducted extensive monitoring in Tampa Bay. Monitoring at middle Tampa Bay and Hillsborough Bay indicate wastewater plant upgrades implemented in 1979 reduced nitrogen and chlorophyll concentrations and blue-green algae levels in Hillsborough Bay. Dissolved oxygen concentrations and water transparency also increased. At the same time, sea grasses colonized shallow areas around Hillsborough Bay, which had been barren of attached vegetation for several decades preceding the sewage plant upgrades. The Bay Study Group has documented a fourfold increase in the quantity of sea grasses since they began monitoring sea grass in 1986.

Although historical information and current investigations have expanded our understanding of estuarine problems, cooperative scientific studies must continue to evaluate management options for correcting estuarine impairments. Knowledge of estuarine systems lays the foundation for successful management plans.

Looking to the Future: Trends and Needs

As we approach the end of this century, it is encouraging to consider the advances in pollution control achieved during the past two decades. Under the Clean Water Act, many regulatory controls evolved to minimize point source discharges (see Chapter 13 for a discussion of point source controls). New technologies have also improved the effectiveness of wastewater treatment processes. These pollution controls have led to some improvements in estuarine water quality, particularly with respect to reduced toxic discharges.

In spite of these advances, some problems persist and challenge all of us: pollution from the air, waste sites, and ground water; runoff from agricultural land and urban streets; and the loss of wetlands and other vital habitats. Alliances of Federal, State, and local agencies with the scientific community and the public will accelerate our pursuit of these challenges.

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Closer Integration with EPA Programs

There is growing concern about impacts on estuaries from air deposition, solid and hazardous waste sites, and contaminated ground water. Several NEP projects are investigating cross-media pollutant sources. The Long Island Sound Study is investigating the role that vehicle emissions play in polluting the Sound. Work at Superfund sites in Puget Sound and Buzzards Bay has been coordinated with NEP projects, but even closer ties between remediation activities at waste sites and estuary projects are needed. Although the New York-New Jersey Harbor estuarine program addresses the problems caused by solid waste, few projects deal directly with trash by encouraging household recycling and waste reduction. With cooperation from the Rhode Island business community, the Narragansett Bay Project is performing hazardous waste audits and encouraging source reduction, recycling, and safer chemical substitution.

Though much interaction among EPA's base programs is under way, more integration is needed at EPA Regional Offices and Headquarters.

A Scientific/Management/Public Partnership

Using the scientific knowledge gathered and interpreted during the characterization phase ensures that the public, elected officials, and special interest groups—all part of the Management Conference—understand the problems of the estuary and are prepared to support the measures needed to correct the problems.

This process is simple in theory but complex in practice. Scientists do not always agree on the causes of a problem or the solutions. Furthermore, scientists and managers do not always communicate well with each other. In the NEP, managers operate on a 5-year plan; scientists rarely operate on a fixed 5-year plan. Under the auspices of the Management Conferences, however, scientists are focusing their research and applying their results to project managers' needs and time constraints. Managers are challenging scientists to direct their studies to meet Management Conference needs for short-term answers. The Management Conference enhances communication between scientists and managers and results in better solutions to management issues.

Members of the public often express concerns about highly visible problems, yet these issues may not be the most important problems for the Management Conference to consider. In fact, spending resources on a highly visible but relatively insignificant problem could divert attention from a crucial matter. It is imperative, therefore, that scientific findings be widely communicated and form the basis for public education efforts.

■ Faced with diverse constituencies, each with a different idea of what constitutes a monitoring program appropriate for Santa Monica Bay, the Santa Monica Bay Restoration Program held a 2-day consensus-building conference for scientists, managers, dischargers, regulators, and public interest group

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representatives. The conference goal was to outline monitoring objectives that would guide the development of detailed hypotheses and sampling and analysis plans. Conference participants were led through a set of structured exercises that focused on the overall concerns driving the regulatory/monitoring system, agreement on a monitoring philosophy for the Bay, and determination of which Bay resources were the most highly valued. These exercises were followed by a decisionmaking process through which specific monitoring objectives were developed. The selected objectives reflected management goals, scientific knowledge, and public concerns.

Every estuary program in the NEP has a public participation and education component. Solutions to pollution problems are grounded in scientific information, but protection of habitats and commitment to action are dependent upon public education. Through education and participation, the public gains an understanding of the estuary and its problems, the will to act to solve immediate problems, and the desire to be stewards of the ecosystem for the future.

Priority Concerns

The public, in partnership with scientists and government managers, faces enormous challenges compounded by the population growth projected to continue in the coastal zone well into the 21st century. We will need to manage this growth more effectively to protect our coastal resources. Critical management areas that must be addressed include general growth and development, nonpoint sources, and natural habitat destruction.

Growth and Development

Coastal population growth and development patterns disrupt natural processes in coastal ecosystems and threaten both the ecologic and economic values of estuaries. As we approach the year 2000, we must improve conventional pollution controls and accelerate enforcement actions. However, new strategies are required to solve the more complex problems brought about by increasing pressure to develop rural areas and sensitive pristine areas.

Shoreline development often strips vegetation and eliminates wetlands, which exposes the land to erosion. Increased sedimentation in shallow waters chokes underwater grasses and threatens fish and shellfish habitats. Development near shorelines also damages life-sustaining habitats for shore birds and animals.

As development replaces vegetation with less pervious surfaces (such as buildings, parking lots, and roads), rainwater cannot seep slowly into the soil and replenish ground water. Instead, storm water runs off the impervious surfaces, collecting pollutants deposited from the air, and delivers the pollutants directly into surface waters. Without wetlands and other vegetated areas, the land cannot filter pollutants from storm water runoff before it enters estuarine waters. Looking ahead, our major challenge is controlling nonpoint sources resulting from population growth and their impacts on estuarine habitats.

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Nonpoint Source Control

Section 319 of the Clean Water Act provides funding for some nonpoint source control projects in estuarine waters (see Chapter 14 for a full discussion of the Section 319 Nonpoint Source Program). States employ both voluntary and regulatory controls to encourage implementation of best management practices to minimize nonpoint source pollution generated by agriculture, construction, silviculture, marinas, and urbanization.

The 1990 amendments to the Coastal Zone Management Act (CZMA) require States with federally approved coastal zone management programs to develop nonpoint source pollution control programs in coastal areas. Each State's program will consist of selected management measures for source categories, such as construction, marinas, and agriculture. The States will develop and implement the coastal nonpoint source programs through existing State coastal zone management programs administered by NOAA under Section 306 of the CZMA and State nonpoint source programs administered by EPA under Section 319 of the Clean Water Act.

In May 1991, EPA, in consultation with NOAA, proposed management measures to control nonpoint sources in coastal waters. In October 1991, EPA and NOAA proposed guidelines to help States develop their coastal nonpoint source pollution control programs. EPA issued final guidelines in 1992.

EPA also issued new stormwater regulations in 1992 that will require National Pollutant Discharge Elimination System (NPDES) permits for urban storm drainage systems and runoff discharges from various industrial and commercial sites (see Chapter 12 for a complete discussion of storm water controls). The rule applies to 173 cities, 47 urbanized counties with populations exceeding 100,000 people, and several smaller communities using storm sewers in covered jurisdictions. The rule applies to industries that discharge into municipal storm sewers or directly discharge storm water into surface waters. The rule stops illegal connections to storm drains.

Habitat Protection

NEP projects are looking beyond traditional pollution control approaches toward strategies that address total estuarine ecosystem health. These strategies base habitat protection plans on a scientific understanding of how ecosystems function. These long-term strategies require further coordination of research and monitoring activities performed by EPA, NOAA, individual NEP projects, marine academic institutions, and other Federal and State agencies.

While long-term strategies are being developed, management conferences act locally to address immediate threats to estuarine habitats. For example, management conferences limit fish harvesting, replant seagrass beds, seek building restrictions such as setback requirements, create land conservation areas, and curb harmful uses of waterways. Such efforts are not implemented in all NEP sites but will

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likely be more widespread in the future.

Management conferences will need to work even more closely with agencies such as the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers to improve our understanding of habitat problems and develop new technologies to mitigate adverse impacts. Examples of new technologies include stabilizing shorelines with vegetation instead of bulkheads and techniques for creating wetlands. EPA is working with Management Conferences to increase habitat mitigation activities, such as removing dams blocking fish migrations and eliminating freshwater diversions.

Steps in the Right Direction

The NEP recognizes that it may take decades to fulfull Congress' directive to restore and protect estuaries' of national significance. In the short term, however, progress continues. Each estuary project in the NEP is focusing on the key environmental problems in its estuary and integrating protection efforts conducted by Federal, State, and local agencies. NEP projects are considering air and land pollution sources in addition to controls for traditional point source polluters. Finally, NEP projects are developing restoration and protection strategies based upon an understanding of estuarine ecosystem functions and encouraging the public to care for estuarine ecosystems.

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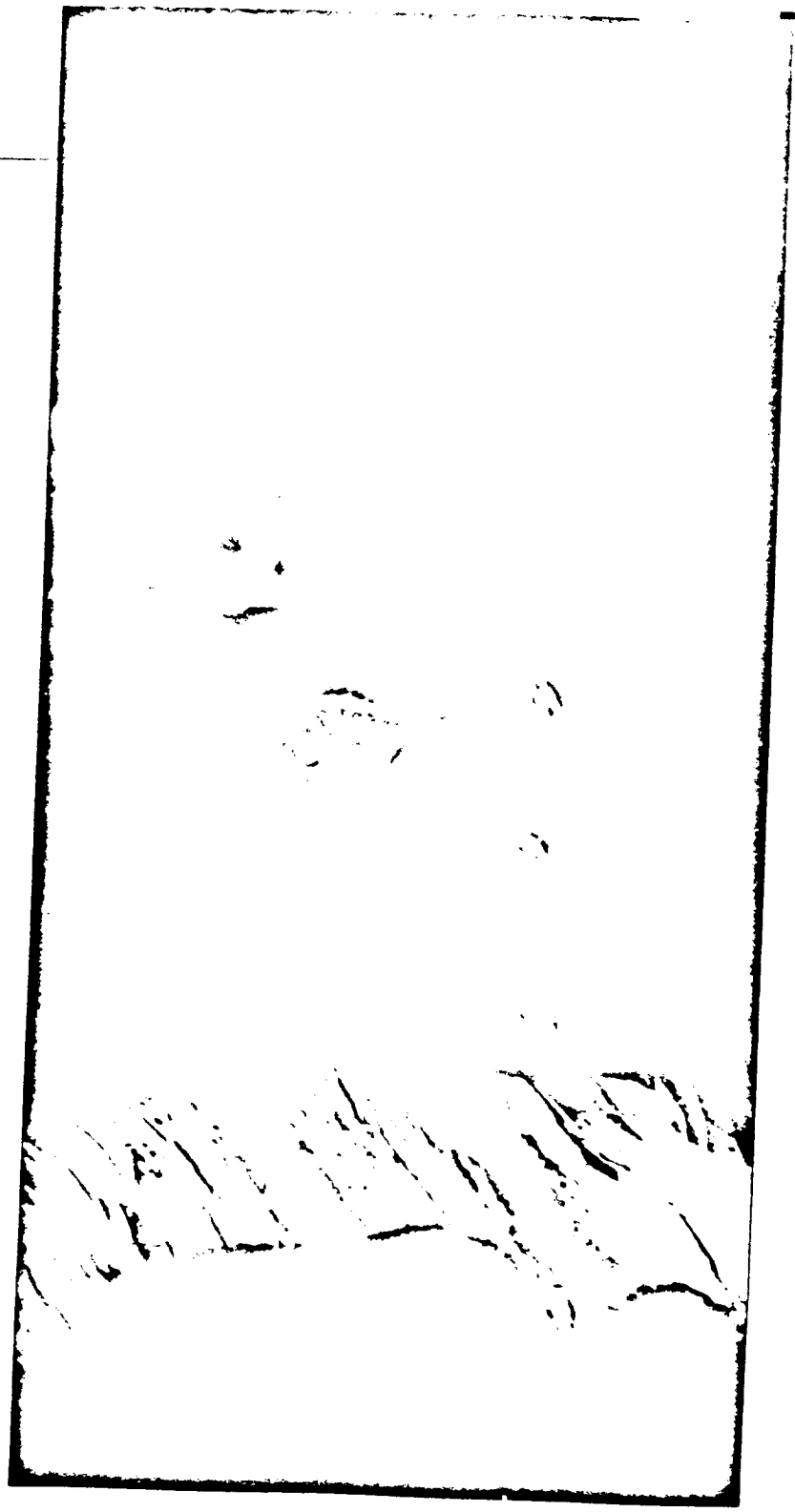

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Surface Water Monitoring and Assessment Programs

Introduction

Water quality monitoring is essential for an understanding of the condition of water resources and to provide a basis for effective policies that promote wise use and management of those resources. A large number of Federal, State, and local agencies and private sector organizations currently collect water quality information for a wide range of purposes that can generally be divided into five categories: (1) status and trends, (2) detection of existing and emerging problems and setting priorities among them, (3) designing and implementing programs, (4) evaluating program or project success, and (5) emergency response monitoring.

Numerous public and private groups conduct many and varied monitoring programs to fulfill one or more of these purposes. This chapter discusses current conditions of water resource quality monitoring in the United States and efforts to establish an integrated nationwide monitoring strategy.

Overview of National Monitoring Activity

Water resource quality monitoring is conducted by Federal, interstate, State, local, and Tribal agencies, as well as public, private, and volunteer organizations. A recent survey undertaken by the Intergovernmental Task Force on Monitoring Water Quality indicates that 18 Federal agencies conduct approximately 141 separate monitoring programs across the country, as do all States and Territories, local governments, and an increasing number of American Indian Tribes.

At the Federal level, ambient water quality data are collected by the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (FWS), the U.S. Forest Service, the Bureau of Reclamation, the National Park Service, EPA, National Oceanic and Atmospheric Administration (NOAA), the Tennessee Valley Authority (TVA), the Bonneville Power Administration, the U.S. Army Corps of Engineers (COE), the Bureau of Land Management (BLM), and various other organizations within the Departments of Agriculture, Energy, Defense, and Interior. Of this group, the USGS, FWS, EPA, NOAA, and TVA have either long-term regional or both regional and national programs for water quality monitoring. The other agencies and organizations monitor ambient water quality primarily at site-specific or

18 FEDERAL AGENCIES
conduct 141 monitoring programs across the country

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project scales, usually for limited periods of time.

Results from Federal monitoring programs have provided important information at the national and regional scales. For example, USGS data indicate that fecal bacteria counts and total phosphorus concentrations have decreased at a considerable number of stations across the United States from the late 1970s to the late 1980s. The FWS and NOAA data show that bioaccumulation of trace elements, pesticides, and trace industrial compounds has occurred at many locations in our rivers, estuaries, and near-coastal areas. And data from EPA monitoring indicate substantial improvement in the phosphorous concentrations of the Chesapeake Bay during the past 6 years.

Similarly, within each State, both State and local monitoring programs have provided the data to characterize State water resource quality and assess the effectiveness of water management and regulatory programs. Contributing to the picture are the monitoring programs run by industrial and municipal dischargers, by private groups, and by volunteer monitoring organizations.

This wealth of information from individual agencies, however, cannot be easily aggregated to provide an overview of national water quality conditions. Individual reports, such as this 305(b) report, aggregate State information. Individual agency reports, such as that of USGS, give nationwide information on particular constituents. Because of inconsistencies among the various agencies in monitoring purpose and design as well as data collection methods and assessment procedures, data from the various sources cannot be easily combined to give an overall national water quality picture. In addition, data are often stored without accompanying descriptors, thus other data users cannot determine if they can use the data for their own purposes.

Effects of Changes in Water Programs

In addition to this multiplicity of effort, water programs themselves are changing, necessitating similar changes in water monitoring activities. The country is moving beyond single-media command-and-control programs into more holistic management programs based on risk assessment and reduction. New emphases include watershed, ecoregion, and geographically based programs; a focus on biological, ecological, and habitat integrity and diversity; wet weather runoff control programs such as those for nonpoint sources, stormwater, and combined sewer overflows; and wetlands and sediment contamination programs. Traditional monitoring programs must be expanded to include assessment of biological and ecological resources and new methods must be developed to identify and control pollution from hard-to-trace, diffuse sources of pollution such as wet weather runoff and sediment contamination.

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Intergovernmental Task Force on Monitoring Water Quality

In January of 1992, representatives from EPA, USGS, NOAA, FWS, COE, USDA, DOE, OMB, and seven State agencies and one interstate agency formed a 3-year Intergovernmental Task Force on Monitoring Water Quality (ITFM) to prepare a strategy for improving water quality monitoring nationwide. The Tennessee Valley Authority, National Park Service, one State, and one American Indian Tribe, have since been added. The ITFM is part of the implementation of Office of Management and Budget (OMB) memorandum 92-01 to strengthen coordination of water information across the country. The USGS has lead responsibility for this and has designed its Water Information Coordination Program for this purpose.

The ITFM is chaired by the EPA with the USGS as vice chair and Executive Secretariat. To date, over 100 additional Federal, State, and interstate agency representatives have been involved in the deliberations of the ITFM and its seven task groups:

- Institutional Framework
- Environmental Indicators
- Methods
- Data Management Sharing
- Assessment and Reporting
- Financial Survey
- Ground Water.

The ITFM is considering the full range of nationwide water resources, including surface and ground waters, near-coastal waters, associated aquatic communities and habitat, wetlands, and sediment. Water resource protection factors include human and ecological health and the uses designated for the Nation's waters through State water quality standards. Monitoring activities include gathering data on physical, chemical/toxicological, and biological/ecological/habitat parameters.

The mission of the ITFM is to develop and implement a national strategic plan to achieve effective collection, interpretation, and presentation of water quality data and to improve the availability of existing information for decisionmaking at all levels of government. To accomplish this, the ITFM has recommended and will develop an integrated nationwide voluntary strategy that will meet the nationwide objectives of various monitoring programs, make more efficient use of available resources, distribute information more effectively, and provide comparable data and consistent reporting of water quality status and trends.

A standing national monitoring committee is envisioned to provide guidelines and support for comparable field and laboratory methods, quality assurance/quality control,

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environmental indicators, data management and sharing, ancillary data, interpretation techniques, and training. Regional data collection under the national guidelines would provide the needed information for nationwide assessment of water resource quality.

The ITFM is also producing products that can be used by monitoring programs nationwide, such as an outline for a recommended monitoring program, environmental indicator selection criteria, and a matrix of indicators to support assessment of State designated uses.

The ITFM will disband in favor of full implementation overseen by a permanent committee in January 1995.

Major Nationwide Monitoring Programs

■ Environmental Monitoring and Assessment Program (EMAP)

EPA's Office of Research and Development initiated EMAP in 1990 to provide information on the current status and long-term trends in the condition of the ecological resources of the United States. EMAP develops indicators to measure ecological condition, monitors for those indicators, and presents analyses of data in periodic reports. Site selection is based on a random design within natural resource areas so individual results can be interpolated with confidence to the condition of the Nation as a whole. EMAP, in cooperation with NOAA and the FWS, monitors seven resource groups: Near Coastal Waters, Surface Waters, Wetlands, Forests, Arid Lands, Agroecosystems, and Great Lakes.

■ National Acid Precipitation Assessment Program (NAPAP)

During the 1970s, the effects of acid rain on the environment and human health became a major concern for many scientists, public policy officials, public interest groups, the media, and the general population. Reports were published linking emissions from industry, electric power plants, and automobiles with acid rain. Many believed that acid rain damages crops, forests, buildings, animals, fish, and human health. Congress established NAPAP under the Acid Precipitation Act of 1980 to provide the information needed for policy and regulatory decisions on acidic deposition. The areas of investigation addressed by NAPAP Task Groups are Emissions and Controls, Atmospheric Processes, Atmospheric Transport and Modeling, Atmospheric Deposition and Air Quality Monitoring, Terrestrial Effects, Aquatic Effects, and Effects on Materials and Cultural Resources. NAPAP has also developed Assessment Work Groups in the areas of Atmospheric Visibility, Human Health Effects, and Economic Valuation.

■ U.S. Geological Survey, National Water Quality Assessment Program (NAWQA)

The USGS developed NAWQA to provide a nationally consistent description of current water quality conditions for a large part of the Nation's water resources; to define long-term trends (or lack thereof) in water quality; and to identify, describe, and explain, to the extent possible, the major factors that affect observed water quality conditions and trends. This program is

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concerned with both ground and surface water quality; ultimately, 60 drainage basins will be monitored under this program.

■ U.S. Geological Survey, National Stream Quality Accounting Network (NASQAN)

This network is composed of 420 stations on large rivers, located at the outlets of major drainage basins to collectively measure a large fraction of total runoff in the United States. The stations reflect general water quality conditions in the country. Measurements at NASQAN sites include inorganic constituents, radionuclides, and bacteria, but exclude routine analyses for organic chemicals.

■ U.S. Geological Survey, the Hydrologic Benchmark Network (HBN)

Composed of 55 stations located in relatively pristine headwater basins, this network is designed to define baseline water quality conditions and the effects of atmospheric deposition on water quality. The Network measures inorganic constituents, radionuclides, and bacterial contamination, among other parameters.

Both NASQAN and HBN achieve their objectives but neither is designed to provide a statistically representative sample of basins throughout the Nation, nor are stations in NASQAN purposefully located downstream from industry, municipal, and urban runoff outfalls to isolate and measure maximum impacts. These network design considerations are a component of the NAWQA program.

■ U.S. Geological Survey, the National Atmospheric Deposition Program/National Trends Network

Composed of 200 sampling sites within the interagency NAPAP, this network is designed to determine spatial patterns and temporal trends in chemical wet-only deposition. It supports research into impacts on aquatic and terrestrial ecosystems. Measurements are limited to inorganic constituents only.

■ U.S. Fish and Wildlife Service, National Contaminant Biomonitoring Program (NCBP)

This program, now being revised, determines tissue residue levels in fish and birds nationwide. The fish tissue part of the program consists of 110 stations at nonrandomly selected points along the Nation's major rivers and in the Great Lakes. Fish tissues are analyzed for organic contaminants (pesticides and industrial chemicals) and seven elements. Sampling has been conducted on a 2- to 4-year basis since the mid-1960s.

■ U.S. Fish and Wildlife Service, Biomonitoring of Environmental Status and Trends (BEST) Program

This program, now under development, has three major goals: (1) to determine the status and trends of contaminants and their effect on natural resources; (2) to identify and assess the major factors affecting resources and provide current and predictive information to alleviate impacts; and (3) to provide summary information in a timely manner to decisionmakers and the public. The BEST Program has two major components: FWS lands and

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The National Biological Survey

Secretary of the Interior, Bruce Babbitt, has proposed the creation of an independent, non-advocacy biological science bureau within the Department of the Interior. The National Biological Survey (NBS) will provide information and technical assistance. The NBS will be created by incorporating elements from eight bureaus within the Department. The NBS will have three major functions:

- *biological and ecological research*
- *inventory and monitoring of the Nation's biological resources*
- *information transfer activities.*

The NBS became operational on November 11, 1993.

FWS trust species and their habitats. Activities include collection and evaluation of existing data for site characterization and bioassessment data from four general categories–ecological surveys, tissue residue, organism health or biomarkers, and toxicity tests/bioassays.

■ U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI) Program

This program determines status and trends of U.S. wetlands to produce comprehensive, statistically valid acreage estimates of the Nation's wetlands. This information is widely distributed and mandated by the Emergency Wetland Resource Act of 1986. To date, more than 32,000 detailed wetlands maps have been completed covering 72% of the coterminous United States, 22% of Alaska, and all of Hawaii and Puerto Rico.

■ National Oceanic and Atmospheric Administration (NOAA), National Status and Trends Program (NS&T)

NOAA conducts the NS&T, which includes the Benthic Surveillance Program and the Mussel Watch Program. Indicators for determining the effects on marine biotas of contaminated sediments are currently under development. Parameters that are sampled for NS&T include accumulated compounds in the tissues and conditions of physical features of selected biota as well as sediment chemistry.

■ National Oceanic and Atmospheric Administration (NOAA), National Estuarine Research Reserves

The National Estuarine Research Reserve System was created to protect representative areas of the estuarine environment and to provide a system of protected sites for long-term monitoring and research. It is a State-Federal partnership managed by NOAA under the Coastal Zone Management Act. The Act requires nomination of a reserve site by the Governor of a State and designation by the Secretary of Commerce. Since 1972, NOAA has kept this partnership, and the evolving statutory mission of the program, by providing resources and guidance to the States, by developing national programs, and by shaping the legislation into an operating program. Twenty-one reserves have been designated including sites in Hawaii, Puerto Rico, the Great Lakes, the Gulf of Mexico, the Atlantic Coast, and the West Coast.

■ Tennessee Valley Authority (TVA), Water Resource Monitoring

TVA conducts a regional water resource monitoring program to evaluate ecological health and suitability for body-contact recreation of reservoirs and major streams in the Tennessee Valley and to evaluate the suitability for human consumption of fish in those waters. The program includes systematic measurement of physical, chemical, and biological variables at strategic locations. Results are used to draw attention to pollution problems, to set cleanup goals, and to measure the effectiveness of water quality improvement efforts over time. TVA also monitors aquatic plant and

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mosquito populations around TVA lakes to help target management efforts. Monitoring of conditions in tailwaters below several dams focuses on prioritizing facilities for reaeration of reservoir releases and providing data to evaluate the effectiveness of those efforts.

■ U.S. Department of Agriculture, Resource Conservation Act of 1977 (RCA)

Mandated by the Resource Conservation Act (RCA) of 1977, the U.S. Department of Agriculture (USDA) is "to provide for furthering the conservation, protection, and enhancement of the Nation's soil, water, and related resources for sustained use." In recognition of the importance of, and need for, obtaining and maintaining information on the current status of soil, water, and related resources, USDA makes a continuing appraisal of the soil, water, and related resources of the Nation. The objective of the appraisal currently under way is to present information to assist policy decisionmakers and program managers to form better policies and programs to address soil, water, and other environmental concerns for the next 2 decades.

RCA appraisals include data on: the quality and quantity of soil, water, and related resources, including fish and wildlife habitats; the capability and limitations of those resources for meeting current and projected demands on the resource base; the changes that have occurred in the status and condition of those resources resulting from various past uses, including the impact of farming technologies, techniques, and practices; and the current Federal and State laws, policies, programs, rights, regulations, ownerships, and their trends and other considerations relating to the use, development, and conservation of soil, water, and related resources.

Developed by the Interagency Work Group on Water Quality, the *Guide to Federal Water Quality Programs and Information* is an attempt to inventory all significant Federal water quality programs and information of national scope or interest. The guide contains information on (1) factors affecting water quality including underlying demographic pressures, use of the land, water, and resources, and pollutant loading; (2) ambient water quality information, including biological, chemical, and physical/ecological conditions; (3) other effects of water pollution including waterborne disease outbreaks; and (4) a listing of programs established to preserve, protect, and restore water quality. For a copy of the Guide, contact EPA's Public Information Clearinghouse (PIC) at (202) 260-7751.

For a description of other Federal water quality programs, see the Guide to Federal Water Quality Programs and Information, *available from EPA's Public Information Clearinghouse at (202) 260-7751.*

Office of Water Programs to Support Monitoring

Environmental Indicators

The EPA Office of Water (OW) is developing a strategic plan that outlines its future directions and articulates its goals. To measure success toward these goals, OW is establishing indicators to accurately characterize the health of national water resources

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and measure how well the waters meet their designated uses. This effort has identified data sources to track the indicators. Future indicator development activities include developing comparable monitoring and reporting mechanisms by working with other agencies and national trends programs, such as EPA's EMAP and USGS' NAWQA, through the ITFM.

Monitoring Program Grant Guidance

EPA gives grants to States to assist them in administering pollution prevention and control programs, including monitoring activities. In fact, the law states EPA shall not give such grants unless the State adequately monitors surface and ground waters, compiles and analyzes the data, and reports them in 305(b) reports. EPA, working with States and the ITFM, is developing an outline for a recommended monitoring program. A comprehensive monitoring program would include both ambient monitoring and monitoring to determine the effectiveness of individual projects and individual programs designed to protect waterbodies or control sources of pollution. Recommended elements of a monitoring program include monitoring program objectives; a monitoring design description; written protocols; analytical laboratory support; quality assurance and quality control procedures; data storage, management, and sharing; water resource assessment and reporting; training; and volunteer monitoring support.

305(b) Consistency Workgroup

The 305(b) Consistency Workgroup, convened in 1990, was expanded in 1992 to address issues of consistency in water quality reporting and to improve accuracy and coverage of State assessments. The 1994 305(b) Consistency Workgroup consists of representatives of 21 States, 6 Federal agencies, the 10 EPA Regions, and EPA Headquarters. This standing workgroup, which will develop future 305(b) guidance, makes recommendations to improve each iteration of guidance to the States. Recent recommendations have included refining total State waters estimates and providing more detailed guidance for aquatic life use support assessments, including appropriate methods for using biological data along with physical and chemical data.

Water Monitor Newsletter

Since the early 1980s, EPA has issued a regular status report on monitoring activities at EPA and among the States. Now known as the *Water Monitor*, this report provides monthly updates on State, EPA Regional, and EPA Headquarter activities in areas such as biological monitoring, total maximum daily load development, biological criteria and protocol development, volunteer monitoring, and the watershed approach. New documents and upcoming meetings are highlighted. To obtain a copy or be placed on the mailing list for the *Water Monitor*, write to Editor, *Water Monitor*, AWPD (WH-553), 401 M St. SW, Washington, DC 20460.

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Biological Monitoring

The Biological Criteria Program

Priorities established in 1991 by EPA call for States to adopt biological criteria (biocriteria) into their water quality standards. To support this priority, the Agency has provided guidance for development and implementation of biocriteria. Several future guidance documents will provide additional technical information to facilitate activities directed toward that implementation. When implemented, biocriteria will expand and improve water quality standards programs, help to quantify impairment of beneficial uses, and aid in setting program priorities. These criteria will be useful because they provide for direct measurement of the condition of the resource at risk, detect problems that other methods may miss or underestimate, and provide a systematic process for measuring progress resulting from the implementation of water resource quality programs. Biocriteria are intended to supplement, rather than replace, chemical and toxicological methods.

Rapid Bioassessment Protocols

In 1989, EPA's Office of Water issued rapid bioassessment protocols (RBPs) for streams as a tool intended to provide States with biological monitoring methods to supplement traditional instream chemical analyses. The key concept underlying these protocols is the comparison of the structure and function of the aquatic community in the context of habitat quality at a given stream study site to that of an ecological reference site. On the basis of this comparison, a water resource quality assessment can be made. EPA has provided technical support and training to States to encourage the implementation of the RBPs. Currently (1993), 24 States have active RBP-based water resource monitoring programs for streams and another eight have RBP programs under development.

Additional guidance is being developed to aid States in adapting the protocol framework to fit a variety of ecological regions in the United States (lakes/reservoirs, estuaries, and others). Work is also under way to evaluate the effectiveness of RBPs for assessing combined sewer overflows.

Quality Assurance/Quality Control for Biological Monitoring and Biological Assessment

The U.S. EPA Office of Water and Office of Research and Development are assembling generic guidance documents for production of quality assurance project plans for biological monitoring and assessment. This work is currently under way and involves review and input from State and EPA regional monitoring personnel.

EPA Habitat Cluster

In ranking habitat degradation and loss as one of the highest environmental risk problems facing EPA and other governmental agencies today, the EPA's Science Advisory Board (SAB) recommended in 1990 that EPA attach as much importance to reducing ecological risks as to reducing human health risk. EPA

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has since progressed toward a more comprehensive approach to environmental problems and their remedies, and habitat is an integral part of this perspective. In 1992, EPA established the Habitat Cluster, cochaired by OW and EPA's Office of Policy, Planning and Evaluation, which is developing a strategy for the agency to deal comprehensively with habitat issues.

Fish Advisory Guidance and Information

In response to interest on the part of States to have nationally consistent methods for issuing fish consumption advisories, EPA's Office of Science and Technology (OST), Standards and Applied Science Division, is developing guidance documents for sampling and analysis of contaminated fish tissues for the purposes of issuing consumption advisories. This guidance became available in October, 1993.

In addition to this guidance, OST has developed two databases, one for States to report fish advisory information and another that contains fish tissue contaminant data. The Fish Advisory Database contains fish advisory information reported nationwide by States including the waterbody affected, the type of fish species, the type of advisory, and a contact person. It is updated regularly and can be accessed through the Fish Advisory Special Interest Group on the Nonpoint Source Bulletin Board. The National Fish Tissue Contaminants Database can be accessed through the Ocean Data Evaluation System (ODES).

National Study of Chemical Residues in Fish

In late 1992, EPA issued a report on results of the EPA National Study of Chemical Residues in Fish (NSCRF), formerly called the National Bioaccumulation Study. This study is a followup to the EPA National Dioxin Study and substantially broadens that work with regard to both the number of chemicals analyzed and the number of sites examined. The NSCRF was a screening study designed to determine the extent to which water pollutants are bioaccumulating in fish and to identify correlations with sources of the contamination within a watershed/drainage basin (see the highlight in Chapter 7 for further information about the NSCRF).

Specific Water Program Monitoring

National Estuary Program Monitoring Guidance

EPA is developing guidance on the design, implementation, and evaluation of estuary monitoring programs required under Section 320 of the Clean Water Act. The guidance document identifies the major steps involved in developing and implementing estuary monitoring programs, documents existing monitoring methods, and describes their use in monitoring the effectiveness of estuarine management actions. Case studies of existing programs are included.

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Nonpoint Source National Monitoring Program

EPA is developing a national monitoring database designed to provide information on the success of nonpoint source pollution control activities. To be included in the database, projects must have ambient monitoring of chemical, physical, and/or biological/habitat conditions, and the monitoring must be part of a rigorous nonpoint source abatement program with well-defined goals and objectives. Each of the 10 EPA Regions is to allocate a portion of the Section 319 grant funds for these projects. Data provided through this program will document the effects of well-developed nonpoint source pollution control efforts, provide better understanding of management programs and results, and provide a model for adjusting best management practices, where necessary, to achieve better results.

Wetlands Monitoring

National estimates of wetlands acreage have been available since 1975 from the FWS National Wetlands Inventory (see Chapter 16). EPA's Wetlands Division is now working closely with FWS and EPA's EMAP-Wetlands Program to characterize the ecological status and trends of existing wetlands. Standardized protocols are being developed for measuring wetlands conditions. See Chapter 16 for further information about EPA and State wetlands monitoring and protection programs.

Contaminated Sediment Strategy

In early 1993, EPA issued its Contaminated Sediment Management Strategy: A Proposal for Discussion. One of its main objectives is to describe EPA's current understanding of the extent and severity of sediment contamination. A major principle outlined in the Strategy describes EPA's commitment to continue to develop and improve methods for identifying contaminated sediments, to provide a basis for assessment of sediment contamination, to outline steps to reduce risk supported by sound science, and to outline a strategy for assessing the extent and severity of sediment contamination.

One of the initial steps to implement not only this strategy but to meet mandated statutory requirements to address and resolve contaminated sediment problems is to develop a national inventory of contaminated sediment sites for which a detailed monitoring database will be developed entitled the National Inventory of Contaminated Sediment Sites. Based on existing data, the site inventory will provide a near-term screening assessment of the national extent and severity of sediment contamination across the country and will contain sampling locational data, site characteristic data, quality assurance and quality control information, and sampling parameters. It is expected to be completed by December 1994.

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Ground Water Monitoring

EPA's support for State Ground Water Protection Programs has expanded in line with the Ground Water Task Force's recommendations in the report *Protecting the Nation's Ground Water: EPA's Strategy for the 1990's*. This document addresses the development of consistent data collection protocols to improve accessibility, quality, and the usefulness of ground water quality data. To that end, the Ground Water Minimum Set of Data Elements for Ground Water Quality was finalized requiring their use for EPA ground water monitoring.

Volunteer Monitoring Programs

In recognition of the value of volunteer water monitoring efforts and to encourage the development of carefully planned volunteer programs that work in conjunction with State water quality agencies, EPA, in 1990, developed a volunteer water monitoring guide for State managers (see sidebar). This guide provides specific steps for planning, implementing, and maintaining a volunteer water monitoring program, and includes sections on quality assurance and quality control, data management and presentation, and funding.

EPA also developed a variety of other documents in support of volunteer monitoring, including a lake monitoring methods manual for volunteers, which provides step-by-step instructions for common volunteer monitoring techniques of lakes, a directory of volunteer monitoring programs nationwide, and the proceedings of the third national conference on volunteer monitoring.

EPA will continue to provide technical support in the area of volunteer monitoring by developing additional methods manuals (one for streams and one for estuaries are under way) and guidance on preparation of quality assurance project plans for volunteers. To help facilitate technical transfer and information exchange, EPA is sponsoring regular national and regional volunteer monitoring conferences, working to strengthen its own network of volunteer monitoring coordinators in the 10 EPA Regions, and sponsoring technical transfer tools such as the *Volunteer Monitoring* newsletter and an electronic bulletin board for volunteers. In addition, many of the EPA Regions issue Clean Water Act grants to the States under the Nonpoint Source and Clean Lakes programs that include volunteer monitoring components.

EPA Publications About Volunteer Monitoring

Citizen Volunteers in Environmental Monitoring: Summary Proceedings of the Second National Workshop. New Orleans, Louisiana. EPA 503/9-90-009. Office of Water, Washington, DC.

National Directory of Citizen Volunteer Environmental Monitoring Programs, Third Edition. EPA 503/9-90-004. Office of Water, Washington, DC.

Proceedings of Third National Citizen's Volunteer Water Monitoring Conference – Building Partnerships in the Year of Clean Water. March 29-April 2, 1992. EPA 841/R-92-004. Office of Water, Washington, DC.

Volunteer Lake Monitoring: A Methods Manual. December 1991. EPA 440/4-91-002. Office of Water, Washington, DC.

Volunteer Water Monitoring: A Guide for State Managers. August 1990. EPA 440/4-90-010. Office of Water, Washington, DC.

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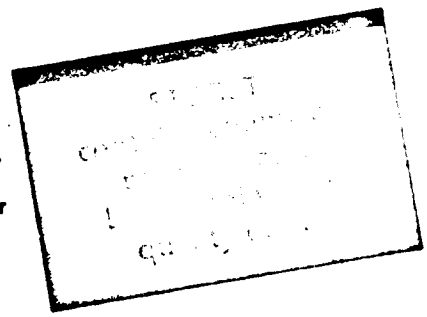
EPA Data and Information Systems

Storet Modernization

The STORET (STOrage and RETrieval) Database of ambient water quality data, first developed in 1964, is one of the oldest and largest water information systems currently in use. It has been jointly maintained by EPA's Office of Information Resources Management and the Office of Wetlands, Oceans, and Watersheds. STORET stores information on ambient, intensive survey, effluent, and biological water quality monitoring and provides users with an array of analytical tools and linkages to other data systems. STORET primarily contains chemical and physical water quality monitoring data in the water quality system, with biological sampling and site information stored in the BIOS (Biological System) Database, another major component. ODES (Ocean Data Evaluation System) is a separately maintained and linked information system specifically for water quality and biological data for marine, estuarine, and freshwater environments. ODES users can access STORET information for further manipulation using ODES graphical and modeling tools.

EPA information systems are being called upon to respond to new program needs, including geographically oriented management approaches, storage of ground water quality and associated geologic data and biological and habitat assessment information, and to enhance sharing of data (across EPA, other Federal, State, and local programs). STORET, BIOS, and ODES are undergoing a major modernization scheduled to be complete in 1997 with interim products throughout, including a prototype in late 1993. This effort will result in a more flexible, efficient, and usable state-of-the-art information system, which, in turn, will provide improved tools for ground and surface water quality decisionmaking.



The Waterbody System

The Waterbody System (WBS) is a data management tool used by States to record assessments of ambient water quality for surface waters. Although originally designed to facilitate the reporting under Section 305(b), the WBS is used by many States to track results of all their ambient water quality assessments. During the 1992 reporting cycle, 30 States, Territories, and Interstate Water Commissions submitted WBS data files. Approximately 10 additional States used the WBS in some capacity but did not submit files compatible with the 1992 version of the WBS.

The Waterbody System contains information that program managers can access quickly on the water quality status of a particular waterbody. Data elements include waterbody identification, water quality status, assessment information, designated use evaluations, causes of impairment (nutrients, pesticides, siltation, etc.), and sources of impairment (municipal treatment plants, agricultural runoff, etc.).

Enhanced twice since it was originally developed in 1988, system users communicate regularly with each other and can receive user information and support from the Monitoring Branch at EPA Headquarters.

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Volunteer Monitoring

Across the country, people are learning about water quality issues and helping to assess and protect our Nation's water resources by monitoring waters in their communities. Volunteers commonly measure physical and chemical water quality parameters, including dissolved oxygen concentrations, acidity (pH), nutrient concentrations, and temperature. Some volunteers also evaluate the health of stream habitats and aquatic biological communities, inventory stream-side conditions, and assess land uses that may affect water quality. Other volunteers collect and catalog beach debris and restore degraded habitats.

State and local agencies may use volunteer data to screen for water quality problems, establish trends in waters that would otherwise be unmonitored, or make planning decisions. Volunteers benefit by learning more about their local water resources, identifying conditions and activities that might be contributing to pollution problems, and working with clubs, environmental groups, and government agencies to address problem areas.

What is EPA's Role in Volunteer Monitoring?

The EPA supports volunteer monitoring by providing technical guidance, establishing formats for information exchange, and offering limited funding. EPA sponsors national and regional conferences to encourage information exchange among volunteer groups, government agencies, businesses, and educators. EPA publishes sampling method manuals for volunteers and provides technical assistance (primarily on quality control and laboratory methods) through the 10 EPA regional offices. The EPA Regions also manage grants to States to support volunteer monitoring in lakes and waters impacted by nonpoint sources.

What is the State's Role in Volunteer Monitoring?

Every year, citizens initiate new volunteer monitoring programs. Many of these volunteer monitoring groups work with State agencies. In 1988, only 14 State agencies provided technical and/or organizational assistance to volunteer

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monitoring groups. In 1992, 32 States supported volunteer monitoring programs and 6 additional States were planning volunteer monitoring programs.

Over 24,000 volunteers monitor more than 985 streams, 4 major estuaries, and 2,800 lakes, ponds, and wetlands in State-supported programs. Without volunteers, the States could not monitor many of these waterbodies.

Who Pays for Volunteer Monitoring?

Volunteer monitoring programs are funded through a variety of private and public sources. In some cases, public agencies sponsor volunteer programs by providing staff to train and organize volunteers, equipment, and services, such as data analysis. City, county, and Tribal governments, State agencies, and Federal agencies (such as the U.S. Park Service, the U.S. Forest Service, and the EPA) support volunteer monitoring programs financially or with guidance and training.

Many volunteer programs also receive private support from foundations, corporate sponsors, universities, and other research centers. This support may include funding for full- or part-time organizers, equipment, training workshops, and data analysis. Many volunteers contribute by purchasing their equipment and hosting training sessions.

How Do Volunteer Monitoring Programs Improve Our Environment?

The following examples demonstrate the important contributions volunteers have made to improving the environment.

Snohomish County's Adopt-a-Stream Program: Improving Fish Resources in Washington State

Over 20 school groups and 16 parent groups currently maintain and monitor adopted streams and tributaries in Snohomish County, Washington. The groups look for evidence of pollution, erosion, and activities that might disrupt fish spawning in their adopted streams.

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Volunteers and county employees, working together, completed over 105 stream restoration projects and opened 30 miles of previously restricted spawning and rearing habitat for salmon and steelhead trout.

Neighborhoods United: Protecting the Cold Stream in Cedar Rapids, Iowa

With only 13 members, Neighborhoods United began protecting the Cold Stream in Cedar Rapids, Iowa, 3 years ago. The volunteers accomplished the following tasks:

- Identified a sewer overflow and convinced the City to repair it by presenting a video tape of the overflow to city officials.
- Organized city-wide cleanup days that dramatically reduced the stream's solid waste content by several commercial truckloads of garbage.
- Involved children and adults in regular biological monitoring of the stream.

Vermont Lay Monitoring Program: Lake Champlain's Steward

Hundreds of volunteers measure Secchi disk transparency (a measure of the water turbidity) and collect water samples from 30 monitoring stations on Lake Champlain. The State analyzes chlorophyll and total phosphorus concentrations in the water samples collected by the volunteers. Volunteers also conduct user perception surveys. Volunteer data helped the State establish phosphorous standards for Lake Champlain and obtain a Federal grant to study phosphorus in Lake Champlain. The volunteer data also enabled the State to include information on Lake Champlain in the State's 305(b) report.

Volunteer Lake Monitoring Program: Benefits in Illinois

Every year, 270 volunteers donate 2,400 hours of their time to monitor over 150 lakes in Illinois. Volunteers collect data on water transparency, nutrients, and suspended solids. State agencies and local lake associations perform the following tasks with the data:

- Plan and implement over 30 lake and watershed management projects, such as a cost-sharing project with farmers to implement safe and effective use of agricultural chemicals.
- Determine water quality trends and the effectiveness of lake and watershed management projects.
- Prepare the State's 305(b) report.

Trout Unlimited: Restoring and Protecting Fish Habitat

Trout Unlimited is a nonprofit cold water fisheries conservation organization with 66,000 members in 400 local chapters. Trout Unlimited offers technical assistance to its members who participate in dozens of water monitoring and river restoration projects each year. Trout Unlimited members recently completed the following projects:

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■ Constructed a barbed-wire fence along California's Trout Creek in the Shasta-Trinity National Forest to prevent cows from damaging fish habitat. Chevron Corporation assisted.

■ Restored fish habitat on Spring Creek in Missouri's Mark Twain National Forest. Trout Unlimited members planted 20,000 trees along a 6-mile segment of the creek, restored the creek banks, and reclaimed the natural Ozark vegetation.

The GREEN Project: Empowering People to Improve Water Quality Around the World

The Global Rivers Environmental Network (GREEN) is affiliated with the School of Natural Resources at the University of Michigan in Ann Arbor. GREEN provides a clearinghouse of scientific information and ideas for people with an interest in studying and improving local water quality through hands-on monitoring and problemsolving. Several examples of student actions arising from GREEN's water monitoring programs include:

■ In Swaziland on the African continent, students reduced the cases of schistosomiasis (a tropical disease caused by parasitic worms) by locating an alternative river site for washing clothes and providing basins and water pumps at the new site.

■ In Australia, students and teachers identified partially treated sewage near public beaches and appeared on national television to advise the public of the health risks.

■ In Detroit, Michigan, students identified a malfunctioning municipal sewage treatment station emptying raw sewage into the Rouge River. The city immediately repaired the station's equipment.

For More Information

To learn more about volunteer monitoring and how to participate, contact:

Alice Mayio
Volunteer Monitoring Coordinator
U.S. Environmental Protection Agency (4503)
401 M Street, SW
Washington, DC 20460
(202) 260-7018

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For further information about data systems and information systems, see the Office of Water's Environmental and Information Systems Compendium available from the EPA Office of Water at (202) 260-5684.

The Permit Compliance System

The Permit Compliance System (PCS) is an information management system maintained by the Office of Wastewater Enforcement and Compliance (OWEC) to track the permit, compliance, and enforcement status of facilities regulated by the National Pollutant Discharge Elimination System (NPDES) program under the Clean Water Act. PCS tracks information about wastewater treatment and industrial and Federal facilities discharging into navigable rivers. Tracked items include facility and discharge characteristics, permit conditions, inspections, enforcement actions, and compliance schedules. PCS distinguishes between major and minor facilities based on the potential threat to human health or the environment. Only major facilities must provide complete records to PCS, currently numbered at around 7,100; however, States and Regions do submit information for approximately 56,300 minor facilities. PCS users are able to use graphical and statistical tools to analyze PCS data and can use a PCS/STORET interface to link the systems and support additional analyses.

Nonpoint Source Information Exchange

The Nonpoint Source Information Exchange, housed at the Assessment and Watershed Protection Division of EPA's Office of Water, is designed to serve as a national center for the exchange of information concerning (1) the nature of nonpoint source (NPS) pollution, (2) NPS management techniques and methods, and (3) institutional arrangements for the planning and implementation of NPS management including financial arrangements.

The Exchange contains two major activities: a technical bulletin, the *NPS News-Notes*, published approximately eight times per year, and the NPS Electronic Bulletin Board System (NPS BBS). The target audience for the *News-Notes* is State and local water quality managers although, with a circulation of over 10,000, other interested parties including public officials, environmental groups, private industry, citizens, and academics receive *News-Notes* regularly.

The NPS BBS, first opened in 1991, provides timely and relevant NPS and other information to a similar audience. There are more than 1,200 users of the NPS BBS who, through the system, can access several special interest areas: Agricultural Issues, Fish Consumption Advisories and Bans, Waterbody System Users Group, NPS Research, Watershed Restoration Network, Total Maximum Daily Loads, and Volunteer Monitoring. Also available are on-line searchable databases such as the Clean Lakes Clearinghouse, *NPS News-Notes* database, the Fish Consumption Bans and Advisories database, and the National Registry of Watershed Projects.

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Great Lakes Envirofacts

The Great Lakes National Program Office (GLNPO) is initiating a computer system development pilot effort called *Great Lakes Envirofacts* (GLEF) to assist managers and technical staff in developing strategies to reduce toxic chemical loadings. The keystone goal of GLNPO's data integration program is developing a system to enable technical staff to access, display, analyze, and present Great Lakes multimedia and geographic information from their desk top, providing environmental decisionmaking support for Great Lakes Program managers. The GLEF pilot project will explore both the system requirements of Great Lakes Program staff and the technical means (hardware, software, and telecommunications) to begin realizing its keystone goal.

The GLEF will build upon the Envirofacts/Gateway system developed by EPA's Office of Information Resources Management (OIRM) Program Systems Division (PSD). The *Envirofacts* database stores environmental monitoring and program (e.g., PCS, TRIS, FINDS) information in a relational structure. *Gateway* is a graphical user interface that provides spatially referenced access to the Envirofacts database. The Great Lakes Envirofacts project will be the first implementation of the Gateway/Envirofacts concept, testing its capability and utility for the Great Lakes Program.

Other Information Clearinghouses & Electronic Bulletin Boards

Several other clearinghouses, electronic bulletin boards, newsletters, and information updates on water quality activities have been developed by EPA for use by State and local governments, Federal agencies, and the public. These include COASTNET bulletin board for coastal waters and estuary protection activities, the Clean Lakes Clearinghouse, the *Contaminated Sediment News* bulletin, the Water Monitor (described on page 218), and the Office of Science and Technology's Resource Center.

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Point Source Control Program

Treating Municipal Wastewater

Municipal treatment facilities receive wastewater from residential sources as well as from industry, ground water infiltration, and storm water runoff. The array of pollutants that may be associated with these sources includes suspended solids, organics, pesticides, heavy metals, nutrients, acids, viruses, and bacteria.

Adequate treatment of municipal wastewater is important for the protection of the Nation's water resources and public health. Without adequate treatment, this pollution poses a potentially serious threat to aquatic life, commercial and recreational opportunities, surface water drinking supplies, ground water drinking supplies, and the general health and stability of many of the Nation's stream, river, lake, estuarine, and coastal ecosystems.

The Clean Water Act requires municipalities to achieve treatment levels based on technology performance. The 1981 CWA amendments extended the deadline for eligible treatment plants to achieve "secondary treatment" to July 1, 1988. Secondary treatment removes at least 85% of several key conventional pollutants. If secondary treatment is not enough to meet water quality standards, the Clean Water Act mandates additional treatment as necessary.

Historically, under the Clean Water Act, EPA has been authorized to help municipalities solve their wastewater treatment problems by providing grants for construction. For this purpose, $18 billion was originally appropriated to the construction grants program. Funding has continued since the initial appropriation in 1972, and the Federal investment in municipal wastewater treatment was $56 billion through fiscal year 1992.

Through the 1987 amendments to the Clean Water Act, the State Revolving Fund (SRF) Program was established to follow the phaseout of the Construction Grants Program. Under this program, the Agency provides grants to States to fund the establishment of State-run loan programs. This is a major step in restoring the responsibility for financing wastewater treatment to States and municipalities. Congress appropriated more than $9 billion through fiscal year 1994 for State Revolving Funds. States must provide a 20% match as part of their commitment toward establishing their SRFs. In addition to providing loans for construction of wastewater treatment facilities, SRFs allow funding for activities not previously eligible under the Construction Grants Program. The amendments

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of 1987 expanded eligibilities and also led to the promulgation of new rules related to new enforceable requirements. The major categories of new eligibilities are nonpoint source control and programs for the protection of ground water and estuaries. The primary programs with new enforceable requirements are those dealing with storm water, toxic discharges, and sludge use and disposal. The SRF loan program provides States with more discretion than ever before in selecting projects for funding. States are now able to finance projects they may consider to be of higher priority, such as nonpoint source, estuarine, combined sewer overflow, or storm water control projects. All States and Puerto Rico had approved SRF programs in place as of September 1990.

The States provided some examples of water quality improvements due to municipal construction and upgrading in their 1992 305(b) reports (see sidebar).

Funding Needs for Wastewater Treatment

The Needs Survey, a biennial report to Congress, is the primary mechanism for assessing municipal wastewater treatment needs nationwide. The 1992 Needs Survey focuses on the expanded CWA funding eligibilities under the SRF in the 1987 Amendments to the Clean Water Act. Models were used to supplement documented needs estimates for combined sewer overflows (CSOs). Models were also used to develop preliminary urban storm water and agricultural and silvicultural nonpoint source (NPS) pollution control implementation costs since very little documentation of specific projects or costs was available from the States.

EPA's needs estimates include those facilities and activities for which a water quality or public health problem could be documented using specific criteria established by EPA. The capital investment necessary to satisfy all categories of need is presented in Table 13-1. Additional nonconstruction estimates are included for program development costs associated with storm water and NPS control. The

Table 13-1 Needs for Publicly Owned Wastewater Treatment (Dollars in Billions)

Needs Category	Total Needs
Title II Eligibilities	
I Secondary Treatment	31.3
II Advanced Treatment	15.5
IIIA Infiltration/Inflow Correction	2.8
IIIB Replacement/Rehabilitation	3.6
IVA New Collector Sewers	17.9
IVB New Interceptor Sewers	14.7
V Combined Sewer Overflows	41.2 [a]
VI Storm Water (institutional source controls only)[b]	0.1 [a]
Total Categories I-VI	127.1
Other Eligibilities (Sections 319 and 320)	
Nonpoint Source (agriculture and silviculture only)	8.8 [a]
Ground Water, Estuaries, Wetlands	1.2
GRAND TOTAL	137.1

[a] Modeled needs.

[b] Includes SRF-eligible costs to develop and implement storm water plans but not eligible structural and construction costs.

NOTE: Costs for operation and maintenance are not eligible for SRF funding and therefore are not included.

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1992 total documented and modeled needs are $137.1 billion to satisfy all categories of needs eligible for SRF funding for the design year (2012) population.

This amount included $50.1 billion in modeled needs for CSO, storm water, and NPS pollution control. For storm water and NPS, the estimates exclude operation and maintenance costs (O&M) since O&M costs are ineligible for SRF funding. However, O&M costs are the major costs associated with storm water and NPS program implementation. Only agriculture and silviculture NPS pollution control costs were estimated. Many types of NPS pollution were not addressed: abandoned mines, urban areas, septic systems, contaminated sediments, hydromodification, and atmospheric deposition.

The needs estimate for the Nation rose in constant dollars by $53.4 billion (39%) from 1990 to 1992. The increase was due to a variety of factors, primarily improved documentation of SRF eligibilities and the use of models to capture full CSO, as well as partial urban storm water and NPS costs.

Water Quality Improvements from Treatment Plant Upgrades

- Wisconsin reported that construction of new municipal treatment plants restored large segments of the Fox and Wisconsin Rivers. These segments now fully support fishing use and aquatic life use. As a result, sport and commercial fisheries have returned to some river segments.
- Vermont reported that a secondary treatment facility constructed in Troy addressed untreated municipal discharges and corrected long-term stream use impairments.
- The Ohio River Valley Water Sanitation Commission (ORSANCO) detected statistically significant declines in total suspended solids and total nitrogen in the Ohio River mainstem between 1977 and 1987. These pollutants commonly occur in municipal wastewater discharges and their decline suggests that treatment plant upgrades are reducing pollution in the Ohio River.
- New Mexico attributed a sharp decline in the total loading of oxygen demanding wastes (BOD) into the State's surface waters between 1977 and 1991 to sewage treatment plant construction. During the same period, population growth spurred an increase in the total volume of wastewater treated. However, the construction of more efficient treatment plants outpaced the increase in wastewater load.

Treating Industrial Wastewater

The Clean Water Act required EPA to establish uniform, nationally consistent effluent limitation guidelines for industrial discharges. At this time, EPA has established Best Available Technology Economically Achievable (BATEA) and Best Conventional Pollutant Control Technology (BCT) guidelines for about 28 industrial categories. EPA has also promulgated technology-based guidelines for approximately 15 additional secondary industries that represent Best Practicable Control Technology Currently Available (BPT) levels. EPA is studying an additional dozen industries for future guidelines development.

In addition to these technology-based requirements, EPA, in 1984, issued a policy on the water-quality-based control of toxic pollutants discharged by point sources. In 1985, EPA issued the *Technical Support Document for Water Quality-Based Toxics Control* to support the national policy. EPA updated and enhanced this document in 1991. Both the policy and guidance

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	Major Permits	Minor Permits
Total Facilities	[illegible]	[illegible]
EPA-Issued Permits		
Total	2,070	7,243
Expired	217	4,055
Percent	10.5%	56%
State-Issued Permits		
Total	5,035	49,900
Expired	1,119	18,518
Percent	22.2%	37.1%

Source: Permit Compliance System, February 1993.

recommend using overall toxicity as a measure of adverse water quality impact and as a regulatory parameter. In 1989, EPA amended its NPDES regulations to require the use of effluent discharge limitations for whole-effluent toxicity in addition to specific toxic chemicals. The use of whole-effluent toxicity as a regulatory tool coupled with controls for specific chemicals provides a powerful means of detecting and controlling toxic problems.

Permitting, Compliance, and Enforcement

EPA and the States use rigorous permit conditions to control point source discharges from industrial and municipal wastewater treatment facilities. During the early 1980s, the rate of permit issuance fell behind the rate of permit expiration, and large backlogs of unissued permits developed. Efforts to remedy these backlogs have been largely successful. Table 13-2 illustrates the status of permit issuance as of February 1993.

Once the permit is established, compliance with these conditions is essential for achieving water quality improvements. Despite examples of water quality improvements associated with upgrading municipal facilities, 10% of major municipal treatment plants are in significant noncompliance with applicable permit conditions. Industrial permittees have historically achieved a higher rate of compliance; 7% of industrial facilities are in significant noncompliance with their permit conditions.

EPA and States with approved NPDES programs are responsible for ensuring that municipal and industrial facilities comply with the terms of their discharge permits. Currently, 39 States have approval from EPA to administer their own NPDES programs. This responsibility includes issuing permits, conducting compliance inspections and other compliance monitoring activities, and enforcing compliance. EPA has the lead implementation responsibility in the remaining States. EPA and the States evaluate compliance by screening self-monitoring reports submitted by the permitted facility. Facilities that are determined to be in noncompliance are subject to Federal as well as State enforcement action.

Figure 13-1 illustrates rates of significant noncompliance based on statistics maintained by EPA from December 1983 through June 1992. Significant noncompliance rates for municipal and industrial facilities jumped in FY90 primarily because, for the first time, EPA calculated noncompliance directly from its automated database. Therefore, if data are not entered into the Permit Compliance System in a timely manner (e.g., failure to enter the receipt of a required report within 30 days), the system will automatically determine that the facility is not in compliance. EPA is continuing to refine its tracking of compliance with permit conditions to better reflect instances of noncompliance by the regulated community.

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National Municipal Policy

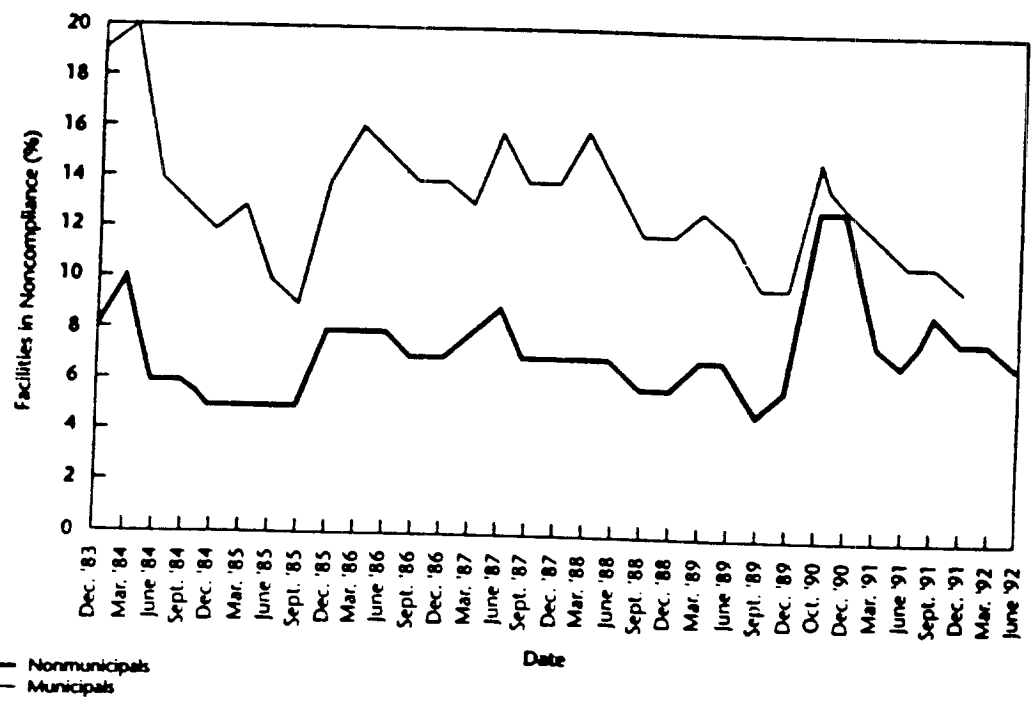
Due to the generally poor municipal compliance record, and because of congressional concern over the performance of treatment works built primarily with Federal funds, EPA developed the National Municipal Policy (NMP) to address the failure of publicly owned treatment works (POTWs) to meet treatment levels required for compliance with the CWA. On January 23, 1984, the EPA Administrator signed the NMP into effect. The NMP clarified and emphasized EPA's resolve to ensure that municipalities comply with the Clean Water Act as quickly as possible, regardless of whether Federal grant assistance was available for treatment plant construction.

The deadline established for full compliance with the Clean Water Act was July 1, 1988. By this date, all municipal treatment facilities were to be in compliance with the secondary treatment requirement of

INDUSTRIAL FACILITIES have a higher rate of compliance with discharge permits than do municipal facilities.

Figure 13.1

Percent of Facilities in Significant Noncompliance with NPDES Permit Requirements



Source: USEPA Permit Compliance System, June 1992.

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Section 301(b)(1)(B) of the CWA or with more stringent limitations established to meet State water quality standards. Of the total universe of 3,731 major municipal facilities, 1,478 facilities were identified as requiring construction to meet the 1988 deadline. By July 1, 1988, all but 423 municipal facilities achieved compliance with the requirements. Since the 1988 deadline, 188 facilities have come into compliance, and, of the remaining 235 facilities, all but 50 have been placed on enforceable compliance schedules. EPA is continuing to track the progress of these facilities in meeting the requirements of the CWA.

In the 1987 Water Quality Act amendments to the CWA, EPA was given authority to seek administrative penalties from permittees in noncompliance with the Act's requirements. EPA issued guidance and delegated the authority for issuing these orders to the regional level in August 1987. The first Administrative Penalty Order (APO) was issued in September 1987. Through October 1990, 396 APOs have been issued assessing a total of $7.5 million in penalties. These orders have been an effective tool in expeditiously addressing violations of the CWA and represent an integral component of EPA's overall enforcement strategy.

Controlling Toxicants

The 1987 amendments to the Clean Water Act reinforced both the water-quality-based and technology-based approaches to point source control, requiring EPA to develop and update technology-based standards and adding specific direction as to how water-quality-based limits should be used to achieve additional improvements. One of the Act's primary emphases lay in strengthening the Nation's toxics control program.

Identifying Waters Impaired by Toxicants

Section 304(l) of the CWA required States to develop lists of impaired waters, identify point sources and the amounts of pollutants they discharge that cause toxic impacts, and develop an individual control strategy (ICS) for each such point source. These ICSs are NPDES permits with new or more stringent limits on the toxic pollutants of concern. The individual control strategies must be accompanied by supporting documentation to show that the permit limits are sufficient to meet water quality standards as soon as possible but no later than 3 years after establishment of the ICS. The general effect of Section 304(l) was to immediately focus national surface water quality protection programs on addressing known water quality problems due entirely or substantially to point source discharges of Section 307(a) toxic pollutants. Under Section 304(l), EPA and States identified 68 facilities in the United States that were required to have individual control strategies. ICSs have been established for 58 of these facilities.

EPA implements control measures for all toxic pollutants as part of its ongoing surface water program. Section 304(l) emphasized implementing point source controls to protect particularly impaired

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surface waters for priority toxic pollutants. EPA will continue identifying impaired waters and controlling the discharge of toxic and other pollutants through existing reporting, standards setting, and permitting programs.

In developing lists of impaired waters under Section 304(l), States used a variety of available data sources (including State Section 305(b) reports). At a minimum, dilution analyses were conducted based on existing or readily available data. EPA asked States to assemble data quickly to report preliminary lists of waters, point sources, and amounts of discharged pollutants by April 1, 1988, in their Section 305(b) reports. These lists were then to be refined and expanded by the statutory deadline of February 4, 1989.

Section 304(l) encourages the States and EPA to address problems identified through review of existing and readily available data. The States and EPA Regions will continue to collect new water quality data to fill existing data gaps and ensure that changes in water quality are identified.

Status of 304(l) Implementation (as of August 1993)

As of August 1993, 529 waterbodies had been identified as being impaired entirely or substantially by point source discharges of Section 307(a) toxic pollutants. In addition, 687 point sources were listed as being responsible for impairing the quality of those waters. There are also 18,770 waters on the "long" list that includes all waters impaired by any pollutant from either point sources or nonpoint sources. The long list will be used for long-term planning and setting of priorities for monitoring, total maximum daily load development, nonpoint source controls, and permit revisions.

In a September 1990 decision in NRDC v. EPA, the U.S. Court of Appeals, Ninth Circuit, remanded portions of EPA's regulations interpreting Section 304(l) of the Clean Water Act. The Court said that EPA erred when it required States to identify only those point sources discharging to waters listed by States as impaired entirely or substantially due to the point source discharge of toxic pollutants; there are 529 such waters. Instead, the Court said that EPA must require States to identify point sources discharging toxic pollutants to any water identified under Section 304(l) as impaired for any reason; there are 18,770 such waters. The States are currently listing the additional point sources and EPA expects the new listings to be finalized by November 1993.

In its 1990 decision in NRDC v. EPA, the U.S. Court of Appeals, Ninth Circuit, recognized it might be significantly changing the list of point sources under Section 304(l). So the Court required EPA to reconsider whether all point sources under Section 304(l) should be required to have individual control strategies (EPA's regulations at issue had required control strategies for all point sources listed under Section 304(l)). EPA is currently considering this question and has invited public comment (see 57 FR 33051, July 24, 1992).

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EPA Regions and the States continue to work on implementing 304(l) requirements. Approximately 80% of the ICSs required are in place as EPA-approved draft or final NPDES permits.

Toxicity Testing

On March 9, 1984, EPA issued a policy designed to reduce or eliminate toxics discharge and help achieve the objectives of the Act. The "Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants" (49 FR 9016) described EPA's integrated toxics control program. The integrated program consisted of the application of both chemical-specific and biological methods to address the discharge of toxic pollutants. To support this policy, EPA issued the *Technical Support Document for Water Quality-Based Toxics Control (TSD)* guidance. EPA continued the development of the toxics control program by revising the TSD in 1991 and by including some aspects of the policy in NPDES regulations at 40 CFR 122.44(d)(1) in June 1989.

Toxicity reduction evaluations (TREs) identify and implement whatever actions are needed to reduce effluent toxicity to the levels specified in the permit. TREs combine toxicity testing, chemical analyses, source investigations, and treatability studies to determine either the actual causative agents of effluent toxicity or the control methods that will reduce effluent toxicity. EPA is currently documenting successful TREs conducted by permittees, States, and EPA researchers. Methods and procedures for conducting TREs are described in several EPA guidance documents and referenced in the TSD.

In October 1992, EPA conducted a survey of the 50 States and the District of Columbia to determine the extent of implementation of whole effluent toxicity (WET) controls for industrial and municipal point sources. The District of Columbia and 49 States are using the whole effluent approach in permitting as part of their water-quality-based toxics control program. Thirty-five States and the District required numeric WET limits in NPDES permits for industrial and municipal dischargers, while 14 States required monitoring. Forty States and the District required both acute and chronic testing.

The National Pretreatment Program

The primary goal of the National Pretreatment Program is to protect POTWs and the environment from the adverse impact that may occur when toxic, hazardous, and concentrated conventional wastes are discharged into sewer systems from industrial sources. To achieve this goal, the EPA has promulgated national pretreatment standards for pollutants that: (1) interfere with the operation of a POTW, including interference with its use or disposal of municipal sludge; or (2) pass through the POTW and contaminate the receiving stream or are otherwise incompatible with the operation of the treatment works. In addition, the program is intended to improve opportunities to recycle and reclaim

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municipal and industrial wastewaters and sludges. The prevention of interference, the prevention of pass-through, and the improvement of opportunities to recycle wastewater and sludge are the three regulatory objectives of the National Pretreatment Program. These objectives are accomplished through a pollution control strategy with two elements:

■ **National Categorical Standards:** National technology-based standards developed by EPA Headquarters reflecting best available technology (BAT) in establishing effluent limits for the 126 "priority pollutants" as well as for conventional and nonconventional pollutants for specific industrial categories.

■ **Prohibited Discharge Standards:**

General Prohibitions: National regulatory prohibitions established by EPA against pollutant discharges from any nondomestic user that cause pass-through or interference at the POTW.

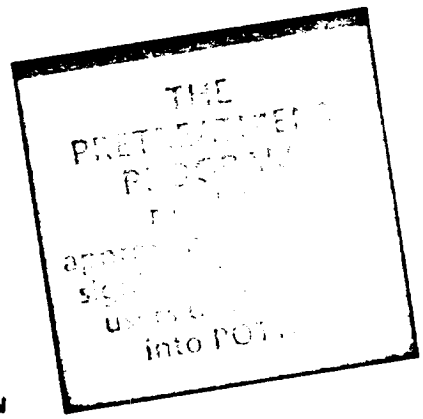
Specific Prohibitions: National regulatory prohibitions established by EPA against pollutant discharges from any nondomestic user that cause: (1) fire or explosive hazard, (2) corrosive structural damage, (3) interference due to obstruction, (4) interference due to flow rate or concentration, (5) interference due to heat, (6) interference from petroleum-based oil, and (7) acute worker health and safety problems from toxic gases.

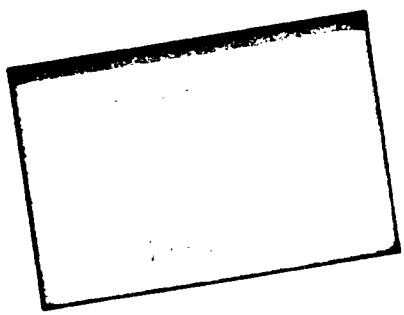
Local Limits: Enforceable local effluent limitations developed by POTWs on a case-by-case basis to reflect site-specific concerns and implement the Federal general and specific prohibited discharge standards as well as State and local regulations.

To ensure the success of the pretreatment program, EPA also issues guidance documents and has conducted scores of training seminars to assist POTWs in developing, implementing, and enforcing effective pretreatment programs.

The primary focus for pretreatment implementation is at the local level since the POTW is in the best position to regulate its industrial users. States may become involved in pretreatment implementation through a formal approval process in which the Federal Government transfers its oversight responsibilities to the State. The Federal Government, through the EPA, is involved in pretreatment through standard setting, policy development, and oversight of program implementation by approved States and POTWs in States without approved pretreatment programs. At present, 27 States have received approval from EPA to administer the pretreatment program, including five States that have chosen to directly regulate the industrial community in their States in lieu of local program approval and implementation. In addition, 1,442 local programs have been approved by either EPA or approved States, and another 100 programs are under development. The pretreatment program currently regulates approximately 30,000 significant industrial users (SIUs).

On July 24, 1990, the EPA promulgated the Domestic Sewage





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Study (DSS) final rule, which implements the recommendations made in the DSS. Specifically, the rule is designed to improve the control of hazardous wastes discharged to POTWs as well as strengthen the enforcement of pretreatment program requirements. In addition, the rule requires that POTWs conduct toxicity testing of their effluents. A continuing task will be to integrate the implementation of these requirements into the normal operations of the POTWs' pretreatment programs.

The environmental accomplishments of the National Pretreatment Program have been significant. Nationwide, EPA estimates that toxic pollutant loadings to POTWs have decreased by up to 75% through pretreatment. In many cases, the effects on surface water and sludge have been dramatic. Between 1975 and 1985, for example, 15 POTWs discharging to San Francisco Bay decreased their overall metals loadings by 80%, despite a 15% increase in POTW flows. In Wisconsin, 14 of 24 POTWs reported marked decreases in average total metals concentrations in their sludge after approval of their local pretreatment programs.

The compliance status of industrial users and POTWs is an indicator of the programmatic success of pretreatment implementation. Based on data reported by POTWs or States, approximately 54% of significant industrial users of sewage treatment plants are in significant noncompliance with discharge standards and/or reporting and self-monitoring requirements. This compares with a rate of 7% significant noncompliance for the major industries in the NPDES program, which discharge directly to waterbodies. According to data in EPA's national database, 39% of POTWs are failing to implement at least one significant component of their approved pretreatment programs.

EPA has focused its oversight and enforcement resources on ensuring that local municipalities properly implement their approved programs. Toward that end, on October 4, 1989, EPA announced the National Pretreatment Enforcement Initiative against cities for failure to adequately implement their approved pretreatment programs. In this action, EPA joined with several States in bringing civil judicial suits or administrative penalties against 61 cities. This effort was designed to alert cities as to their requirements under the pretreatment program and to ensure adequate implementation of the program. A followup announcement was made on May 1, 1991, containing 755 additional actions against both POTWs and significant industrial users.

In July 1991, EPA issued a report to Congress on the effectiveness of the pretreatment program as required under Section 519 of the CWA. This report analyzed the major strengths and weaknesses of the program and has provided direction for improving the program.

Managing Sewage Sludge

The need for effective sewage sludge management is continuous and growing. In the United States, the quantity of municipal sewage sludge produced annually has

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almost doubled since 1972. Municipalities currently generate approximately 5.3 million dry metric tons of wastewater sludge per year, or approximately 47 pounds per person per year (dry weight basis). Improper sewage sludge management could lead to significant environmental degradation of water, land, and air, as well as adverse human health conditions.

Prior to the 1987 amendments to the Clean Water Act, the authorities and regulations related to the use and disposal of sewage sludge were fragmented and did not provide States and municipalities with adequate guidelines on which to base sludge management decisions. There was no single legislative approach or framework for integrating the various Federal laws to ensure that sludge would be used or disposed of in a consistent or environmentally acceptable manner. Although the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, the Marine Protection, Research and Sanctuaries Act, and the Toxic Substances Control Act all regulate some aspect of sludge management, coverage is uneven, and the requirements are based on different methodologies and approaches.

Section 406 of the Water Quality Act of 1987, which amends Section 405 of the Clean Water Act, for the first time sets forth a comprehensive program for reducing the environmental risks and maximizing the beneficial uses of sludge. The program is based on the development of technical requirements for sludge use and disposal and the implementation of such requirements directly through the rule and through permits.

In May 1989, EPA promulgated regulations for including sewage sludge conditions in NPDES permits and for issuing sludge-only permits. These rules also outline the requirements for States to seek EPA approval to implement the new statutory requirements.

EPA will be the permitting authority for sewage sludge since there are currently no approved State programs. Initially, EPA will rely strongly on the self-implementing nature of the technical regulations. EPA will focus its initial permitting efforts on

- Sewage sludge incinerators (which require site-specific pollutant limits)
- Facilities posing a threat to human health and the environment
- Facilities needing a permit to promote beneficial use
- Facilities with NPDES permits up for renewal.

In implementing the new sewage sludge requirements, EPA will also focus on approving State programs and educating the general public and the regulated community.

In addition, regulations that address sewage sludge disposal in municipal solid waste landfills were proposed in August 1988 and are scheduled to be promulgated on October 9, 1993.

Pursuant to Section 405, EPA has developed regulations for each of the major use and disposal options for sewage sludge. These options include land application, incineration, landfilling, and surface

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disposal. The standards for each end use and disposal practice consist of general requirements, numerical limits on the pollutant concentrations in sewage sludge, management practices, and, in some cases, operational requirements. The final rule also includes monitoring, recordkeeping, and reporting requirements.

Standards apply to publicly and privately owned treatment works that generate or treat domestic sewage sludge, as well as to any person who uses or disposes of sewage sludge from such treatment works. The rule requires compliance with these standards as expeditiously as possible but not later than 12 months after the date the rule is published, or within 24 months of publication if construction of new pollution control facilities is required to comply with the regulations.

New Initiatives in Point Source Control

Combined Sewer Overflow Control

Currently about 1,100 communities served by 1,303 CSO facilities nationwide use combined sewer systems, which are designed to carry sanitary and industrial wastewater and storm water. These facilities are mainly located in older cities in the Northeast, the midcentral States, and along the west coast. Combined sewer overflows occur when the capacity of the combined sewer system is exceeded during a storm event. During these storm events, part of the combined flow in the collection system is discharged untreated into receiving waters. The overflows may contain high levels of suspended solids, floatables, heavy metals, nutrients, bacteria, and other pollutants. Pollution from CSOs can pose health risks, degrade the ecology of receiving waters, and impair the beneficial use of water resources.

EPA published the National Combined Sewer Overflow Control Strategy in the *Federal Register* on September 8, 1989, at 54 FR 37370. Although implementation of the 1989 strategy has resulted in some progress toward controlling CSOs, significant public health and water quality risks remain.

In August 1991, EPA determined that implementation of the 1989 strategy was not proceeding rapidly enough. EPA's Office of Water (OW) initiated an Expedited Plan to accelerate the implementation of the 1989 National CSO Control Strategy. At the recommendation of OW's Management Advisory Group, a negotiated policy dialogue with key stakeholders was also initiated. The negotiations occurred during the summer of 1992.

Based on the negotiated policy dialogue and subsequent negotiations between municipal and environmental groups and States, a *CSO Framework Document – Recommended Guidance to NPDES Permit Writers*, dated November 2, 1992, was submitted to EPA's Office of Water for consideration as part of the development of a draft CSO policy. Although the framework was not the result of consensus among the negotiating parties, significant agreement was reached, allowing OW to use the framework as the basis to develop a draft CSO policy.

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On December 22, 1992, the Assistant Administrator for Water and the Assistant Administrator for Enforcement issued a draft CSO Control Policy (dated December 18, 1992) for comment. A notice of availability was placed in the *Federal Register* on January 19, 1993, establishing a public comment period until March 22, 1993, on the draft policy (58 FR 4994).

The main purposes of the Policy are to elaborate on the 1989 National CSO Control Strategy and to expedite compliance with the requirements of the Clean Water Act.

The Policy is being developed to provide guidance to permittees with CSOs, NPDES authorities, and State water quality standards authorities on coordinating the planning, selection, sizing, and construction of CSO controls that meet the requirements of the CWA and to allow for public involvement during the decisionmaking process.

Contained in the Policy are provisions for developing appropriate, site-specific NPDES permit requirements for all combined sewer systems that overflow as a result of wet weather events and enforcement initiatives to require the immediate elimination of overflows that occur during dry weather and to ensure that the remaining CWA requirements are complied with as soon as practicable. The 1992 Needs Survey modeled the cost of compliance with the draft 1992 CSO Policy. The Needs Survey estimated that the national cost of CSO corrections will be $41.2 billion. The modeled estimate compares to the State-documented costs of $22.4 billion for 375 of the approximately 1,300 CSOs needing correction.

EPA will finalize this policy in the fall of 1993. As it finalizes the draft policy, EPA is preparing a number of guidance documents to assist in the implementation of the final policy when it is issued. Specific programmatic areas that this guidance will address are implementing minimum CSO control measures by all communities with CSOs; monitoring and modeling of combined sewer systems, CSO discharges, and receiving water impacts; preparation of long-term CSO control plans by CSO communities; and drafting NPDES permit requirements for CSO discharges by EPA and State NPDES permit writers.

NPDES Storm Water Controls

Since 1972, State and EPA efforts under the NPDES program have traditionally focused on controlling pollutant discharges from POTWs and industrial process wastewaters. As these sources of pollution came increasingly under control, the need for controlling pollutants in storm water point source discharges became more critical to efforts to achieve the goals of the CWA. As reflected in this report, storm water discharges from a variety of sources, including storm sewers discharging urban runoff, construction site runoff, runoff from resource extraction activities, and runoff from land disposal sites, are major sources of use impairment.

Section 402(p) of the CWA amendments of 1987 established a timetable and framework for EPA to address storm water discharges

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under the NPDES program. Section 402(p) required EPA to develop a two-phase program to control point source discharges of storm water. On November 16, 1990, EPA promulgated permit application requirements for the first phase for discharges from municipal separate storm sewer systems serving populations of 100,000 or more and for storm water discharges associated with 11 industrial categories:

- Manufacturing facilities
- Construction operations or activities disturbing 5 or more acres
- Hazardous waste treatment, storage, and disposal facilities
- Landfills
- POTWs with approved pretreatment programs and/or discharging over 1 million gallons per day
- Recycling facilities
- Power plants
- Mining operations
- Some oil and gas operations
- Airport facilities
- Certain transportation facilities (such as vehicle maintenance areas).

Permits are required to be issued for these sources, for the most part, by October 1, 1993.

For the second phase, EPA is required to develop two storm water reports to Congress. The first will identify storm water discharges and determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges. The second study will establish procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality. Based on these two studies and recommendations from experts, as well as public input, Congress will direct EPA to control additional sources under Phase II.

Control of Bioconcentratable Contaminants

Bioconcentratable contaminants can damage both human health and aquatic life. In response, EPA has developed draft guidance to identify and, where necessary, control bioconcentratable organic compounds that may be present in effluents, nonpoint source runoff, receiving waters, sediments, dredged material, and the tissues of aquatic organisms.

The approach outlined in EPA's draft guidance is designed to assist

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regulatory authorities in identifying and determining the concentration of specific organic compounds in complex mixtures and to make more informed decisions concerning control of these substances. EPA's approach provides: a comprehensive screen for organic chemicals that are likely to bioconcentrate, procedures for assessing and controlling complex mixtures, a standardized assessment methodology, and triggers for regulatory action and control development. EPA's draft guidance focuses principally on the development and implementation of point source limitations on bioconcentratable organic compounds.

Pollution Prevention

EPA has established an Office of Pollution Prevention that works with other program offices to improve pollution prevention activities within the Agency. For example, an Agency pollution prevention policy has been developed, and a strategy to address pollution prevention in manufacturing and chemical use has been drafted. Future strategies will focus on the municipal water and wastewater, agricultural, energy, and transportation sectors. A subcommittee comprising representatives from EPA Headquarters and Regions has been formed to develop an Agency-wide training strategy to ensure that pollution prevention concepts are integrated into all Agency activities.

In terms of the point source control program, the Agency's draft pollution prevention strategy recognizes the importance of permitting and enforcement activities and will continue support for a strong program in these areas. Training is being provided to familiarize NPDES permit writers with pollution prevention opportunities, how their permit decisions can affect other media, and how to effectively communicate the concept of pollution prevention to industrial managers.

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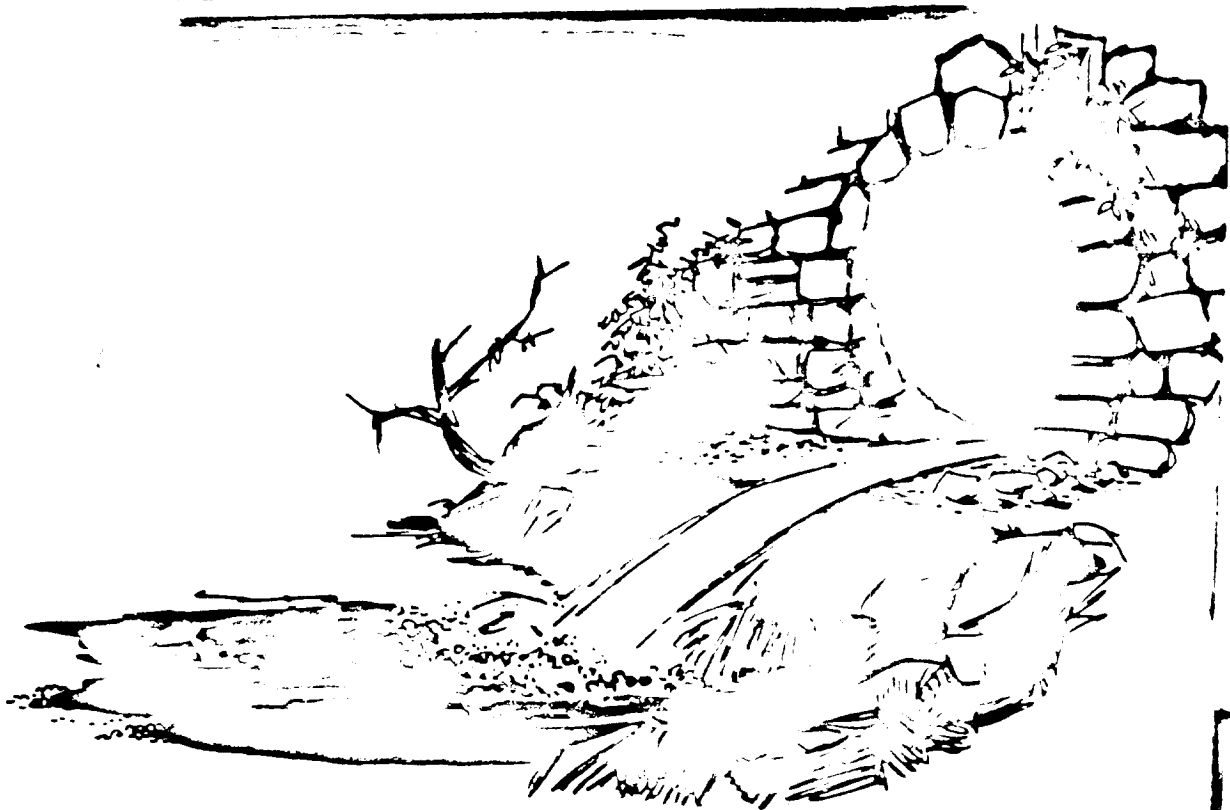

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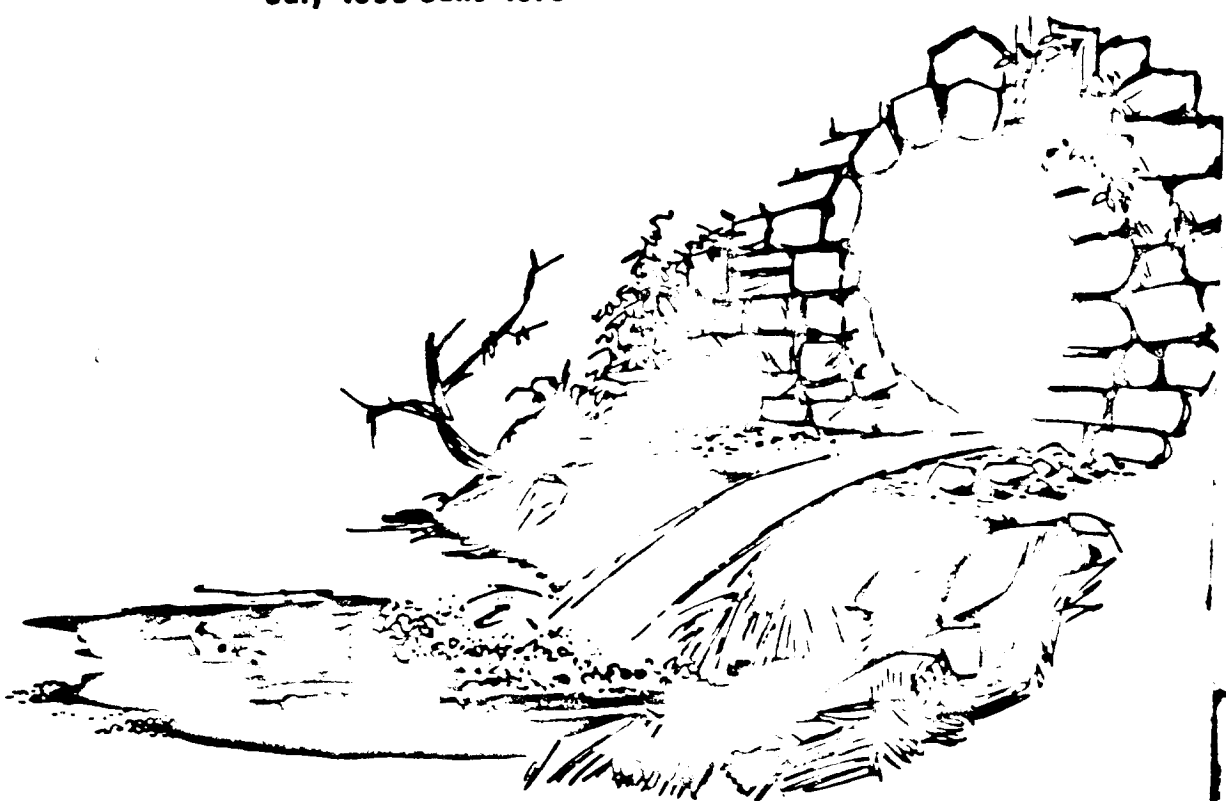
Selected Urban Storm Water Runoff Abstracts

July 1968-June 1970



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ENVIRONMENTAL PROTECTION AGENCY • WATER QUALITY OFFICE

R0036100

SELECTED URBAN STORM WATER RUNOFF ABSTRACTS

by

Science Information Services Department
The Franklin Institute Research Laboratories

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
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ABSTRACT

A compilation of abstracts summerizing articles from a variety of technical publications constituting the problem of urban drainage was developed by the Franklin Institute Research Laboratories. The present work includes 599 abstracts of documents published for the most part from July 1968 through June 1970. The abstracts are classed in ten sub-topic categories and arranged alphabetically by author and numerically by abstract number within each category. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors and identifiers. A cumulative subject index at the end of the volume provides the necessary access to individual concepts. An author index and journal list are also included.

This work was submitted in fulfillment of Contract 14-12-904 between the Federal Water Quality Administration and the Franklin Institute Research Laboratories.

Key Words: Storm runoff, urbanization, drainage systems, overflow, rainfall-runoff relationships, sewers, sewage treatment, water pollution control.

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FOREWORD

SELECTED URBAN STORM WATER RUNOFF ABSTRACTS is a compilation of abstracts summarizing articles from a variety of technical publications, covering the subjects of urban runoff, storm water drainage, storm sewers, and legislation -- together constituting "the problem of urban drainage". Articles on more general subjects, such as "sewerage" or "sanitary engineering", and topics not closely related to storm water have been excluded.

The present work includes 599 abstracts of documents published from July 1968 through June 1970. A few abstracts summarize material published before this period that were not included in the previous volume of SELECTED URBAN STORM WATER RUNOFF ABSTRACTS, published in June 1969. For convenience, the abstracts are classed in ten sub-topic categories and arranged alphabetically by author and numerically by abstract number within each category. Since most of the papers fit into more than one category, a cumulative subject index at the end of the volume provides the necessary access to individual concepts and should be utilized for locating all abstracts in which this concept is significant. The numbers following an index term are the numbers for the abstracts in which this term is found. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors (subject terms listed in the WATER RESOURCES THESAURUS, November 1966 edition) and identifiers (newly suggested index terms). The most important index terms are marked by an asterik. An author index and journal list are included for the reader's benefit.

Copies of the articles abstracted in most cases can be obtained from research libraries covering water pollution or public health engineering literature.

Suggestions concerning the improvement of content and format, or expansion of subject coverage in future supplements to this compilation, which will be issued quarterly, will be gratefully received.

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Section 1

CONSTRUCTION: EQUIPMENT AND MATERIALS;

AND INSTRUMENTATION

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001
APPLIES EXISTING TECHNOLOGY FOR A CLEANER LAKE ERIE,

Am City, Vol 85, No 4, p 18, Apr 1970,

Descriptors: *Waste treatment, *Storage, Instrumentation, Storm runoff.
Identifiers: *Lake Erie, Monitoring system, Stormwater storage.

The Detroit Metropolitan Water Service is putting existing technology into effect to help decelerate the aging of Lake Erie. Proposed programs include: solids reduction by addition of mechanisms to the regional wastewater plant, coliform removal through chlorination, phosphate reduction using pickle liquor from steel mills, waste oil and grease removal using oil skimmers, construction of phenol-removing systems, and installation of smokestack air cleaners to prevent air pollution. A monitoring system to reduce stormwater overflows is also being built to warn of approaching rainfall, thus allowing sewers to be pumped before the storm. This will permit sewers to store contaminated stormwater, the dirtiest water being sent to the treatment plant. Further long range plans are being made to meet future demands of the region.

002
STEEL PIPE SELECTED FOR STORM SEWER SYSTEM,

Am City, Vol 85, No 3, p 22, Mar 1970.

Descriptors: *Pipes, Construction costs.
Identifiers: Steel pipes, Storm sewers, Sewer system.

Steel piping instead of the more-commonly used reinforced concrete was employed to construct a storm sewer system in Lakewood, New York. Advantages of this material include its strength, lighter weight, and lower cost. Savings in material cost alone were about 15%, and lower labor costs were incurred because steel is simpler to handle than other materials. Dimensions of the storm sewer system are given.

003
UNDERWATER SEWAGE STORAGE AN AID TO POLLUTION ABATEMENT,

Am City, Vol 84, No 9, pp 30 and 34, Sep 1969.

Descriptors: *Construction materials, Storm runoff, Pollution abatement, Waste storage, Overflow.
Identifiers: *Rubber storage containers, Storm tank, Anacostia River.

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Goodyear Tire & Rubber Co. and Underwater Storage, Inc. of Washington D.C. have announced a joint project to attack water pollution by collecting wastes in huge, collapsible, underwater, rubberized tanks. Two prototype systems are being tested in the Anacostia River in Washington; one to trap stormwater overflow, and the other near a marina to collect wastes from boats. These storage tanks could resolve a variety of problems such as threats of river fires caused by accidentally-ignited oily wastes, and pollution from stormwater which was previously eliminated only through costly sewer reconstruction.

004
UNDERWATER LINE SPANS 32 FEET BETWEEN SUPPORTS,

Am City, Vol 84, No 8, p 58, Aug 1969.

Descriptors: *Concrete pipes, *Installation, *Construction equipment.
Identifiers: *Underwater pipeline.

An underwater pipeline of prestressed concrete units was installed in St. John's River as an outfall sewer from a waste treatment plant to serve a new industrial area of Jacksonville, Florida. Double sections of cylinder pipe were laid on concrete piles topped with precast concrete caps to cradle the pipe. Scuba divers guided and joined pipe sections. Extensions and other installation techniques are given.

005
IT'S IN THE BAG,

Am City, Vol 84, No 4, p 88, Apr 1969.

Descriptors: *Storage tanks, Overflow, Storm runoff, Ohio.
Identifiers: *Rubber storage containers, Combined sewers, Storm tank.

The problem of stormwater overflows from combined sewers is being combatted in Sandusky, Ohio through the implementation of a plan which is much less costly than the common solution of sewer separation. The new system consists of rubberized storage reservoirs that trap the heavily-polluted "first flush" of stormwater. When the storm ends, pumps transfer the stored stormwater to the treatment plant for processing along with the normal wastewater. Costs, details, and a diagram of the system are included in the article.

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006
SCREEN TREATMENT FOR SEWER OVERFLOWS,

Am City, Vol 84, No 3, p 24, Mar 1969.

Descriptors: *Screens, Storm runoff, Overflow, Oregon.
Identifiers: *Runoff treatment, Combined sewers.

An alternative to separation of combined sewers in Portland, Oregon is being tested under a FWPCA grant. The experimental pilot plant includes high-rate, fine-mesh screens which treat overflow that is pumped to the plant during periods of heavy rainfall. Previously, only one-third of the rainy season flow was treated while the remainder was discharged untreated into a receiving stream. A description of the structure and workings of the screen operation is given. Laboratory tests will determine the effectiveness and feasibility of the system.

007
TRENCHER AND BOX SHIELD MAKE SEWER JOB ALMOST ONE-RIG OPERATION,

Construct Methods Equip, Vol 51, No 4, pp 134-135, 138-140 and 143, Apr 1969. 8 fig.

Descriptors: *Excavation, *Construction equipment, *Cost analysis.
Identifiers: *Hydraulic trencher, *Storm sewers, *Guidance system, Oakland, Michigan, Laser beam.

A tractor-powered hydraulic trencher used a three-line bucket arrangement to perform digging for a 43,000-foot storm sewer in Oakland, Michigan. A box shield moved ahead 28 inches at a time and carried a hopper to distribute gravel for the pipe bed. Job difficulties held cost savings to about 10% below conventional backhoeing, but the trencher did protect against cave-ins in addition to providing safety in opening a trench parallel to gas and water lines. The trencher had three basic components: (1) a standard Cat D9 up front; (2) a ladder type bucket line and transverse unloading conveyer; and (3) a hydraulically powered telescoping box that slid along two sled type runners. Dimensions of each part are given along with details of the workings and operation of the trencher and its parts. Loading of spoils to trucks is described. Two guidance systems are mentioned; one which used a survey string line, and the other which employed an Acme laser gun.

008
TOOLS OF THE BUILDER,

Construct Methods Equip, Vol 51, No 2, pp 164-168, 170-172, 174-175,

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177-178, 180, 183-184, 186, Feb 1969. 15 fig.

Descriptors: *Construction equipment, *Tunneling machines, *Tunneling, *Hydraulic equipment, Tunnel construction, Piping, Control systems, Concrete construction, Electronic equipment.
Identifiers: *Mole, Laser beam.

This article explores advances made since 1963 in equipment used by contractors in non-highway construction. Means for handling, lifting, and moving materials grew steadily in size and power. Conventional-type equipment—cranes, derricks, conveyors, and pumps, became taller, stronger, and more versatile. Earth and rock boring for tunnel construction became easier with the development of machines able to tackle any type of geological formation. Special rigs are described which place large-diameter piping inside long tunnels. Advances in mole tunneling are cited. Hydraulic pumps, driven by electric motors, provide rotation, twist, and up-and-down actions of the boom and bucket, and they also propel the machine. Construction crews use laser beams as constant reference lines. They are visible day and night for long distances and are weak enough to be harmless. Future tunneling may be accomplished by rapid melting of rock with lasers or electron beams. New innovations discussed include: hydraulic-boom cranes, hydraulic fork lifts to handle heavy wall and slab forms, lightweight plastic-foam materials, concrete pumps, electronic computers, and television.

009
WASHED-OUT PLATE CULVERT RESET IN 17-TON SECTIONS BY CRANE,

Construct Methods Equip, Vol 50, No 7, pp. 54-57, Jul 1968. 6 fig.

Descriptors: *Flood damage, *Culverts, *Cranes, *Repairing, *Construction, *Installation.

When a 500-foot length of culvert comprised of 600 plate sections was washed out by a flash flood, the contractor unbolted the conduit in 36-foot barrels instead of dismantling the pipe plate by plate and lifted the sections out by crane. The sections were stored on the bank to be reset after the bed dried and was restored. A simple wooden screed shaped the concrete sand bed for the 21-foot diameter culvert. Details of the construction and installation procedures are included.

010
WORK STARTS ON 11-MILE INTERCEPTOR TO SOLVE TORONTO'S SEWER PROBLEM,

Eng Contract Record, Vol 83, No 6, pp 68-69, Jun 1970. 2 diag.

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Descriptors: *Construction, *Contracts, *Interception, *Design, *Sewers.
Identifiers: *Canada, *Interceptor sewer, Toronto.

In metropolitan Toronto an interceptor to relieve existing high- and low-level interceptor sewers, which are inadequate for the area they cover, is under construction. S. McNally and Sons Ltd. was among a number of bidders, and it was awarded all portions of the project. The project entails the construction of a 61,640 foot-long shaft varying in diameter from 60 to 120 inches spanning the city from east to west. The estimated time of construction is three years. Information on the operation and techniques used is included.

011
PLASTIC FITTINGS SPEED LAYING OF SEWER PIPE,

Eng Contract Record, Vol 81, No 10, p 73, Oct 1968.

Descriptors: *Pipes, *Construction equipment, *Construction materials, Installation.
Identifiers: *Transite pipe system.

The Roll-Tite system which combines a Transite asbestos-cement pipe with a new type of plastic fitting blow-molded from black polypropylene, is described. The installing operation for this system takes considerably less time than for other systems. Other advantages of this system as well as distributive information are mentioned.

012
PLASTIC MAY BE PIPELINER'S BOON,

Eng News-Record, Vol 184, No 10, pp 28-29, Mar 5, 1970.

Descriptors: *Plastic pipes, *Installation, Cost comparisons, Construction materials.
Identifiers: *Germany, *Fusion welding.

In Germany, plastic pipes with up to 40-inch diameters and pieced in 500 to 1,000 foot sections are common engineering equipment. These polyethylene pipes cost slightly more than other types of pipes; however, installation costs are drastically lower, especially when used in long runs. The butt-fusion welding practice is quite routine in Europe. This process of installation is described.

013
WINNER 3.6% UNDER ON CALIFORNIA STORM DRAIN,

Eng News-Record, Vol 184, No 3, p 46, Jan 15, 1970. 1 tab.

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Descriptors: *Construction materials, *Costs, *Concrete pipes, *Concrete construction, *Bids, California.
Identifiers: *Bedding material, Solid shoring, Storm drainage system.

Costs and quantities of materials proposed for use in the construction of a storm drainage system in Torrance and Los Angeles, Calif. are tabled for the two lowest contract bidders. The hired contractor will use reinforced concrete box construction and reinforced concrete pipe. Excavated sandy silt material will be used for bedding. Solid shoring is necessary for most of the project.

014
STORMWATER OVERFLOW GETS BAGGED,

Eng News-Record, Vol 181, No 18, p 14, Oct 31, 1968.

Descriptors: *Construction equipment, *Construction costs, *Separation techniques, Overflow.
Identifiers: *Rubber storage containers.

The FWPCA is financing projects to install rubber stormwater storage bags at three locations: Washington's Anacostia River, Sandusky, Ohio at Lake Erie, and Cambridge, Md.'s Choptank River estuary. The bags will store stormwater overflow that normally flows untreated into rivers and lakes along with sanitary sewage, when flows exceed treatment plants' capacities during heavy rainfall. The Washington bags rest on the bottom of the Anacostia River offshore of the pumping plant. The plant will chop overflow solids before the water reaches the bags, and an aerator will suspend the solids. The solids come out with the stored water when it is pumped back into the sewers for treatment. These plans are considerably less costly than sewer separation which would cost an estimated $48 billion to accomplish throughout the United States.

015
STORMWATER SEWER DESIGN IN METRIC,

Inst Munic Engrs, Vol 97, No 5, supplement no 4, May 1970.

Descriptors: Measurement, Design.
Identifiers: Metric system, Conversion charts, Storm sewers.

First impressions of the use of metric units in stormwater sewer design are expressed. In using the metric system, awkward multipliers are removed. Conversion charts are listed.

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016
DESIGN EXAMPLES IN METRIC,

J Inst Munic Engrs, Vol 97, No 2, supplement no 2A, Feb 1970.

Descriptors: Measurement, Design.
Identifiers: *Combined sewers, Metric system.

A metric example of the combined sewer and small pumping station is worked out using the rational formula and the Ministry of Health figures for intensities of rainfall.

017
STORAGE BLADDERS FOR SEWAGE,

Ind Water Eng, Vol 5, No 8, p 30, Aug 1968.

Descriptors: *Construction equipment, *Rubber, *Storage tanks, Storm runoff, Overflow.
Identifiers: *Rubber storage containers, *Anacostia River.

Two large 100,000 gallon tanks of nylon-impregnated rubber have been anchored in metal cradles on the bottom of the Anacostia River. During rainfall the tanks are used to hold overflow and later, when the water has receded, the tanks are emptied and their contents pumped easily to the sewage treatment plant. These tanks have also been used for holding fuel, water, oil, beer, and wine.

018
REMOTE-CONTROL 'MINI-DAMS' GUARD MINNEAPOLIS SEWERS,

Munic Eng, London, Vol 146, p 358, 1969.

Descriptors: *Construction materials, Overflow, Outlets, Water pollution control, Mississippi River.
Identifiers: *Minneapolis-St. Paul, Rubber storage containers, Storm sewage.

A description is given of the installation of inflatable bags of rubberized fabric at the outlet points of the storm-sewage overflows serving Minneapolis and St. Paul, Minn. The bags, which were installed to reduce pollution of the Mississippi River during storms, can be inflated by remote control to provide dams varying in height, thereby at any time diverting as much storm sewage into the interceptor sewers as the treatment works can accept.

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019
ISLAND CITY SOLVES TOUGH SEWERAGE PROBLEM,

Public Works, Vol 101, No 2, p 95, Feb 1970.

Descriptors: *Sewers, *Steel pipes, *Design, Construction costs, Construction equipment, Infiltration.
Identifiers: *Galveston, Texas, *Truss pipe.

By using Armco Steel Corporation's double-walled Truss pipe, a groundwater infiltration problem was eliminated from Galveston's sewer system. The Truss pipe can also be easily tapped for house connections, and its low infiltration specifications make possible an economical design for factory-built treatment plants. Construction costs for such plants are included, as well as dimensions of the extra-strength piping.

020
CONSTRUCTION COST REQUIREMENTS FOR WATER AND WASTEWATER FACILITIES,

Public Works, Vol 98, No 12, pp 112-113, Dec 1967.

Descriptors: *Cost analysis, Waste water treatment.
Identifiers: *Wastewater facilities.

The Business Defense Services Administration surveyed 1200 major water utilities in order to predict the construction cost requirements for water and wastewater facilities. The forecasted average annual expenditure over the 14-year period (1967-1980) showed a 139% increase over annual amounts for the past 12 years. These expenses result from the need to remedy present defects, to account for depreciation and obsolescence, and to counter the demands of an increasing population. Data included indicating costs required for various types of water supply and wastewater utilities in addition to amounts to be spent to combat individual problems can serve to guide manufacturers in planning future construction.

021
INTERNATIONAL BUILDING EXHIBITION - OLYMPIA LONDON 13-25 NOVEMBER 1969,

Surveyor, Vol 84, No 4039, pp 54, 74, 77, Nov 7, 1969. 3 fig.

Descriptors: *Plastic pipes, *Rain gages, *Design criteria, *Construction materials, *Underground structures, Flow rates, Drainage systems, Equipment, Plastics.
Identifiers: *Great Britain.

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This article reviews exhibitions of products, equipment, materials, and techniques at the International Building Exhibition at Olympia, London. A new square-line instead of round rainwater gutter system of plastic was displayed, in addition to a squareflow rainwater gage. Both have greater flow capacity than their traditional counterparts. A new drainage system exhibited has the following features: simplicity of layout and specification, push jointing of pipes, fittings, and plumbing connections, and fast laying speed. A domestic underground stormwater drain using plastic Polydrain PVC pipe was demonstrated; this material is now being employed extensively for underground drainage systems.

022
SEWERS UNDER ATTACK,

Surveyor, Vol 85, No 4048, p 38, Jan 9, 1970. 2 fig.

Descriptors: *Construction, *Construction materials, *Sewers, *Pipes, *Installation, Cements.
Identifiers: *Great Britain.

Doncaster sewers were improved once in 1956, but in 1966 a major reconstruction of the pipes was necessitated due to corrosion by sulfuric acid produced by bacterial action. Adjacent to the old sewer, the new sewer was constructed in the material most resistant and readily available, namely, bitumen-coated asbestos-cement. Procedures followed for construction and installation of the pipes is described.

023
PUBLIC WORKS EXHIBITION PREVIEW,

Surveyor, Vol 82, No 3988, pp 82, 130, 135, Nov 9, 1968. 5 fig.

Descriptors: *Construction materials, *Construction equipment, *Drainage systems, *Underground structures, Sewerage, Plastic pipes, Pipes.

Among the previewed exhibits of the Public Works and Municipal Services Exhibition were Metrex sewage and drainage and rigid PVC rainwater systems, a large range of PVC pressure pipe, examples of asbestos-cement pressure pipes, Polydrain PVC underground drainage systems, and plastic pipes. The PVC pressure pipes had a push type Z joint with a lip rubber seal. This joint, which is easy and quick to assemble, had been made practicable for pressure mains of large diameters up to 18 inches. The asbestos-cement pipe display showed not only new pipes but also old, well-preserved pipe that had lain in the soil for many years. One exhibit demonstrated the economy gained in cost, labor, weight, and maintenance when using plastic pipes and systems.

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024
DRAINAGE AND TREATMENT,

Surveyor, Vol 82, No 3988, p 150, Nov 9, 1968. 1 fig.

Descriptors: *Piping, Pipes, *Linings, Drainage engineering, Drainage systems, Plastic pipes, Sewers.

This brief review of recent advances and contracts in drainage and treatment includes a description of a new continuous length land drainage piping made from rigid unplasticised PVC which can be laid by mole-ploughing with backfill fed into the trench via a hopper above the plough. Also described is a new inexpensive method for relining sewer pipes using a sectioned plastics pipe, and a contract for a new £½ million, mile-long trunk sewer.

025
COMBINED SEWER SOLUTION SOUGHT IN SANDUSKY FIELD DEMONSTRATION,

Water Sewage Works, Vol 116, No 10, pp 386-387, Oct 1969.

Descriptors: *Overflow, *Construction materials, Storm runoff.
Identifiers: *Storm overflows, Rubber storage containers, Storm tank, Sandusky, Ohio.

The use of flexible rubber containers for off-shore underwater temporary storage of storm overflow from a combined sewer has been proposed for the Sandusky Bay area as the answer to its storm overflow problems. The containers are predicted to temporarily hold overflows equivalent to a one-year storm. When the plant can handle the excess, the contents of the containers are pumped back to the plant where the sewage is treated and piped into the bay.

026
SEWER IMPROVEMENTS CALL FOR TRUNK,

Water Sewage Works, Vol 116, No 10, pp 406-407, Oct 1969. 3 fig.

Descriptors: *Construction materials, *Pipelines, *Installation, Infiltration.
Identifiers: *Asbestos-cement piping, *Palo Alto, California.

Asbestos-cement piping was installed in Palo Alto when urban growth caused an increase in sewer problems and demands. Because a large portion of the pipe had to be laid below the water table level, city engineers considered endurance, infiltration factors, and a construction course in deciding upon materials for the sewers. Steps in the installa-

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tion procedure were outlined. Prior to final acceptance of this trunk line, tests were performed, and no infiltration was found. Dimensions are listed for amounts used of each type of asbestos-cement piping in the three-mile project.

027
LASER BEAM AND POWDER-ACTUATED TOOL SPEED PIPE LAYING,

Water Sewage Works, Vol 115, No 12, pp 574-578, Dec 1968.

Descriptors: *Installation, *Construction equipment, *Application methods, Sewers.
Identifiers: *Laser beam, Laser kit.

A new laser beam-aligner system, which includes a powder-actuated fastening tool as basic hardware, is enabling contractors to complete sewage installations at least 35% faster and with virtually 100% accuracy. Basic kit and hardware can meet more than 95% of requirements for average storm and sanitary sewer contracting job. Laser kit is designed for application with precast manhole with concrete base, concrete base without precast manhole, or simple bottom-of-the-ditch installation without concrete base. It is accurate in uphill or downhill alignments.

028
ALUMINUM PIPELINE FOR SEA OUTFALL SEWER,

Water Waste Treat, Vol 12, No 11, p 361, Jan/Feb 1970.

Descriptors: *Aluminum, *Pipelines, *Installation, *Construction equipment, *Construction materials, Outfall.
Identifiers: *Great Britain, *Trestles.

A welded aluminum pipeline has been used to extend a sea outfall sewer at Anglesey. Aluminum was selected because of its weight, corrosive nonliability, strength, and resistance to seawater and domestic sewage. The pipeline was assembled progressively by bolting the flanged ends of the 100-foot pieces underwater. The aluminum trestles, to support the pipeline, and the method of installation are described.

029
SUSPENDED SEWAGE PIPELINE,

Water Waste Treat, Vol 12, No 8, p 256, Jul/Aug 1969.

Descriptors: *Construction equipment, *Installation, *Pipelines.
Identifiers: *Great Britain, *Suspended pipeline.

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By the use of Hepworth-Polva pvc pipe with flexible couplings, a 12-inch diameter sewage pumping main has been suspended from a bridge (which crosses the River Tay) on fabricated metal brackets which allow for pipe movement arising from thermal expansion and contraction of the pipeline. The method of suspension allows for leveling, and the completed pipeline has an insulating wrapping. The installation also has advantages over traditional materials in that the pipeline is light in weight, immune to corrosion, and requires no maintenance.

030
STORM WATER STORAGE SCHEME,

Water Waste Treat, Vol 12, No 7, p 221, May/Jun 1969.

Descriptors: *Construction materials, *Storm runoff.
Identifiers: *Rubber storage containers, *Storm overflows, *Sandusky, Ohio, Storm sewage.

A pilot project to study the storage of storm sewage from combined sewers at Sandusky, Ohio, is described. Two 100,000 gallon collapsible fabric-reinforced rubber tanks have been installed on the bottom of Sandusky Bay; the tanks will fill by gravity and will temporarily store overflows equivalent to a 1-year storm on a small area. Subsequently the storm sewage will be pumped to the works for treatment and discharged to the bay between storms.

031
TRENCHLESS PIPELAYING DEMONSTRATED,

Water Waste Treat, Vol 12, No 2, p 71, Jul/Aug 1968.

Descriptors: *Tunneling machines.
Identifiers: *Great Britain, *Badger Major.

The Badger Major, a trenchless pipelaying machine, has been designed to revolutionize the laying and ducting of plastic pipes, pvc pipes, and cables in all types of soil and climatic conditions for water supply, sewage, land drainage, etc. The Badger Major works on a trenchless principle, passing through the ground a narrow blade with specially designed expanders at its base to create a smooth tunnel for the pipe. The control of the machine is fully automated by the use of an infra-red light beam and hydraulic systems engineering. The system gives a working range of 2000 feet; accuracies of ±½ inch vertically and ± 3 inches laterally are achieved.

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032
GALVANIZED BETH-CU-LOY STEEL SHEETS - FOR CULVERT PIPE AND UNDERDRAINS,

Bethcon Galvanized Steel Sheets, Bethlehem Steel, Bethlehem, Pa., Booklet 1956, pp 13-14. 2 fig.

Descriptors: *Steel, *Fabrication, *Construction materials.
Identifiers: *Beth-Cu-Loy.

Beth-Cu-Loy is Bethlehem's trade name for steel which has a small amount (.2 to .3 percent) of copper added to it for resistance to corrosion. When given a 2-oz coating of zinc, and then corrugated, these steel sheets form ideal materials for fabrication of culvert and drainage structures. Bethlehem manufactures culvert sheets for fabricators who form them into culverts and underdrains. Dimensions available are given along with advantages of the materials used, such as their strength and their light weight.

033
CORRUGATED STEEL PIPE STORM SEWERS,

National Corrugated Steel Pipe Assoc, Schiller Park, Illinois, Booklet STM 168, 32 p.

Descriptors: *Construction materials, *Steel, *Culverts, *Design, *Steel pipes, *Construction equipment, Installation, Data collections, Design standards.
Identifiers: *Storm sewers.

Corrugated steel is the accustomed material used in urban areas for culverts and storm sewers which form a part of Interstate highway construction. This technical manual provides information needed for the design of storm sewers which differ from culverts in details of hydraulics and fittings. The use of corrugated steel pipe insures that the following essentials will be provided: (1) strength, (2) positive couplings, (3) long service life, (4) unchanging hydraulic properties, (5) versatile fittings, and (6) proved materials. Each of these factors is demonstrated in corrugated steel pipe storm sewers. Product details are discussed, including sizes and details of the pipe and pipe-arch; couplers and fittings; and bituminous protective coatings. Technical data explained include: hydraulics and the determination of size, Manning charts, structural design, the height of cover tables, and service life design. Also described are techniques for installation and specifications for materials, fabrication, workmanship and finish, and inspection.

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034
TANKS,

Owens-Corning Fiberglas Corp, Toledo, Ohio, Publ No 1-PE-3578-F, June 1970. 8 p.

Descriptors: *Storage tanks, *Construction materials, *Construction equipment, *Design, *Plastics, Treatment facilities.
Identifiers: *Fiberglas reinforced plastics.

The combined Fiberglas reinforced plastics have been utilized for years in demanding applications because of their chemical and electrolytic corrosion resistance and structural stability. The process industry uses these plastics for chemical storage tanks, gathering lines, salt water injection, and disposal oil well tubing. A detailed description of the design and manufacturing of Fiberglas Reinforced Plastic (FRP) storage tanks is included. Applications for this type of non-corrosive tank are mentioned with special reference to the use of Fiberglas tanks in providing the most economical solution to severe corrosive problems in holding, treating, and settling tanks.

035
CONTROL OF POLLUTION BY UNDERWATER STORAGE; Feasibility of Providing Temporary Underwater Storage of Storm Overflow from a Combined Sewer System,

Underwater Storage, Inc., Water Pollution Control Research Series, DAST 29, 161 p, Dec 1969. 9 tab, 56 fig, 12 ref.

Descriptors: *Pumped storage, *Waste storage, *Waste water treatment, *Overflow, Water pollution control, Laboratory tests, Storage tanks, Costs, Storm runoff, Estimated costs.
Identifiers: *Storm overflows, *Combined sewers, *Rubber storage containers, *Washington, D.C.

A pilot plant was designed, constructed and operated to assess the feasibility of providing a facility for the collection, treatment, storage and final disposition of a portion of the storm overflow from a combined sewer system serving a thirty-acre drainage area in Washington, D.C. A Parshall flume was installed in the overflow line for measurement of flow rates and determination of total overflow volume. A portion of the overflow was diverted to the pilot plant through grit chambers and a comminutor. Flow was stored in two 100,000-gallon underwater bags fabricated of nylon reinforced synthetic rubber and fastened to the river bed by a system of patented anchors. During the period of storage, compressed air was delivered to the tanks for agitation of the

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solids. Following cessation of the storm, contents of the bags were pumped to the interceptor sewer for delivery to the District of Columbia Sewage Treatment Plant at Blue Plains. Flow into and out of each underwater storage tank was metered and recorded. Samples of the combined sewage overflow discharged to the bags and pumped discharge from the bags were collected and subjected to laboratory analyses. During the operation period from January through September, 1969, a total of 1,600,000-gallons of diverted overflow from 38-storms was stored in the tanks. In addition, 600,000-gallons of river water was pumped into the underwater storage tanks for testing during dry weather periods. The total amount stored was pumped to the interceptor sewer in 26-separate pump out periods. The cost of the pilot plant was $341,480.00, or $1.70 per gallon of storage. This included facilities for testing, samples and flow measurement. Estimates for larger installations, without these special requirements range from 28.2 cents to 14.6 cents per gallon for plants with storage from two to twenty million gallons. The project demonstrated that temporary storage of overflow from combined sewers in underwater rubber storage tanks is feasible and may, under suitable conditions, be effective in eliminating direct, untreated discharge of combined sewage into surface waters during storm periods.

036

IMPROVED SEALANTS FOR INFILTRATION CONTROL; The Development and Demonstration of Materials to Reduce or Eliminate Water Infiltration Into Sewage,

Western Company of North America

Prepared for FWPCA, Program No 11020 DIH, Contract No 14-12-146, June 1969. 95 p.

Descriptors: *Evaluation, *Sealants, *Materials testing, *Sewers, *Cost analysis, *Leakage, Specifications, Infiltration, Comparative costs, Equipment.

Identifiers: *Cost-effectiveness analysis, *Infiltration control, *Sewer linings.

The objective of this program was to develop new, more effective sealants for sewer line leaks. This purpose was achieved, and all equipments and materials investigated, tested, or compared are presented, along with test results, supporting data, conclusions, and recommendations. Candidate materials were surveyed and weaknesses of rejected materials were noted. Specific properties of acceptable materials were ascertained, and materials having these properties were identified and subjected to tests designed to demonstrate their effectiveness as sealants. It was concluded that infiltration adversely influences sewer system operating costs and effectiveness, and that leakage repair systems are limited in their effectiveness. No significant cost increase beyond that experienced with present sealers was indicated. Some present sealant application

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equipment can be modified for use with the new materials, but new equipment designs are described and recommended.

037
MAIN DRAINAGE,

T. A. Anderson
Surveyor, Vol 83, No 4010, pp 92-94, Apr 18, 1969. 6 fig.

Descriptors: *Sewers, *Construction, Tunneling, Geomorphology, Installation, Legal aspects.
Identifiers: *Construction problems, *Sewer construction, *Scotland.

The author describes several sewer jobs he undertook as a Resident Engineer in the Glasgow Office of Public Works. One job entailed the construction of a two-mile main duplicate sewer in Rutherglen. Problems arising due to encounters with varying types of ground are related and measures taken explained. As a result of high pressure, escapes of air (blow-outs) occurred on a nearby railway line. Tunneling was halted until a tunnel shield was installed which helped complete the job. Other construction problems relating to sewer jobs are discussed. Interference with Glasgow parking areas due to sewer construction was solved through the institution of a program of conversion of open spaces to off-street car parks. In conclusion, the author recommends the establishment of regional sewerage authorities similar in organization to Scotland's Water Board, plus the formation of drainage boundaries on a topographical rather than a parochial basis.

038
COMPUTERS IN HONG KONG PUBLIC WORKS,

A. T. Armstrong-Wright
Surveyor, Vol 84, No 4029, pp 34-39, Aug 22, 1969. 12 fig.

Descriptors: *Computers, *Computer programs, *Project planning, Highways, Water supply, Expenditures, Sewage disposal, Design, Hydrologic data.

This article describes applications of electronic computers to public works projects in Hong Kong. Their feasibility is obvious due to their speed and accuracy. Applications of computers are discussed for the following areas: project scheduling; highways (road alignment, flyover beam design, pile loading and setting-out road curves and flyovers); water supply (hydrologic data, dam stability analyses, flood balancing reservoirs, yield of water supply schemes, operation of reservoirs, and project appraisal); and expenditure control. In the area of sewage

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disposal, computers aid in developing suitable designs for multi-port diffusers on ends of submarine outfalls. Computers also process hydrologic data which engineers use in water management and operation of existing facilities. The author concludes that as time progresses, increased use will be made of computers, not only in sophisticated studies but also in day-to-day operations.

039
PROFESSIONALISM AND WATER POLLUTION CONTROL IN GREATER CHICAGO,

Vinton W. Bacon and Frank E. Dalton
J Water Pollution Control Fed, Vol 40, No 9, pp 1586-1600, Sep 1968.

Descriptors: *Overflow, *Construction materials, Storm runoff.
Identifiers: *Storm overflows, Rubber storage containers, Storm tank.

Rubberized fabric tanks are under construction along Lake Erie at Sandusky, Ohio to solve the pollution problem resulting from combined sewer overflows. The tanks will be submerged underwater to store sewage during storm periods. The sewage will be pumped back to treatment plants during normal flow periods. The tanks are designed to hold overflows of a one-year storm.

040
PLASTICS IN WATER AND SEWAGE CONTROL,

C. A. J. Benfield
Surveyor, Vol 85, No 4048, p 2, Jan 9, 1970.

Descriptors: *Construction materials, *Design criteria, *Plastics.
Identifiers: *Polyester resins.

In this letter to the editor, the author attempts to clarify the original article's reference to inadequacies of glass fiber reinforced polyester resin (RP) when submersed in water. He notes that considerable research has shown raw materials in the form of improved polyester resins, glass sizes, and fabricating processes to permit application of RP in environments of total immersion in water. Practical experience has demonstrated that by considering certain design criteria, RP laminates can be and are being used in the water and sewage control industry. The author also suggests that "case histories", written by users of plastics components, be published in the journal in order to promote dissemination of design and performance data within the water purification industry, as was recommended in the original article.

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041
STRUCTURES PREVENT URBAN SEDIMENT DAMAGE,

Stephen M. Boysen
Public Works, Vol 100, No 8, pp 116-117, Aug 1969. 3 fig.

Descriptors: *Design, *Construction, *Settling basins, *Storm runoff, Performance, Operations research, Sediment control.

District of Columbia area engineers and the USCA Soil Conservation Service jointly worked to improve sediment basin design. These basins prevent damages originating from soils disturbed by intensive construction. Their purpose is to trap eroding soil and keep it on or near its original site while earth-movers do grading for new developments. These structures are temporary, but they protect stream-channels, impoundments, roads, etc. from damaging sediment. A typical sediment basin holds ponded runoff from which soil particles settle as water passes slowly into a vertical drain shortly after a heavy rain. Details regarding construction and performance are discussed. The fundamental design problem of striking a balance between detention time and economical basin size is also explored. Effectiveness of these basins is proven by the increasing number of counties employing the structures in the metropolitan Washington and Baltimore areas.

042
PLASTIC RELINING OF SMALL-DIAMETER PIPES,

Raymond M. Bremver
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA2, pp 297-317, Apr 1970.

Descriptors: *Storm drains, *Sewerage, Pipes.
Identifiers: *Toronto, *Storm sewers, *Combined sewers, Plastic pipes, Capacity.

The combined sewer system of the city of Toronto measures approximately 933 miles. In 1965, a 25 year staged and planned program for installing new storm sewers at a net cost of $154 million was instituted as a result of the hydraulic inadequacies of the then existing system. A chart showing the inventory results concerning the sewer system is given. The surcharge amount on water bills is explained and the common defects in the existing sewers are discussed. A detailed report on the method of relining the existing sewers, which involves the insertion of high density plastic pipes into the sewers and the connecting of all private and catch basin drains into the plastic conduit, is given. The effect of relining on hydraulic capacity is explained.

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043
INSTALLATION OF SOIL, WASTE AND DRAINAGE PIPING IN FILL OR UNSTABLE SOIL,

T. Cecil Brown
Water Sewage Works -- Reference Number, pp R-47 to R-50, Nov 28, 1969.

Descriptors: *Installation, *Sewers, *Drainage engineering, *Costs, Subsurface runoff, Infiltration.

Drainage lines, which can be sanitary, storm or combined sewers, should be well designed and constructed, properly supervised during construction, and closely inspected. Recommendations are made in this article to facilitate compliance with these objectives. Sewer installation is described in terms of considerations to be made regarding the filled area. Cost criteria are also discussed. Economy is not always limited to the selection of the least expensive materials because cheaper material may prove to be the most expensive to the taxpayer in the long run. Infiltration and joint failure are treated briefly with recommendations for tight joints and for the prevention of stormwater entrance into sanitary sewers.

044
PLASTICS IN WATER AND SEWAGE CONTROL,

G. M. Cave
Surveyor, Vol 84, No 4041, p 44, Nov 21, 1969. 1 fig.

Descriptors: *Plastics, *Flow control, *Control systems, *Construction materials, *Equipment.

Rigid plastics, able to provide structural as well as protective functions, are suggested for use in fluid control equipment such as valves, penstocks, sluice gates, etc. Improvements made in plastics over the years are noted, and requirements needed for introducing the materials to industry are listed. Also listed are advantages of a well-designed plastic penstock compared to a conventional unit in cast iron, with copper-alloy sealing and bearing surfaces. Benefits of these modern materials cannot be realized until they are employed to a greater extent by civil engineering contractors and by engineers in the water purification industry.

045
SCRAPER PRODUCTION SPEEDS PIPE TRENCHING AT LOWER COSTS,

William Donnely
Construct Methods Equip, Vol 51, No 8, pp 38-41, Aug 1969.

Descriptors: *Trenches, *Excavation, *Backfill, *Construction equip-

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ment, Comparative costs, Comparative productivity, Linings.
Identifiers: *Scraper.

Extra-wide slots for pipes were opened by scrapers thus adding width that provides operating room for direct machine excavating and backfilling and eliminates any hand shoveling. With this method, the scrapers complete the trenching and backfilling 50% faster with an overall saving of some 20% in total labor costs. Before pipes are placed the trench receives a 2-inch layer of leveling sand followed by a plywood screed creating a contoured bed in the sand for the pipe. A detailed description of the equipment used in the trenching is included.

046
A GUIDE FOR CONTRACTORS ON THE CONSTRUCTION OF DRAINAGE SYSTEMS,

A Drechsel
Ber Abwassertech Ver (BABVAD), No 17, pp 123-131, 1964.

Descriptors: *Hydrogeology, *Drainage patterns (geologic), *Drainage engineering.
Identifiers: *Drain pipes, Storm sewers.

The author stresses the importance of preliminary hydrogeological investigations and studies on flow conditions of the area where a drainage system is to be installed. He then deals with the design, construction, materials, and equipment which should be used where drain pipes are required for ordinary drainage systems and/or storm-sewage systems.

047
ANGLESEY ALUMINUM SEA OUTFALL,

Bruce Dumbleton
Surveyor, Vol 85, No 4049, pp 22-25, Jan 16, 1970. 5 fig.

Descriptors: *Outlets, *Methodology, *Aluminum, *Construction materials, *Construction.
Identifiers: *Great Britain.

Decisions and procedures involved in constructing an aluminum sea outfall extension are reviewed. Methods employed for determining the following factors are discussed: length of the extension, material selection, the method of support, construction and launching procedures. Although extension of the outfall presented many constructional problems, its cost was less than for any alternate scheme involving sewage treatment. A significant feature of the construction process was that work took place from a ten-man inflatable craft with heavy materials towed into position using buoyancy tanks.

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048
RUBBER TANKS AID SEWAGE FIGHT,

Jonathan Eberhart
Sci News, Vol 94, No 5, p 115, Aug 3, 1968.

Descriptors: *Construction materials, *Construction costs, Storm runoff, Overflow.
Identifiers: *Storm overflows, Rubber storage containers, Washington D.C.

In Washington D.C.'s Anacostia River, a new technique is being tried to eliminate pollution of the river caused by sewage overflows during severe rainstorms. This new method is less expensive than Chicago's underground sewer project which will cost almost $15 million for the pilot project and more than $2 billion for city-wide installation. In Washington, large rubber tanks will be anchored beneath the surface of the Anacostia. Stormwater and sewage overflow will be diverted to these tanks and stored there until the water has receded, and the tanks' contents can be pumped to the nearby sewage treatment plant.

049
GLASS FIBER-REINFORCED PLASTICS PIPES FOR WATER PIPELINES,

E. Faust
Kunststoffe-Plastics (KUPLAK), Vol 15, No 6, pp 191-193, 1968.

Descriptors: *Pipelines, *Plastics, Construction equipment, Sewers.
Identifiers: *Fiberglass pipe.

Glass fiber-reinforced plastics pipes for water pipelines and sewer pipe systems are described. The technical and economic advantages of applications of plastics in sewer pipes are detailed. Requirements that must be taken into account in selecting proper plastics for special purposes with regard to the use of a glass reinforced polyester pipe are mentioned. The properties and performances of the pipe made by filament winding and centrifugal casting techniques are listed, and the comparison of the production method by filament winding with that by centrifugal casting is examined.

050
STABILIZED BASE FOR RESIDENTIAL STREETS,

W. J. Gallup
Civil Eng, Vol 39, No 5, pp 40-42, May 1969.

Descriptors: *Design, *Construction materials, *Illinois, Cements, Construction equipment.

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A public works project devised to improve streets and drainage in Stickney Township, Ill. is described. For street improvements, soil cement was used to stabilize bases when streets were covered with 2 in. of asphalt. Depending on the conditions in a particular area, a contractor would either set up a central-mix plant to process base material or would mix it in place. Excavation for the central-mix operation was done with a track-type end loader, a motor grader and dump trucks. Equipment as well as self-loading scrapers were used for in-place processing.

051
CATAD SYSTEM CONTROLS FOR REGULATION OF COMBINED SEWAGE FLOWS,

Charles V. Gibbs and Stuart M. Alexander
Water Wastes Eng, p 46-49, Aug 1969. 2 fig.

Descriptors: *Mathematical models, *Computer programs, *Sewers, *Storage capacity, *Storm runoff, Sewage disposal, Municipal wastes, Automatic control, Hydrologic properties.
Identifiers: Combined sewers.

The installation of a computer-augmented treatment and disposal (CATAD) system to utilize optimum storage within an existing municipal combined sewer system was described. The other objectives of CATAD were: (1) to make available the maximum capacity of the interceptor for combined storm and sanitary flows in unseparated areas by utilizing the storage capability of trunk and interceptor sewers in separated areas; and (2) to control necessary overflows at selected locations so as to minimize harmful effects on marine life and public beaches. Control commands were generated internally by a computer under program control. A mathematical model was developed in order to implement a fully automatic control. The model incorporated elements of meteorology and hydrology including seasonal precipitation patterns and area runoff characteristics. An analysis of the regulation of stormwater inflows by the use of trunk sewer storage established the operating rules required for effective utilization of the available storage.

052
THE LE ACOUSTIC FLOWMETER - AN APPLICATION TO DISCHARGE MEASUREMENT,

C. R. Hastings
J Water Works Assoc, Vol 84, No 2, pp 127-151, Jun 1970.

Descriptors: *Flowmeters, *Discharge measurement, *Hydraulics, *Instrumentation, Testing.

A variety of discharge measurement devices have been invented of which a flow measuring system using the LE Flowmeter is the most recent system to substantially advance the art. The concept employed is an application of numerical integration by Gaussian Quadrature. Test results under

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varying conditions of fully developed and distorted flow show that this measurement system has an rms accuracy better than 1.0 percent. Use of the LE Acoustic Flowmeter gives this flow measuring system features not possessed by other devices, such as linearity, bidirectionality, no head loss, and no need for calibration.

053
REHABILITATION OF A CONCRETE SEWER UNDER INFILTRATION PRESSURE,

Harold H. Haugh
Public Works, Vol 100, No 7, pp 89-90, Jul 1969.

Descriptors: *Concrete additives, Concrete technology, Sewers.
Identifiers: Coating method.

The successful conversion of a storm sewer into a sanitary sewer in Albert Lea, Minnesota is discussed. It was necessary to apply Cital-Aquacoat as a coating on the wet surface of the concrete sewer, which was under hydrostatic head conditions, in order to give the required protection.

054
A GENERAL REVIEW OF CONTINUOUS WATER QUALITY ANALYSIS INSTRUMENTATION,

Robert H. Jones
Beckman Instruments, Inc. Process Instruments Division, Fullerton, Calif. 15 p.

Descriptors: *Instrumentation, *Monitoring, *Water quality.
Identifiers: *Water quality monitor.

Beckman Instruments, Inc. offers a multi-parameter Water Quality Monitor for continuous measurement of: disolved oxygen, temperature, pH, chloride ion, turbidity, oxidation-reduction potential, sunlight radiation intensity and conductivity. The new instrument features sensors which improve reliability of continuous monitoring while reducing maintenance requirements. This instrument is compatible with conventional forms of transmission and data handling. Pollutants in water such as silt, slimes, soluble and suspended solids, and algae coat and contaminate sensing elements. This paper explains Beckman's approach to this problem of continuous water quality monitoring.

055
ACCURATE SMALL ORIFICE RAIN GAGE,

J. D. Kalma, J. Lomas, M. Thaller, and Y. Shashoua
Water Resources Res, Vol 5, No 1, pp 300-305, Feb 1969.

Descriptors: *Rain gages, *Instrumentation.
Identifiers: *Small-orifice rain gage.

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An accurate, inexpensive, small-orifice rain gage with an orifice diameter of 29.2 mm was developed for use in rainfall networks and in agrometeorological and hydrological studies. It has a large capacity and can be installed and read easily. In comparison with standard rain gages, the small-orifice rain gage showed good agreement under various conditions of exposure and with different observation techniques.

056
DEVELOP AND FIELD TEST METHOD OF INSTALLING PRESSURE CONDUITS IN COMBINED SEWERS.

Henry J. Kazienko

Combined Sewer Separation Project, Johns-Manville R and D Center, Dec 30, 1968. 38 p, 15 fig, 9 tab. FWPCA Program No 11020 EKO.

Descriptors: *Design, *On-site-tests, Epoxy resins, Pressure conduits.
Identifiers: *Development, *Polyester conduit hanger, Allowable load, Combined sewers.

This report describes laboratory development and testing of polyester molded hangers cemented to a sewer pipe crown. Polyester hanger material formulations, epoxy cement, and hanger dimensions are specified, and methods of installation are given in detail. Test of the hanger to failure in the laboratory showed fracture in tension through the conduit ring, leaving the upper part bonded to the concrete sewer crown. The field installation of 100-ft. of 3-in. diameter PVC pipe filled with water was made in a 7-ft. sewer in Evanston, Ill., in cooperation with the Metropolitan Sanitary District of Greater Chicago. The installation was sound and unaffected when removed after 4½ months.

057
WATER POLLUTION CONTROL. 5 BILLION DOLLARS TAB,

C. Laverty
Rubber World, Vol 160, No 1, pp 48-49, Apr 1969.

Descriptors: *Rubber, *Biocontrol, Water pollution control, Construction materials.
Identifiers: *Rubber storage containers, Rubber gates, Acid-resistant hose.

A summary is given of various uses of rubber for combatting water pollution. Chunks or strips of rubber compounds containing relatively insoluble organo-metallic compounds or alkanolamine salts of salicylanilides as toxicants are dropped into contaminated water for biocidal action lasting one year or more. Other antipollution methods employ: giant (100,000 gal) rubberized Pillow tanks, used as temporary storage for sewage overflow triggered by heavy rains; nylon-reinforced polychloroprene Fabridam rubber gates for storm control; and acid-resistant

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hose, for carrying pickle liquor to storage tanks for treatment and ultimate disposal in underground sandstone reservoir.

058
PROBLEM OF FLOOD-CONTROL IN SMALL BASINS,

G. Lombardo
Giorn Genio Civile (GIGCAO), Vol 106, No 2-3, pp 110-115, Feb-Mar 1968.
Descriptors: *Computer programs, *Flood control, *Data storage and retrieval.
Identifiers: *Rainfall analysis.

The study of possible utilization of a computer for control of floods in small basins, with revised methods and procedures for gathering and elaborating hydrological data is examined. The procedure for rapid calculation of a rainfall graph and for obtaining flow regime from rainfall characteristics in absence of analytical relation of hydrology is explained.

059
LOW-PRESSURE AIR TESTS FOR SEWER LINES,

W. J. Malcolm
Am City, Vol 84, No 11, pp 74-75, Nov 1969. 2 diag.

Descriptors: *Testing, *Sewers, *Infiltration, Leakage.
Identifiers: *Sewer lines, *Air-testing.

New wastewater lines can be tested for leakage or exfiltration either by the common method of water pressure or by low-pressure air, a method becoming more popular. Such testing is imperative since if there is no exfiltration, neither will there be infiltration. A tight sewer line lowers the volume flowing into lines and treatment plants, thus, pumping and treatment costs are lowered, and less flooding occurs. The author presents eight frequently-asked questions concerning air testing, and he answers the questions briefly.

060
FIBERGLASS WINS PIPELINE,

William Marquardt
Water Sewage Works, Vol 116, No 6, pp 228-229, Jun 1969. 3 fig.

Descriptors: *Bids, *Piping systems (mechanical), Construction materials, Comparative costs.
Identifiers: *Fiberglass pipe, *San Francisco.

Corrosion resistant fiberglass was chosen over a cement-mortar lined steel pipe in competitive bidding for the replacement of a corroded

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waste return piping system in the San Francisco area. The fiberglass pipe weighed one-tenth of the weight of the cement-lined steel pipe, and the cost of the fiberglass pipe was $5 per foot less. Hydrogen sulfide caused leakage of the original pipe by penetrating the cement lining and steel wall at the welded seams. Three types of fiberglass reinforced plastic (FRP) were used in constructing various parts of the waste return piping system. Dimensions and descriptions of the three pipe types are given, and installation methods are also discussed. Alternate materials investigated and rejected were: cement-lined steel, cement-lined cast iron, asbestos cement, plastic protected metal (IPM), reinforced concrete, glass or glass-lined pipe, uncoated steel or cast iron, epoxy-coated steel, and vitrified clay pipe. Reasons for rejecting these materials were given.

061
SEWERS UNDER ATTACK,

G. L. Marsden-Jones and J. A. Foster
Surveyor, Vol 85, No 4053 and 4055, p 3, Feb 13 and 27, 1970.

Descriptors: *Construction materials, *Pipes, *Concrete pipes, Asbestos cement.
Identifiers: *Sanitary sewers.

G. L. Marsden-Jones: With reference to the article, "Sewers Under Attack" (9 January), he questions whether or not the use of bitumen-coated asbestos pipe implied that concrete could not be used for sanitary sewers. He also wonders if gravel used to surround pipes produces a drainage effect that harms farm land where groundwater is short in supply and, at sewage works, raises groundwater level causing floods.
J. A. Foster: In reply to this first question, he notes that only the specific circumstances at Doncaster warranted use of bitumen asbestos-cement pipes and that for most sanitary sewers, concrete is a suitable material. He further explains reasons for Doncaster's use of the unusual material. In answer to the second point, he states that normal practice in waterlogged ground is to supply impervious clay cut-off walls at proper intervals to prevent groundwater movement along pipelines.

062
FLOOD CONTROL DESIGN UTILIZES LARGE ELLIPTICAL PIPE,

Alfred R. Pagen
Public Works, Vol 100, No 12, pp 87-88, Dec 1969.

Descriptors: *Pipes, Installation, Design, Overflow, New Jersey.
Identifiers: *Elliptical pipes.

The use of 72- by 113-inch elliptical reinforced concrete pipes in checking overflows in Woodbridge, New Jersey is discussed. A number of special fittings were designed which included access structures, con-

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nections, and horizontal storm drain deflection sections. Cylinder tests and installment difficulties are mentioned.

063
LONG-TIME DRAINAGE PROBLEM IS ELIMINATED,

Alfred R. Pagan
Public Works, Vol 100, No 6, pp 98-99, Jun 1969.

Descriptors: *Drainage engineering, Design storm, Hydraulics, New Jersey.
Identifiers: *Pipelines.

The manner in which Demarest, New Jersey solved its drainage problem is discussed. The pipe line has a flow velocity during the design storm of less than 9 feet per second. Calculations indicate that the pipe provides an additional margin of capacity for even greater storms. Costs, contractors, and unforeseen complications are discussed.

064
INVESTIGATION AND REPAIR OF EXISTING SEWERS,

K. F. Perkins
Water Pollution Control, Vol 107, No 11, pp 32-33, Nov 1969.

Descriptors: *Maintenance, *Instrumentation.
Identifiers: *Sewer inspection.

Various modes of repair and investigation of sewer line flaws are explored including techniques of T.V. and photographic examination. Existed combined sewer lines are commonly inspected at the time when separate storm sewer lines are about to be installed. This procedure prevents digging into newly resurfaced roads in order to examine sewer lines.

065
STEEL STORM SEWER SAVES MONEY FOR PHOENIX,

Sam A Phillips
Water Wastes Eng, Vol 6, No 4, pp 56-57, Apr 1969.

Descriptors: *Storm drains, *Installation costs, Construction materials, Steel.
Identifiers: *Storm sewers.

In order to fulfill the need for additional storm sewers at the lowest possible cost, the City of Phoenix asked for bids on types of materials which could be used in the construction of an efficient and durable storm drainage system. The city lately installed two such pipelines of

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asphalt-lined and corrugated, galvanized steel for a cost 20 to 25% below the city engineers' estimate given before other bids were requested. Completed in 1967, these new systems appear completely satisfactory, and their installation was accomplished with greater facility and speed than is usual when materials other than galvanized steel are used.

066
CALCAREOUS PIPE FOR SEWERS,

R. D. Pomeroy
J Water Pollution Control Fed, Vol 41, No 8, pp 1491-1493, Aug 1969.

Descriptors: *Aggregates, *Concrete pipes, *Sewers, *Testing, *Pipes, *Corrosion, Drainage water.
Identifiers: *Pipe materials.

Although the use of calcareous aggregate in the manufacture of concrete pipe for sewers has been advocated for those situations where there is a hazard of mild sulfide conditions, there is a lack of data comparing this material with others. Tests on five 8-inch diameter pipes handling septic wastewater were run for a period of seven years. Results show that the rate of corrosion was inversely proportional to the alkalinity of the pipe materials. The pipe with composition of type II cement plus limestone aggregate had a rate of corrosion approximately one-third as great as the average of the others made without limestone aggregate.

067
INSULATED CO-AXIAL PIPELINES,

J. S. W. Riach
Pipes Pipelines Intern, Vol 13, No 11, pp 27-28, 30, Nov 1968.

Descriptors: *Pipes, *Installation, *Piping systems (mechanical), Drainage.

The installation procedure of a conduit system of inner and outer pipes that is prefabricated off-site in 40 ft lengths together with all elbows, expansion loops, tees, and other special sections is described. It is then delivered to the site for assembly. The annular air space between service pipe insulation and the interior of conduit provides drainage passage for any water which may inadvertently enter the system.

068
HOW TO THINK ABOUT INSTRUMENTATION AND CONTROL,

Martin L. Roth
Calif Water Pollution Control Association, Los Angeles, Bulletin, Vol 6, No 2, pp 12-18, Oct 1969.

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Descriptors: *Sewage treatment, *Instrumentation, *Control structures, *Control systems, *Treatment facilities.

Instrumentation and control are defined and applied to a sewage treatment process. Guidelines for operators are directed toward achieving highest efficiency from plant installations.

069
VALUE OF INSTRUMENTATION IN WASTEWATER TREATMENT,

J. J. Salvatorelli
J Water Pollution Control Fed, Vol 40, No 1, pp 101-111, Jan 1968.

Descriptors: *Instrumentation, *Waste water treatment, *Monitoring, *Sewage treatment, Design, Sewers, Operation and maintenance.
Identifiers: *Treatment methods.

Instrumentation can free the wastewater treatment plant operator to concentrate on matters requiring human attention. Mechanical, physical, and chemical processes can be used to monitor a number of systems and treatment programs. One diagram given illustrates a centrally-controlled municipal wastewater system including pump stations, overflow diversion chambers, and a treatment plant. The monitoring system is located on a central instrument panel found in the main administration and control building of the wastewater treatment plant. Costs usually are less than five percent of total project costs.

070
DENSE NETWORK FOR RAPID MEASUREMENT OF RAINFALL RATE,

R. A. Semplak and H. E. Keller
Bell System Tech J, Vol 48, No 6, pp 1745-1756, Jul-Aug 1969.

Descriptors: *Rain gages, *Design, *Data collections, *Rainfall disposition, *Instrumentation, *Measurement.

The design and operation of a dense rain gage system for obtaining statistical data on both the temporal and spatial distribution of heavy rainfall are discussed. This rain gage is a continuous, flow type with a response time of the order of one second. The system used for recording data on a magnetic tape is described, and typical computer-generated rain maps for large area storms and for localized showers are given.

071
MODIFIED TRENCHER SLICES THROUGH FLINT-HARD ROCK,

Lorraine Smith
Construct Methods Equip, Vol 52, No 6, pp 74-78, Jun 1970. 10 fig.

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Descriptors: *Rock excavation, *Drilling equipment, *Drainage systems.
Identifiers: *Storm sewers, *Trencher.

A Texas contractor bought a strong stock model trencher and modified it to meet the need for a storm sewer to be cut through hard rock in downtown areas where blasting is forbidden. Major changes in the rig include the addition of three unique features: an adjustable three-part wheel, an hydraulic mast, and an adjustable crumbing shoe. Minor modifications include: converting the mechanical drive train from a 21- to a 42-tooth sprocket to increase torque on the cutting wheel, reinforcing the idler axle, and replacing an 8-foot Jetco arc-type conveyor with the Parsons original. The trencher not only cut through flinty rock, but it kept well ahead of rigs forming the cast-in-place drain.

072
SOME THOUGHTS ON SEWER PIPE BEDDING,

William J. Warwick
Water Pollution Control, Vol 107, No 8, pp 30-31, Aug 1969.

Descriptors. *Pipelines, Design criteria, Installation.
Identifiers: *Sewer pipe bedding.

Important aspects of sewer pipe bedding are explored in the areas of: satisfactory bedding needs, economics of installation, special cases, enforcement of design criteria, and performance. Technical information is lacking concerning the special case of common or separate trenches for side-by-side storm and sanitary sewers or sewer connections. Usually two such pipes are laid in a common trench, but the economics and functional usages may not always warrant this choice. More study is needed to determine the advantages or disadvantages of dual trenches.

073
LOW COST STORM DRAINAGE WITH PAVED CHANNELS,

Clifford Wendell and Robert Emmons
Public Works, Vol 101, No 4, pp 110-111, Apr 1970.

Descriptors: *Drainage systems, Design data, Concrete construction, Storm drains.
Identifiers: *Drainage channels.

Rockford, Illinois realized almost a 45% reduction in costs on its drainage system construction by installing concrete paved drainage channels instead of conventional storm sewer systems. Rainfall-runoff data was utilized in designing the channels for the 50-year frequency storm. This longer frequency design provides more adequate protection

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from flooding, and the channels still retain their self-cleaning capabilities. Dimensions and design diagrams of the paved drainage channels are given.

074
A CRITICAL REVIEW OF METHODS OF MEASURING DISCHARGE WITHIN A SEWER PIPE,

H. G. Wenzel, Jr.
ASCE Tech Mem No 4, Urban Water Resources Res Program, Sept 1968. 20 p, 2 fig, 2 append. USGS: 14-08-0001-11257.

Descriptors: *Stream gages, *Flow measurement, *Flowmeters, *Closed conduit flow, *Sewers, Venturi meters, Tracers, Radioactivity techniques, Dyes releases, Tracking techniques, Research and development.
Identifiers: Rating curves, Urban hydrology.

Existing methods of measuring discharge of sewers are discussed with respect to the requirements and physical limitations imposed by their use in an urban study area, and rating curves for a suggested critical flow device are presented with recommendations for future research. The gage must have an output in the form of an electrical signal for recording, be automatically turned on and off, and need no attendant. Laboratory velocity probes are unsuitable because of clogging problems. Desired accuracy is 5% in discharge measurement over a large flow range. The device must be capable of installation in any existing sewer at reasonable cost. Weirs, depth gages, and velocity meters, the methods presently available, all have serious disadvantages and are not recommended. Tracer dilution methods as well as Venturi flumes and other critical flow devices are suggested for development. A pipe section with a narrow throat acts as a Venturi flume for open flow and as a Venturi meter for full flow. Plans and theoretical rating curves for such a device are shown.

075
TV INSPECTION AND IN-PLACE GROUTING OF SEWERS,

R H. White
Water Wastes Eng, Vol 5, No 9, pp 72-74, Sep 1968.

Descriptors: *Inspection, *Cost-benefit analysis, *Equipment, Grouting, Sewers.
Identifiers: *Austin, Texas, *Television inspection, sanitary sewers.

Experiences of Austin, Texas, in using television camera inspection and inplace grouting in sewers are reported. The first experience with television inspection was so successful that lines in question were rehabilitated at a cost less than twenty thousand dollars, instead of two hundred and forty thousand dollars as was considered previously. Tele-

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spection equipment proved to be durable, and down-time was quite low. Television inspection has forced contractors and other utilities to respect sanitary sewers.

076
OPTIMIZING WASTE TREATMENT CONTROL SYSTEMS,

Ernest T. Williams, Jr.
Paper presented at the Third Annual National Pollution Control Conference and Exposition, April 1-3, 1970, San Francisco, California.

Descriptors: *Instrumentation, *Waste treatment, *Control systems, *Measurement.

As waste treatment and recovery processes become more complex and costly, there is increasing reliance upon instrumentation to assume control responsibility for the most economic and efficient operation. This paper describes the control systems normally used on four applications, and discusses what can be done to optimize performance. The use of dissolved oxygen and sludge density measurement in the activated sludge process is explored. The second application is pH neutralization. Feedforward control and the nonlinear controller have dramatically improved neutralization performance. Improvements are also suggested in the control schemes of chromate waste and cyanide waste treatment processes.

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Section 2

OVERFLOWS AND REGULATION DEVICES

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077
CLEANING OUR ENVIRONMENT-THE CHEMICAL BASIS FOR ACTION: SECTION 2 - THE WATER ENVIRONMENT: MUNICIPAL WASTE WATER TREATMENT,

Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs American Chemical Society, pp 100-122, 1969. 2 fig, 4 tab.

Descriptors: *Waste water treatment, *Overflow, *Storm runoff, *Flocculation, *Treatment facilities, *Water reuse, Sewage treatment, Storage tanks, Underground storage.
Identifiers: *Combined sewers, *Stormwater quality.

This subsection discusses existing processes, recent advances, and current problems relating to municipal wastewater treatment. Urban stormwater problems from combined sewer overflows are explained, and possible solutions presented, such as storing overflow and then passing it to plants for skimming and sedimentation and/or polymeric flocculation treatment. Other means of handling overflows include storage in fully or partially flexible underwater tanks or in underground tunnels with subsequent treatment, chlorination, and filtration aided by ultrasonic energy. One current project is evaluating the use of 1-2-acre ponds to collect stormwater runoff and then treat it for reuse. The following recommendations in the area of municipal wastewater treatment were made: (1) more research by biochemists and biologists on sewage treatment, primarily to seek radical innovations based on fundamentals of microbiological processes; (2) research expansion on new methods of handling wastewater treatment sludges and on parameters involved in using synthetic polymers and polyelectrolytes to improve flocculation, sedimentation, and conditioning of such sludges; and (3) more systematic studies on urban stormwater quality to provide a sounder base for evaluating various means of treatment.

078
NEW IDEAS FOR CALCULATING STORM WATER OVERFLOW SETTINGS AND THE DESIGN OF STORM WATER TANKS,

Civil Eng Public Works Rev, Vol 65, No 766, p 487, May 1970.

Descriptors: *Storm runoff, *Overflow, *Design.
Identifiers: *Storm overflows, Storm tank.

The Technical Committee on Storm Overflows devised a new formula for setting storm overflows which enables them to be designed without first conducting infiltration surveys. The report of this committee also condemns the use of low-side weir storm overflows because they cause

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excessive pollution. Ideas for the use of storm tanks during periods when they are not required for their design purposes are proposed. The question of flow standard storm tank effluent discharged at the same time as high-quality standard effluent is presented but not answered in this report.

079
STORM OVERFLOWS AND THE DISPOSAL OF STORM SEWAGE,

Effluent Water Treat, Vol 10, No 3, pp 154-155, Mar 1970

Descriptors: *Storm runoff, *Sewage, Design, Screens, Overflow.
Identifiers: Storm tank, Storm Sewage, Great Britain.

Comments on the final report of the technical committee concerned with storm overflows and the disposal of storm sewage, are discussed. It is the first known official document containing recommendations on the settling of storm overflows and on the bases of storm tank design. The main conclusions and recommendations of this british report are listed.

080
NOTES ON WATER POLLUTION,

Inst Sewage Purif, J Proc, Part 2, pp 199-202, 1966. 1 graph, 3 ref.

Descriptors: *Sewers, Investigations, Sewage, Water pollution, Runoff, Storage tanks.
Identifiers: *Storm sewage, *Combined sewers, *Storm overflows, Great Britain.

Studies were performed in three areas served by combined sewerage systems on the amount, composition, and pollution load of stormwater overflows. There was regularity in the volume of storm sewage at the three sites in relation to impermeable area, total rainfall, and dry-weather flow; however, no regularity was detected in composition. Generalizations were made regarding runoff, sewage dilution, single storm discharges, etc., and specifics for each locale were also described. Recommendations were made for the placement of storage tanks alongside of storm overflows and for experimentation in designing different types of overflows in order to reduce pollution load discharges.

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081
MIDLAND DISTRICT CENTER,

Inst Public Health Engrs, Vol 67, Part 1, pp 51-57, Jan 1968.

Descriptors: *Overflow, *Sewage treatment.
Identifiers: *Storm tank, Great Britain.

The reconstructed and extended Kidderminster Sewage Works will contend with excess water runoff by passing the overflow through screens or by storing it in stormwater tanks. The tanks will contain underwater sludge scrapers. Flow will be diverted from the river until all the tanks are individually filled. The stored water will eventually be pumped out for treatment.

082
DESIGN OF A COMBINED SEWER FLUIDIC REGULATOR; The Development of Basic Configurations and Design Criteria for Applications of Fluidics in Sewer Regulators,
Bowles Eng Corp.

Water Pollution Control Research Series, Report DAST-13, FWQA Contract 14-12-486, Oct 1969. 137 p, 98 fig, 3 ref, 1 append.

Descriptors: *Flow control, Sewers, Diversion structures, Design, Design criteria, Costs, Fouling.
Identifiers: *Sewer regulator, *Combined sewers, *Fluidic regulator, Interceptor sewer.

A generic Fluidic Regulator configuration was developed which diverts 0 to 75% of the combined sewer flow away from the interceptor sewer, or combined sewer, in either an analog or digital operational mode. Application design criteria were evolved for a range of small to medium sized municipal sewers, in terms of a few basic parameters. Preliminary analysis has shown that the installation of a combined sewer fluidic regulator is similar in nature and overall complexity to a conventional leaping weir, or side flow diversion structure. It is estimated that the use of a fluidic regulator would not increase the cost of a large diversion structure, and would add about 20% to the cost of a small diversion structure. A simulated fouling test showed a very low susceptibility to fouling by solid or soft sheet-like debris in the water flow.

083
CRAZED RESIN FILTRATION OF COMBINED SEWER OVERFLOWS,
Hercules Inc, Cumberland, Maryland.

Prepared for FWPCA, Contract No. 14-12-39, Oct 1968. 78 p.

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Descriptors: *Evaluation, *Filters, *Sewerage, *Sewers, *Suspended load, *Storm runoff, *Resins, *Overflow, Construction materials, Filtration, Volumetric analysis.
Identifiers: *Combined sewers.

This study was conducted to evaluate the feasibility of a self-adjusting and self-cleaning filter proposed for use on combined sewer systems to remove a large portion of suspended solids from sewage influent during storm flow conditions. The experimental filters were cylindrical structures about one foot in diameter by one foot in length and whose materials of construction were fibers laid down in predetermined patterns by a winding process and bonded in place by resins. The permeability of the structure is imparted by a mechanical crazing of the resin. Filtration runs showed a 62% reduction of suspended solids in the filtrate; however, sustained runs could not be realized. The self-cleaning capability was not demonstrated.

084
SYMPOSIUM ON STORM SEWAGE OVERFLOWS,

Inst Civil Engrs (London), 1967. 160 p.

Descriptors: Hydraulics, Statistics, Overflow.
Identifiers: Sewer separation, Storm sewage.

The twelve papers presented consist of experimental studies, which provide technical data on flow conditions, performance of sewerage systems, and design factors for various situations. Particular attention is paid to behavior of mixed flows and to both vertical and horizontal separation methods.

085
RAPID - FLOW FILTER FOR SEWER OVERFLOWS: The Evaluation of Course Coal as a Filter Medium to Remove Large Solids from Sewer Overflows, Rand Development Corp.

Water Pollution Control Research Series, Report 11023 DP1--08/69, FWQA Contract WA-67-2, Aug 1969. 81 p, 10 fig, 12 tab, 4 ref, 1 append, photos.

Descriptors: *Sewage treatment, *Overflow, Filtration, Storm runoff, Sampling.
Identifiers: *Rapid-flow filter, *Coal filter medium, *Combined sewers.

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In a pilot installation at the terminus of an existing urban overflow location, a rapid-flow filter using lump coal as the filter medium performed with a minimum of maintenance or difficulty. The preferred filter used lump coal with a size of approximately 3/4 inch by 1½ inch, free of fines, and about 8 inches in depth. The overflow is directed onto the filter bed in such a manner that the filter bed is not displaced. Filter bed depth did not appear to be critical; the degree of solids removal does not materially increase at depths exceeding 8 inches. Because the concept is based on the use of a disposable filter medium, no backwashing or other processing is required. It appears that replacement approximately 6 times per year might be expected as an average. At no time during this investigation was an odor of sewage solids or garbage detected as long as unoiled coal was used and the filter was shaded from the sun.

U86
DISSOLVED-AIR TREATMENT OF COMBINED SEWER OVERFLOWS; The Demonstration Project of a Prototype Treatment Plant Designed to Treat Wastes Found at a Combined Sewer Overflow,
Rhodes Technology Corp., Houston, Texas.

Federal Water Pollution Control Administration, Research Series, WP20-17, Jan 1970. 216 p.

Descriptors: *Infiltration, Storm runoff, Overflow, Flocculation, Investigations.
Identifiers: *Combined sewers, *Dissolved-air flotation, Suspended solids, Treatment methods.

A dissolved-air flotation system was evaluated for primary treatment of combined sewer overflows. The major pieces of component equipment were a gyratory screen, hydrocyclones, an air dissolving tank, and a flotation cell. The principal aspects investigated were: (1) performance of the system during rain events and dry periods; (2) evaluation of individual components; (3) capital costs and operating costs for utilizing a flotation system for various size combined sewage overflows; (4) the adaptability of the system for automation and use in remote location; and (5) the ability of the system to treat intermittent and highly variable flows from combined sewage systems. Some chemical aids to flocculation were also tested. It appears that dissolved-air flotation systems would be economical for handling combined sewer overflows up to 8 MGD. Automation of dissolved-air flotation systems appears possible with conventional control equipment. Chemical aids to flocculation seem to have promise that warrants further study. The system was unique in that all liquid flow passed directly through the air dissolving tank with no recycle. Domestic sewage was studied in lieu of combined sewage during periods of no rain. Conclusions, recommendations, and benefit-cost relationships are presented in the report. A description of the demonstration plant and the drainage area served by the flotation system are appended.

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087
DETROIT SEWER MONITORING AND REMOTE CONTROL; Research Project Aiming at the Reduction of Combined Sewer Overflow Pollution in Detroit using System Monitoring and Remote Control Techniques,
Detroit Metro Water Depart.

In: Combined Sewer Overflow Abatement Technology. Water Pollution Control Research Series, Report 11024--06/70, pp 219-290, Jun 1970. 33 fig, 2 tab.

Descriptors: *Overflow, *Control systems, *Monitoring, *Remote control, Storm runoff, Runoff forecasting, Sewers, Water pollution control.
Identifiers: *Combined sewers.

The Detroit Metro Water Department has installed the nucleus of a sewer monitoring and remote control system for controlling the pollution from the combined overflow from many small storms at a cost of slightly over $2 million. The system includes telemetering rain gages, sewer level sensors, overflow detectors, a centrally located computer and data-logger, and a centrally located operating console for controlling pumping stations and selected regulating gates. Installation has been virtually completed and now enables applying such pollution control techniques as storm flow anticipation, first flush interception, selective retention, and selective overflowing.

088
STORM WATER RETARDING BASINS SOLVE URBAN DRAINAGE PROBLEMS,

A. P. Aitken.
Australian Civil Eng, Vol 10, No 2, pp 35-37, Feb 1969.

Descriptors: *Watersheds (basin), Drainage systems, Design, Hydraulics, Hydrologic aspects.
Identifiers: *Australia, Stormwater basins.

Urban flooding problems solved by Melbourne and the Metropolitan Board of Works are discussed. Hydrologic and hydraulic problems posed in design of retarding basins are explained. 16 stormwater retarding basins varying in capacity from 13 to 2350 acre feet were constructed to reduce peak flow downstream of basin by temporarily storing portion of inflow from upstream catchment. Land acquisition, design considerations, and cost of basins are mentioned.

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089
STRAINER/FILTER TREATMENT OF COMBINED SEWER OVERFLOW,

Stephen S. Blecharczyk and Edward L. Shunney.
Final Report prepared for FWPCA, Report WP-20-16, Contract No 14-12-17, Jul 1969. 53 p, 26 tab, 6 fig, 14 ref, 1 append.

Descriptors: *Evaluation, *Systems analysis, *Overflow, *Cost analysis, Suspended load.
Identifiers: *Strainer-filter system, *Treatment methods, *Combined sewers.

The principal of a "self-cleaning strainer, self-cleaning filter" concept for the treatment of combined sewer overflows was evaluated in this feasibility study. The strainer and filter systems were examined using a synthetic substrate (prepared on the basis of overflow sample analysis data obtained from analysis of a combined sewer overflow in Providence, Rhode Island), primary influent to two separate municipal treatment plants, fresh sewage solids, and combined sewer flow. It was demonstrated that the strainer model produced consistent suspended solids removal rates near 35% under highly varying load conditions, at a flux of 25 gallons/minute/sq. ft. The authors believe that a strainer-filter system of the type originally envisioned is not feasible from a cost and operational point of view if additional treatment is necessary beyond that attainable with a self-cleaning strainer.

090
FREQUENCY OF STORM-SEWAGE OVERFLOWS. THE FREQUENCY OF STORM-SEWAGE OVERFLOWS IN COMBINED SEWERAGE SYSTEMS IN CONNECTION WITH STORAGE AND PUMP CAPACITY, CONCLUSIONS FROM THE RAINFALL DATA OF THE KNMI FOR 1926-1962,

W. O. J. Böttger and A. G. v.d. Herik.
Water (WTRHA7), Vol 50, pp 154-161, 1966.

Descriptors: *Overflow, Data collections, Frequency analysis, Precipitation (atmospheric).
Identifiers: *Storm sewage, *Netherlands.

Tabulated and graphical data on the number of operations of storm-sewage overflows and the amounts of overflow at De Bilt, Netherlands, in the period 1926-1962 are presented. These data were compiled by a computer using the Ribbius-Kragt-Kuipers method (in which it is assumed that no overflow will occur until the sewers are filled to the crest of the lowest weir). The average overflow frequency, calculated monthly, reached a maximum in August and a minimum in March. Results for individual years and individual months were quite variable, and no useful relations could be found between the annual precipitation, the number of operations of the overflows, and the amounts of overflow.

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091
SOME ASPECTS OF SEWAGE TREATMENT AT COVENTRY,

R. W. Brooks, H. V. Lee, and N. J. Price.
Water Pollution Control, Vol 68, No 2, pp 129-145, Mar 1969.

Descriptors: *Sewage treatment, *Sludge treatment, *Filtration, Storm runoff.
Identifiers: *Storm sewage, Storm overflows, Sewer hydraulics, Great Britain.

An historical progress report of Coventry involving the sewage treatment outline development, activated sludge treatment, and sand filtration is presented. In the 1960's, the elimination of direct storm overflows and the provision of regional storm sewage balancing stations was initiated. Excess flow would be diverted to tanks at the stations until available capacity could be made in the sewer downstream and pumps then would automatically return the contents of the tanks. In the reply to the discussion following the article the limits for discharges from the storm overflows are presented.

092
STORM OVERFLOWS AND STORM SEWAGE,

John T. Calvert.
Surveyor, Vol 85, p 22, Apr 1970.

Descriptors: *Sewage disposal, *Design standards, *Design criteria, *Separation techniques.
Identifiers: *Storm overflows, *Storm sewage, Great Britain.

Conclusions of the Final Report of the Technical Committee on Storm Overflows and the Disposal of Storm Sewage are summarized. The Ministry of housing and Local Government accepted the report's recommendations regarding the general design and setting of storm overflows, and they are considering recommendations for further research and investigation. The major outcome of the report proposes a formula for the setting of storm overflows which replaces the former method of fixing the setting at 6 d.w.f. Features and advantages of the formula are given. Sewer separation was considered but eventually rejected by the committee because of the huge cost involved and the inevitable pollution from surface water drains of separate sewers. Other areas studied were the effects of storm sewage on rivers and the composition and strength of storm sewage.

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093
DRAINAGE OF WIDE ROAD PAVEMENTS,

K. W. Dobinson.
Inst Engrs (Australia), Vol CE 10, No 1, pp 1-6,
Apr 1968.

Descriptors: Surface drainage, Design, Drainage engineering, Drainage systems.

The effectiveness of various types of pavement drainage structures is discussed. The surface drainage design method, used under certain conditions, is described. A graphic system for the design of pavement drainage is examined.

094
MORE THAN JUST A BUILDING,

L. C. Dubs.
Am City, Vol 85, No 6, pp 119-124, Jun 1970.

Descriptors: *Drainage systems, Construction, Overflow, Ohio.
Identifiers: *Dry wells.

A three-phase program designed to place all the city's service functions in one area is underway in Canton, Ohio. The first phase involves the construction of two buildings; one a motor vehicle service center, and the other a street and sewer department. The service center's unusual drainage system consists of a system of dry wells constructed throughout the area with one large dry well absorbing overflow from the smaller ones. This system was adopted because storm sewers were not available in the region. Only minor flooding occurred once when there was a heavy rainfall, so the effectiveness of this system was evidenced.

095
CHARACTERIZATION AND CONTROL OF COMBINED SEWER OVERFLOWS, SAN FRANCISCO,

D. W. Eckhoff, A. O. Friedland, and H. F. Ludwig.
Water Res, Vol 3, No 7, pp 531-543, 1969.

Descriptors: *Overflow, Outlets, *Analytical techniques, Runoff, Sewage treatment.
Identifiers: *San Francisco, *Storm sewage.

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In order to find methods for controlling or treating storm-sewage overflows from combined systems in urban areas, overflows from the combined sewerage system of San Francisco were measured and sampled for analysis at two outfalls in the city. The dry-weather flows were also monitored. From the data obtained and other observations, the annual runoff for the whole of the city was compared with its total annual discharge of treated sewage effluent, and the effects of the dry-weather flow on the overflow and of the overflow on receiving waters were investigated. The latter effect produced a considerable increase in the numbers of coliform bacteria which remained higher than normal for about two weeks. The studies showed that treatment of overflows from combined systems could result in a substantial reduction of pollution at less expense than would be involved in separating the systems, and that dissolved - air flotation with chlorination appeared to be a promising method.

096
OVERFLOW STUDIES AT A SEWER SYSTEM OF A METROPOLITAN CITY,

Wilhelm v.d. Emde and Siegfried Hoffman.
Gas Wasserfach (GAWFAN), Vol 110, No 12, pp 321-325, Mar 1969. 4 ref.

Descriptors: *Sewers, *Measurement, *Storm runoff, *Overflow, *Parametric hydrology, *Rainfall, *Mathematical studies.
Identifiers: *Capacity, *Germany.

For determining the capacity of the sewer system including stormwater drainage in Hamburg, the flow speed, the water level, and the sludge deposition during dry weather were measured. The speed is found to be approximately 0.5m/sec, and sludge deposition is hardly avoidable at the low inclination of the canal system. The conditions during rainy weather were determined with automatic level recording units. From these level measurements the frequency of overflow in days/year, the overflow duration in hours/year, and the overflow quantity/year were calculated. From the recordings of rainfall and the level measurements at the overflow spills of the sewer system a diagram is drawn according to Kuipers' equation providing information on the storage capacity and discharge capacity of the overflow spills. These two parameters determine the critical rainfall for the overflow spill. Its magnitude decreases with increasing duration of rain and asymptotically approaches the discharge capacity. To avoid frequent overflow, calculations should be based on the critical rainfall as a function of the overflow time. Since this is not practical, it is recommended to use the normal rainfall for the calculation and multiply the quantities obtained by a constant factor.

097
A RE-EXAMINATION OF THE STORM TANK PROBLEM,

L. B. Escritt.
Water Waste Treat, Vol 12, No 9, pp 298-300, Sep/Oct 1969. 1 tab.

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Descriptors: *Sewers, *Overflow, *Treatment facilities, *Design, Sewage treatment.
Identifiers: *Storm tank, *Capacity, *Stormwater treatment.

Where sewage works treat flow from catchments which are served by combined or partially-separate sewers, a moderately intense rainfall-runoff rate will necessitate passage or storm-tank storage of excess flow. The Royal Commission on Sewage Disposal makes recommendations regarding the handling of such overflows. The author of this paper disputes their statement that storm tanks able to hold one-quarter of the daily dry-weather flow will suffice for storing spill-over from small storms. he notes that a capacity of two days dry-weather flow is often needed to prevent spill-over occurring. Functions of storm tanks and the mathematics of stormwater treatment are described. A suggested design for tanks consists of circular tanks with ratating sludge mechanisms. A formula for calculating the required capacity of a tank to prevent spill-over is included.

098
BUILDING DRAINAGE PUMP STATIONS WITHIN LIMITED BUDGET,

E. W. Fritschi
Public Works, Vol loo, No 2, pp 104-105, Feb 1969.

Descriptors: *Design, *Louisiana, *Pumping plants, Construction.

The design of a pump station, located 15 miles south of New Orleans is described. The primary stage of the pump station was designed for rainfall of 2.5 in. for one hour and then ½ in./hr for a total of 6 in. Emphasis was placed on the design of a sub-structure which had to serve as a cofferdam preventing leakage from the tail bay into the suction bay, and as a retaining wall resisting vertical, horizontal and lateral forces. Requirements were met by designing a series of bays that structurally act as a continuous arch bridge.

099
STEPS TO SUCCESS IN WATER POLLUTION CONTROL,

Charles V. Gibbs
Public Works, Vol 101, No 5, pp 62-67, May 1970.

Descriptors: *Overflow, *Pollution abatement, *Sludge digestion, Sewage treatment, Separation techniques.
Identifiers: *Interceptor sewer, *Seattle, Combined sewers.

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Plans and actions of the Municipality of Metropolitan Seattle (Metro) in regard to combatting the city's water pollution problems are presented. Metro has devised various solutions to underground construction problems with pipelines and pumping stations. Other problems tackled by Metro include the removal of digested sludge from Puget Sound and the elimination of combined sewer overflows. Sewer separation is not presently feasible because of the expense, so the Metro interceptor system is being ordered to run the entire system. In the meantime, money originally reserved for storm water holding tanks is being contributed to the city's proposed sewer separation system. Metro is continuing its innovative engineering programs and is coordinating its activities with community agencies working in the same or related fields.

100
THE CROSSNESS SEWAGE TREATMENT WORKS, GREATER LONDON COUNCIL: FIVE YEARS OPERATION, 1963-68,

R. W. horner.
Water Pollution Control, Vol 69, No 2, pp 180-194, 1970.

Descriptors: *Sewage treatment, *Flow control, Flow rates, On-site investigations.
Identifiers: *Maximum flow requirements, *Average flow requirements, Storm tank, Combined sewers, Great Britain, Stormflow detention.

A description of the structure and an assessment of the 5-year operating success of the Crossness Sewage treatment plant are discussed. All flow which once passed to the river must now be pumped through the plant, even wastewater gravitating in storm tanks oribinally used as reservoirs. Moderate storms occurring after two or three weeks of dry weather create flows which exceed the capacity of the screening gear when old combined sewerage systems are in use. In the "Discussion," H. H. Stanbridge asked how the plant operates under maximum flow in comparison to average flow. The authors replied that maximum flow was 216 mil gal and that flows exceeding this level passed to storm tanks. Most of this excess (3.2% of the total flow in 1968-9) was later returned for treatment, but 19% of this load was discharged to the river. Tables and graphs describing the 5-year operation of the plant include: the effect of rainfall on suspended solid load, syspended solid load per day, main pumping station statistics, and the performance of primary sedimentation tanks, activated-slude plants, primary and secondary digestion plants, and the power-house. Diagrams are drawn of the engine cooling water system, the high tension distribution system, and the grit washing plant.

101
ALL YOU SEE IS THE STREAM,

H. S. Hulme, Jr.
Am City, Vol 85, No 3, pp 77-78, Mar 1970.

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Descriptors: *Drainage systems, *Stream improvement.
Identifiers: Swales, Storm sewers, Arlington County, Virginia.

A controlled stream was constructed above a reinforced-concrete storm sewer enclosing Pimmet Run in Arlington County, Va. to prevent erosion upstream while retaining the aesthetic value of the stream downstream. Swales created along the stream carry local drainage and overflow from storms into the main culvert. Methods of construction and problems encountered are explained. Dimensions and costs of the system are included.

102
LETTERS TO THE EDITOR--WATCH OUT FOR CROSS CONNECTIONS,

Gary D. Hutchinson
Am City, Vol 84, No 1, p 21, Jan 1969.

Descriptors: *Construction equipment.
Identifiers: *Storm sewers.

Additions are made to a previously-published article concerning hazards of well-to-storm-sewer connections. In one southeastern city, these connections were not protected from backflow, thus, the municipal water system was subject to dangerous innundation from storm sewers. City officials corrected the situation by installing above-ground, air-gap separations.

103
WHITHER WATER POLLUTION CONTROL?,

C. P. James
Water Pollution Control, Vol 67, No 5, pp 579-583, Sep 1968.

Descriptors: *Sewage disposal, *Water pollution, *Overflow, Flow rates.
Identifiers: *Hydraulic analysis, Storm sewage.

The author comments on sewage disposal, river pollution prevention services, and research in a general manner. He contends that storm overflow problems are more easily solved on large works than on smaller ones. James contests the equivalent of 3xd.w.f. for the sewage rate of flow in dry weather as the standard measurement.

104
WATER TREATMENT - A GUIDE TO THE TREATMENT OF WATER AND EFFLUENTS PURIFICATION: CHAPTER 13 - INTRODUCTORY: SEWER SYSTEMS--OVERFLOWS--CONSERVANCY,

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G. V. James
The Technical Press Ltd, London, pp 247-252, 1966. 1 fig, 5 ref.

Descriptors: *Sewerage, *Flow characteristics, *Sewers, *Overflow, *Weirs, Sewage treatment.
Identifiers: *Storm overflows.

General facts concerning sewage and sewer systems are presented, including explanations of sewage "strength"; variations in flow; the influence of seasonal and weather changes; and the three types of sewerage systems --combined, partially separate, and entirely separate. The operation of local storm overflows to relieve tributary sewers before they are surcharged is described. The three types of overflows are: the ordinary weir type; the improved weir type with a horizontal iron plate and a vertical deflecting plate directing water to the overflow pipe; and the leaping weir type, the best of the three sewage treatment processes mentioned include: chemical precipitation; use of comminutors; and dilution, bleaching and trenching of cesspool contents.

105
CRITICAL OBSERVATIONS FOR HYDRAULIC MEASUREMENTS OF FIXED STORM-SEWAGE OVERFLOWS,

J. Jehne
Wasserwirtsch-Wassertech (WSWSAO), Vol 17, No 4, pp 122-127, Apr 1967.

Descriptors: *Specific capacity, Sewerage.
Identifiers: *Storm overflows, Combined sewers.

In connection with hydraulic measurements for storm sewage overflows, the author discusses the errors which are caused by using the concept "dilution". The specific concentration of one or more substances (referred to as the specific load) is recommended as the criterion for the permissible load of combined sewerage systems on the receiving water. Equations are developed for calculating the maximal critical values for the specific load and runoff.

106
THE SIMULATION OF INFILTRATION FOR STUDIES IN OVERLAND FLOW,

G. A. Jobling and A. K. Turner
Proceedings of International Hydrology Symposium, Sep 6-8, 1967, Colorado State University, Fort Collins, Vol 1, Paper 27, p 203-210, 1967. 8 p, 7 fig, 3 ref.

Descriptors: *Rainfall-runoff relationships, *Overland flow, *Model studies, *Hydraulic models, *Simulated rainfall, Simulation analysis,

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Artificial precipitation, Rainfall simulators, Runoff forecasting, Routing.
Identifiers: Watershed models.

"Overland flow' over natural surfaces is unsteady and spatially varied, due to both rainfall and infiltration. Most experimental work to date has been done using impermeable surfaces, the effects of time-dependent infiltration being ignored. Research into flows over natural surfaces is time consuming and the results are difficult to interpret at this stage in our knowledge of such flows. A method of simulating infiltration is described which enables experimental work to be undertaken in a tilting flume. The system produces a time-dependent decay in simulated infiltration, and can be described by an equation of the form used by Kostiakov. Since the two parameters involved can be readily altered, the system provides a means of simulating a range of field surfaces. Some initial results using the method are described.

107
COMBINED UNDERFLOW STORAGE PLAN FOR POLLUTION AND FLOOD CONTROL IN THE CHICAGO METROPOLITAN AREA,

Clint J. Keifer, A. L. Tholin, and Marshall Suloway.
Chicago, City Bureau of Engineering, Department of Public Works, Sep 1969. 43 p, 13 fig, 6 tab.

Descriptors: *Underground storage, *Tunnels, *Control structures, *Sewers, *Flood control, *Water pollution control, Water conveyance, Waste Water, Shafts, River regulation, Drainage systems, Drainage engineering, Design, Underflow.
Identifiers: *Chicago.

Three alternative plans, proposed locally as solutions to flood control and pollution problems in the Chicago metropolitan area, are described and compared. The combined sewer systems, which carry the municipal and industrial wastes as well as storm water runoff, spill raw sewage into the Des Plaines, Chicago and Calumet Rivers, and the Sanitary and Ship Canal from 400 outlets, during overflows occuring when interceptor sewers and treatment plants are loaded beyond capacity. The flow from these rivers empty via the Des Plaines River into the Illinois River. Intense rainstorms frequently result in basement and underpass flooding. The $650 million plan suggested by the City proposes the construction of 95 miles of huge conveyance tunnels, 26 ft wide and 50 ft deep, excavated through solid rock beneath the Chicago, Calumet, and Des Plaines Rivers, and the Sanitary and Ship Canal. Flows from the combined sewers would be dropped through shafts into these tunnels to provide temporary storage for flood prevention and to collect sewer overflows for subse-

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quent pumping to three major existing treatment plants. Improvements along the Des Plaines River and the Sanitary and Ship Canals planned by the Illinois Division of Waterways are also described. The project design would be based upon handling the runoff from a storm with a 100 year average recurrence interval.

108
NEW REGULATIONS AND CONSTRUCTIONS OF STORM-SEWAGE OVERFLOWS, FOR THE RELIEF OF RECEIVING WATERS,

R. Lautrich
ber Abwassertech Ver (BALVAD), Vol 19, pp 175-193, 1968.

Descriptors: *Regulated flow, Rainfall-runoff relationships.
Identifiers: *Storm overflows.

This paper deals with the relation between the critical rainfall and runoff and the resulting dilution. Investigating the effect of the fundamental lay-out of storm sewage overflows, the author concludes that if two storm sewage overflows are constructed at a given position in place of one, the polluting load discharged to the receiving water can be greatly reduced.

109
PAVING CURES DUST AND DRAINAGE ILLS,

Jack Lough
Am City, Vol 84, No 7, pp 97-98, Jul 1969.

Descriptors: Concrete construction, Drainage programs, Storm runoff.
Identifiers: Street drainage.

A far-reaching street-paving program was implemented in Albion, Nebraska after heavy rains caused driveway culverts to overflow, ditchwater to stagnate, and runoff to spill into streets and parkways because ditches were clogged. Concrete curbs, gutters, and pavements were installed to ameliorate this situation and also to provide dust control. The entire project cost $473,619.48 (about $5700 per block).

110
A BREAK FROM ACCEPTED PRACTICE . . . BRINGS STORM-WATER CONTROL WITHIN REACH OF OUR BOROUGH'S POCKETBOOK,

L. L. Lowry
Am City, Vol 83, No 6, pp 108-109, Jun 1968.

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Descriptors: *Reservoir storage, Storm runoff.
Identifiers: *Stormwater control.

State College, Pa. constructed a reservoir to contain runoff until after a storm, instead of installing a more costly water-carrying conduit. An electrically controlled gate closes when rain causes the water level in the reservoir to rise, and it opens when the storm subsides, thus, allowing the rainwater to drain. As a part of State College's sewage project, a new storm trunk line was built contrary to common practice; that is, from the center of the job downstream, to reduce the threat of the pipe coming afloat in the event of a flash flood. This plan was also successful; flood water was forced inside the pipe rather than flowing around the outside and causing flotation. State College also formed a Storm Water Authority to undertake the financing of such storm water control projects.

111
WATER STORAGE METHODS -- FROM CUPPED HANDS TO COMPUTERS,

T. W. Lumsden
Water Pollution Control, Vol 107, No 6, pp 16-19, and 30, Jun 1969.

Descriptors: *Reservoir storage, Construction costs, Storm drains, Storm runoff.
Identifiers: *Stormwater systems.

Storage tanks and reservoirs should provide for flow equalizing, fire protection, and emergencies. An overall system analysis is usually necessary to determine the most economical combination of storage facility, trunk mains, and pumping facility. Criteria for locations of storage facilities and construction cost considerations are noted in this article. Stormwater systems exhaust sizable segments of expenditures utilized for water storage in general. Drains must provide for normal stormwater runoff and higher flows resulting from reservoir emptying and inadvertent overflows.

112
THE WRAY FLOOD DISASTER AND ITS EFFECTS ON THE PUBLIC HEALTH SERVICES,

D. H. Maud
Inst Public Health Engrs, Vol 67, Part 4, pp 244-249, Oct 1968.

Descriptors: *Storm runoff, *Outlets, *bypasses, Sewage treatment, Repairing, Sewerage.

Intense thunderstorms and flooding damaged the water supply system and sewerage and sewage disposal systems of the town of Wray on the river

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Roeburn. As a result of the storm, the outlet pipe, which allowed storm water overflow to pass to the river, was completely filled with silt as were other parts of the sewage disposal system. In addition to repairs on the sewer disposal and sewerage systems, town workers cleared the outfall pipe, thus, establishing a bypass to the river. They then connected the washout valve on the filter feedline near the dosing chamber to the humus tanks. By re-opening the inlet valve to the primary sedimentation tank and opening the dosing chamber's washout, primary tank effluent was routed to the humus tanks; and thus, a two-stage settlement treatment system was instituted in place of discharging raw sewage over the side weir storm overflow.

113
CITY OF OXFORD: EXTENSION TO SEWAGE-TREATMENT WORKS,

A. T. Morris, C. E. Copeland, and V. H. Lewin
Water Pollution Control, Vol 69, No 3, pp 249-256, 1970. 1 diag, 2 graphs, 5 ref.

Descriptors: *Sewage treatment, *Overflow, *Separation techniques.
Identifiers: *Storm sewage, Storm tank, Great Britain.

The City of Oxford extended its 1957 sewage treatment works in order to cope with overloads caused by housing, industry, and population expansion. The original plant made no provision for storm sewage; however, the new plant includes storm/sewage balancing tanks with a capacity of 1.5 mil gal ($6.82 \times 10^3 m^3$). The workings and dimensions of these tanks are detailed along with descriptions of other essential portions of the plant such as the activated-sludge plant, final separating tanks, and sludge treatment and disposal parts.

114
SOLVING A SEWER OVERFLOW PROBLEM,

Charles R. North
Public Works, Vol 97, No 4, p 92, Apr 1966. 1 diag.

Descriptors: *Sewers, *Design, *Planning, *Pumping plants, *Overflow, Investigations.
Identifiers: *Painesville, Ohio.

The 1910 sewer line in Painesville, Ohio is discussed. A pump station and force mains were added to an existing sanitary sewer system, and subsequently caused flooding. An investigation was undertaken to identify and correct the cause of the problem. The following conclusions were included: 1) in future designs, considering the capacity of older sewers as two-thirds full; 2) recommending of camera inspection with semi-annual

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cleaning; 3) running of pumps on an alternate basis; 4) telemetering; 5) checking of the upstream side of the pump station for excessive infiltration; and, 6) checking the operation of the regulator.

115
THE DISCHARGE OF STORM SEWAGE TO PUBLIC WATERS FROM AREAS OF GROUNDS WHICH ARE ENDANGERED BY OIL, IN CONNEXION WITH THE CLEAN WATER ACT FOR BERLIN,

K. -H. Salewski
Gesunh Ingr,(GEINAS), Vol 87, pp 265-266, 1966.

Descriptors: *Legislation, *Surface waters, *Design, *Separation techniques.
Identifiers: *Germany, Storm sewage, *Oil separators.

In connection with the legislation for the protection of berlin surface waters, which prohibits the discharge of oil emulsions, the author discusses the use of oil separators for areas where large volumes of oil are handled and where spillage is washed off into the receiving water by rainfall. These oil separators can be installed in sections along areas likely to be affected before storm sewage enters the receiving waters. Standards for the design of such separators are discussed.

116
STORM WATER TREATMENT AT CLEVELAND,

George D. Simpson and Lamont W. Curtis
J Water Pollution Control Fed, Vol 41, No 2, Part 1, pp 151-168, Feb 1969. Paper from Am Water Works Assoc - 88th Annual Conference, Cleveland, Ohio, Jun 2-7, 1968.

Descriptors: *Watersheds (basins), *Multiple-purpose projects, *Pressure conduits, *Pumping plants, *Water pollution control, *Chlorination, *Pollution abatement, *Lake Erie, Biological treatment, Reduction (chemical), Recreation facilities.
Identifiers: *Gravity sewer, *Cleveland, Ohio.

A feasibility study was conducted for the FWPCA of a proposed offshore stabilization-retention basin, for the treatment of various polluting flows now being discharged to Lake Erie. The basin would receive treated effluent flow from the City's Easterly Wastewater Treatment Plant, as well as flow from six large combined sewer overflow outfalls, and flow from five polluted streams which drain the service area. The proposed basin would be approximately 900 acres in area, with a mean water depth of 33.5 ft. A shoreline collection system is included to convey flows to two central points for discharge into the basin. The collection system will consist of a combination of gravity and pressure conduits, with two pumping stations. Two basic types of purification processes will take place in the basin. Biological and chemical oxida-

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tion will result in reduction of BOD and COD; this process will require an aerobic environment. Sedimentation of fine suspended solids, particularly the activated sludge cell matter in the treatment plant effluent, will require quiescent settling. To meet these two conditions, a two stage basin is contemplated. The first stage will be maintained in aerobic condition by air-lift or mechanical pumping. In the quiescent sedimentation stage, it is expected that an upper layer of five to ten feet of water will be aerobic, with the remainder of the depth anaerobic. The basin will create a sheltered bay at the shoreline, which will be used for boating, fishing and swimming. A small boat marina is contemplated as part of the overall project. The basin will be provided with facilities for chlorination. Effluent will be discharged at about 8,000 ft. from shore in a water depth of approximately 42 ft. The basin has been found feasible from the standpoint of pollution abatement and reduction of bacterial contamination of the City's beaches resulting from polluted discharges.

117
ALTERNATIVES TO SEPARATION OF COMBINED SEWERS,

D. H. Waller
Paper presented at the 21st Annual Meeting of the American Water Works Association, Atlantic Branch, Canadian Section, Oct 8, 1968.

Descriptors: *Pollution abatement, *Application methods, *Separation techniques, Overflow.
Identifiers: Combined sewers.

The drawbacks of separation include high costs, public inconvenience during construction, and the continuing problem of polluted stormwater runoff. Alternative solutions to this pollution problem either reduce pollutants in the overflow or decrease amounts of combined sewage that is overflowed. Pollutants can be eliminated from overflows through storage and treatment methods such as disinfection, screening, sedimentation, filtration, and other overflow devices. Possible procedures for diminishing combined sewage overflows outlined include real-time control of discharge points, storage by use of larger pipes, or increased interceptor and treatment plant capacity. Each locality's circumstances will determine which method or combination of methods will provide the best means for solving its pollution problem.

118
METHOD OF AND MEANS FOR DEALING WITH STORM-WATER OVERFLOWS IN SEWERS AND LIKE DRAINAGE SYSTEMS,
F. Wood and Longwood Engineering Co, Ltd.

Brit Patent 1,023,311.

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Descriptors: *Overflow, *Drainage systems, *Bays, *Treatment facilities, Sewerage, Screens, Outlets.
Identifiers: *Storm sewage, *Storm overflows.

The equipment examined for dealing with storm-sewage overflows in sewerage and other drainage systems comprises a bay fitted with a trough or channel which has walls of unequal height and a mouth covered with a filter screen, which can be cleaned by a rake or rakes rotating in the direction of flow of water through the bay. Under normal conditions of flow, water passes through the bay directly to the sewer, but under storm conditions, the increased flow causes a build-up of pressure in the bay so that water and floating trash flows over the lower wall of the trough and through the screen to the storm-sewage outlet. Trash is swept from the screen by the rake(s) over the higher wall into a trash pit and thence to the sewer.

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119
A NEW TWIST (90 DEGREES IN FACT) TO SEGMENTED SEWER - PIPE DESIGN,

Eng Contract Record, Vol 83, No 6, pp 56-57, Jun 1970.

Descriptors: *Sewers, *Design, *Estimated costs, Installation.
Identifiers: *Canada, *Sewer hydraulics.

The City of Edmonton, Canada, is using a new segmented pipe on the sewer line in the downtown area. Chief design engineer F. Bereczky thought of tilting a horizontal sewer line to a 90 degree position, thus changing the flow characteristics. The design of the pipe has been worked out so that all dimensions are a function of the inside diameter, and the design can be adopted to any size of pipe. The installation procedure and the estimated cost of the new line are given.

120
PORTABLE RECORDING OF SEWER FLOW,

Water Wastes Eng, Vol 6, No 12, p 12, Dec 1969.

Descriptors: *Storm runoff, *Manholes, Sewerage, Hydrology.
Identifiers: *Sewer hydraulics, Sanitary sewers, Surface flow, Toronto.

In the region including Toronto, sewer flows were measured in order to assess problems arising from storm flows and infiltration into sanitary sewers. It was found that poor manhole hydraulics in one or two manholes can reduce capacities of large sewer systems. Continued observation and control of methods by which surface water enters sanitary sewers was recommended.

121
POLYMERS FOR SEWER FLOW CONTROL; The Development and Demonstration of the Use of Polymers that Reduce or Eliminate Sewer Overflows by Flow Energy Reduction,
The Western Company of North America

Prepared for FWPCA, Program No 11020 DIG, Contract No 14-12-34, Aug 1969. 179 p.

Descriptors: *Infiltration, *Overflow, *Sewers, Toxicity.
Identifiers: *Overflow control, *Polymers, *Sewer lines, Economic analysis.

Six water-soluble polymers were investigated to determine their effects

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upon aquatic flora and fauna, flow characteristics of wastewater, and the operation of a wastewater treatment plant. It was found that the polymers and gels, in the magnitudes tested, were not toxic to bacteria, algae, or fish, and did not act as a nutrient for algae growth. Based upon calculations obtained from flow test data, a maximum flow increase of 2.4 times the flow prior to injection could be obtained if a constant head was maintained. Laboratory flow test data indicated that if flow rates were held almost constant prior to and during polymer injection, a reduction in the static head occurred as a result of friction reduction within the fluid. The most effective polymers in providing energy reduction were Polyox Coagulant-701, WSR-301, and AP-30; however, AP-30 required higher polymer concentration to obtain equivalent flow characteristics. In field tests on a 24-inch diameter line, it was found that polymer concentrations of between 35 and 100 mg/l, decreased frictional flow resistance sufficiently to eliminate surcharges of more than six feet. Based upon an economic analysis, the average annual cost of new construction was approximately five times the cost of using polymers during peak storm-flow periods.

122
DESIGN OF SUB-SURFACE DRAINAGE SYSTEM FOR INNER RING ROAD OF CITY OF ANTWERP,

E. W. Brand
Roads Road Construct, Vol 46, No 546 and 547, pp 162-168, Jun 1968, and pp 201-207, Jul 1968.

Descriptors: Pump testing, Evaluation, Seepage, Electrical studies, Pipe flow.
Identifiers: *Belgium.

The procedure adopted for the design of a permanent dewatering system for the depressed inner ring road in the City of Antwerp, Belgium is presented. Details are given related to the execution and analysis of extensive field pumping tests; the calculation of seepage quantities; and the study of hydraulics of horizontal intake pipes adopted to effect ground water lowering. A number of electrical model tests that map flow nets for a number of values of parameters determining critical pipe elevations are examined.

123
SOLUTION OF AN UNUSUAL SUBSURFACE DRAINAGE PROBLEM,

E. W. Brand
J Irrigation Drainage Div, Am Soc Civil Engrs, Vol 94, No IR2, pp 199-221, Jun 1968.

Descriptors: *Subsurface drains, *Surface-groundwater relationships,

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Design, Storm runoff.
Identifiers: *Surface runoff, Groundwater, Belgium.

The stages followed in designing a subsurface drainage system for the inner-ring road being built in Antwerp, Belgium are described. The system will collect and carry away surface runoff, will permanently lower the groundwater table, and will collect and carry away seepage water resulting from this lowering. Conventional methods were adopted for stormwater drainage design. The seepage water and stormwater collected in a catch basin will run by gravity in pipes to one of four low points in the road's vertical profile. From two of these points the water will flow to pumping stations and from the other two, into rivers. The most complicating factor in the subsurface drainage design was the possible effect of the precipitation of ferric oxide from groundwater. This factor necessitated complete submergence of the intake system. Factors influencing the final selection of the subsurface drainage system are explored in detail.

124
RATIONAL "RATIONAL" METHOD OF STORM DRAINAGE DESIGN,

Discussions by Lamont W. Curtis and Dah-Cheny Woo.

J Irrigation Drainage Div, Am Soc Civil Engrs, Vol 95, No IR4, pp 634-637, Dec 1969.

Descriptors: *Design storm, Time series analysis, Rational formula.
Identifiers: *Sewer hydraulics.

The value of using the rate-duration-frequency curve as the design storm pattern is discussed in reference to intensify-time rainfall charts compiled in Cleveland, Ohio. Incomplete computation in the Rational Method is due to the omission of time needed for flow traveling through the sewers.

125
VELOCITY MEASUREMENTS IN SEWERS VITAL TO DESIGN AND MAINTENANCE,

Lamont W. Curtis
Water Sewage Works, Vol 116, No 4, pp 144-147, Apr 1969. 2 diag, 2 tab, 2 graphs, 1 ref.

Descriptors: *Flow measurement, *Sewers, *Analysis, *Methodology, *Velocity, Mannings equation.
Identifiers: *Sewer hydraulics.

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Discharges can be converted to wastewater volumes per capita in a sanitary sewer, or can be related to rainfall in a storm sewer. The velocity, depth, and slopes measured can be used to compute Manning's coeeficient of the roughness-friction factor. The salt-concentration method of measuring velocity was best suited for developing a discharge-depth relationship for a number of sewers, as well as giving an indication of the condition of the sewer. The equation applicable for the salt-concentration method is Q = AV, where: Q is the discharge; A is the area, computed from the measurement of the flow depth; and, V is the velocity measurement. The equipment needed, procedure, analyses of data, and continuous gaging methods are discussed in detail. It is concluded that there is no ratio, which when applied to surface velocity measurements, will give accurate average velocities in a pipe. Results of the studies indicate, however, that a ratio of .75 will give a good approximation for flow depths between .2 and .4 of the pipe diameter.

126
DETERMINATION OF FLOOD FLOWS AND DISCHARGE COEEFICIENTS IN MUNICIPAL SEWERAGE SYSTEMS,

T. Dimchev
Vodosnab Sanit Tekh, Vol 3, pp 115-132, 1966.
pp 115-132, 1966.

Descriptors: *Discharge coefficients, Sewers.
Identifiers: *Bulgaria.

Studies have continued on the discharge properties of sewerage systems in Bulgaria, and results are given for catchment areas in Sofia, Varna, and Burgas. From these data a new formula was developed for calculating the overall discharge coefficient for a particular area. The effect of the free volume in the sewerage system on the quality of the discharge was also considered.

127
DEVELOPMENTS IN SEWER MONITORING EQUIPMENT AND TECHNIQUES,

R. Galliers and M. V. King
J. Inst Munic Engrs, Vol 97, pp 27-31, Jan 1970.

Descriptors: *Instrumentation, *Storm runoff, Sewers.
Identifiers: Sewer hydrualics, Birmingham, Alabama.

This paper describes equipment and techniques developed over the last five years by the City of Birmingham Public Works Department concerning flow in sewers. These methods can be applied to the control of trade effluent discharge, the design of sewers and river channels, and to the

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solution of drainage problems brought on by sewer flows such as storm overflows on rivers. Automatic equipment only was used to study storm flows since waiting for storm is not feasible. Automatic depth recording of rivers will soon be undertaken to obtain unit hydrographs for intense storms. This is the best method of designing natural catchments. Included are labeled diagrams of equipment used such as the streamline pressure head and recorder for depths of flow and various sampling machines used for qualitative tests on samples taken at known times.

128

PRACTICAL METHODS FOR DETERMINING SEWAGE FLOW FOR ALL COMMUNITIES,

R. M. Girling
Water Sewage Works, Vol 116, No 7, pp 250-258, 1969.

Descriptors: *Flow, *Instrumentation, *Measurement, *Sewers.
Identifiers: *Sewer hydrualics.

This article comprises a discussion on the principles, uses, and practice of the determination of flow in sewers. Flow measurements taken by the float or tracer methods, or by using weirs or flumes are described. Calculations of pumping rates are listed along with associated experimental apparatus.

129

REAL TIME ROUTING OF HYDROGRAPHS IN STORM SEWERS,

Garth S. Harris
J Hydraulics Div , Am Soc Civil Engrs, Vol 96, No HY6, pp 1247-1260, Jun 1970.

Descriptors: *Flood routing, Storm runoff, Hydrographs.
Identifiers: *Average-lag method, Interceptor sewer.

A rapid computation of routed flood hydrographs in circular sewers was required for use in the evaluation of the effect of storm flooding in the Minneapolis-St. Pual Interceptor sewers. The method of characteristics is used to provide an accurate assessment of the routed hydrograph, but this method requires use of a large computer and a comparatively large amount of computer time. The progressive average-lag method, fully described in the article, is used to carry out the evaluation in real time (i.e., when rainfall is occurring and before the flood wave travels far down the channel). The routing constants of this method are determined by comparing the results of this method with those from the method of characteristics until good agreement is obtained. It has not been possible to determine the routing constants in the progressive average-lag method analytically.

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130
HYDRUALIC DESIGN OF LARGE SURGE TANKS FOR PUMPING PLANTS,

Ravinder K. Jain, Roy T. Nakahara, and John W. White
Tech Memo No 38, Dept Water Resour, Calif, Nov 1968.

Descriptors: *Surge tanks, *Hydraulic design, Water hammer, Pressure, Transients, Discharge lines, Energy losses, Graphical analysis, Surges, Hydraulic structures, Pumping plants, Orifices, Analysis.
Identifiers: *Pressure waves, *Water column separation.

The hydraulic design of large surge tanks is described, placing emphasis on designs used for the Tehachapi surge tank. Graphical and analytical methods for determining the size of large surge tanks for pumping plants are given. Energy loss coefficients for different orifice configurations tested are included. Surge tanks are used to control transient pressures and to prevent water column separation. Flow in discharge lines communications with the surge tank through orifices connecting discharge lines with the tank is related. Normal operation produces changes in flow rates in discharge lines, resulting in positive or negative transient pressure waves reflected at the surge tank as minor fluctuations in water surface elevation protecting discharge lines and downstream tunnels from these surges. During emergency conditions all pumps could be shut down at once by a power failure. This condition causes the pumps to halt, changing rotational direction as soon as water begins to flow back. The reverse flow continues until the downstream valves are closed. To prevent low pressures in discharge lines or water column separation under this condition, water is supplied from the surge tank.

131
THE SEWER HAD TO BE CLEANED BEFORE SNOWFALL,

Charles Knecht
Am City, Vol 84, No 10, pp 120 and 123, Oct 1969.

Descriptors: *Maintenance, *Sewers, Hydraulics.
Identifiers: *Sewer cleaning, Sewer hydraulics.

In Houghton, Michigan, a cold-climate town, water pollution and sewage problems are serious due to the sand and grit from street traction abrasives, which enter sewer interceptors during rain and spring thaw conditions. Not only do the interceptors become clogged and sewers inoperable, but public health is threatened by unclean water developing from overflow bypassing treatment. The town hired a company this year to utilize traditional cleaning techniques to unclog the sewer system. The line was only two years old and designed to self-clean, but preventive maintenance programs are necessary for all sewers in cold-climate towns like Houghton.

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132
STUDIES ON THE CHEMICAL CONTROL OF TREE ROOTS IN SEWER LINES,

O. A. Leonard and Neal Townley
Paper presented at the Calif WPCA 42nd Annual Conference, Sacramento, Calif, April 29 to May 1, 1970.

Descriptors: *Sewers, *Laboratory tests, *Root systems.
Identifiers: *Tree roots, Sewer hydraulics.

This study was a cooperative effort by the authors and Dr. Ahrens of the Connecticut Agricultural Experiment Station. The problem was studied at Davis and the Utilities Division of Sacramento by growing wood plants in pots filled with a potting mix which were placed on open cans. Roots which grew into cans were treated for periods of time by solutions of different chemicals. The most promising treatments were examined in a single test in July, 1969 in the sewer lines of Sacramento County. All treatments were effective in killing the roots in the lines but some were more effective than others in killing roots in and outside of joints. Studies are being continued to evaluate factors influencing kill, cost, and safety to trees.

133
PRACTICAL HYDRAULICS FOR PUBLIC WORKS ENGINEER,

F. E. McJunkin and P. A. Vesilind
Public Works, Vol 99, No 9, 10 and 11, pp 88-97, Sep 1968, pp 114-120, Oct 1969, pp 77-81, Nov 1968.

Descriptors: *Hydraulic engineering, Multiple-purpose projects. Flow, Flow measurement, Pumping.
Identifiers: *Sewer hydraulics.

This article is a review of methods of application of hydraulic engineering principles and procedures to meet the needs of engineers involved in hydraulic work of design and analysis of public works projects. The conveyance of water by means of flow in closed conduits, flow in open conduits, and fundamentals of flow measurement are explored. The hydraulics of pumps are investigated.

134
DEPTH OF FLOW AS DESIGN CRITERION FOR CHANNELS WITH ARTIFICIAL LINERS,

J. C. McWhorter, T. G. Carpenter, and R. N. Clark
Nat Acad Sciences—Nat Research Council—Highway Research Rec, No 261, pp 18-24, 1969.

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Descriptors: *Design criteria, *Drainage water, *Erosion control, *Channels, *Linings, Testing.

A study of water disposal systems which drain runoff is presented. Six artificial liners were investigated to develop design criteria for erodible channels. Liners installed on flat-bottom earth channels (2 ft wide, 60 ft long) and on slopes were subjected to increasing flows to channel failure. Test sections of sand to heavy clay were inserted in the channel floor, and the effectiveness of the liners was observed. Measurements consist of flow rates, channel and water surface profiles, and test section erosion.

135
INCREASING WASTE-WATER FLOW VELOCITY BY USING CHEMICAL ADDITIVES,

J. L. Overfield, H. R. Crawford, J. K. Baxter, L. J. Harrington, and I. W. Santry
J Wat Pollution Control Fed, Vol 41, No 9, pp 1570-1585, 1969.

Descriptors: *Model studies, *Flow rates, *Sewers, *Analysis, Overflow, Costs.
Identifiers: *Polymers, *Additives, Sewer hydraulics.

Pilot-scale experiments are reported on the effect of adding polymers to sewers in order to increase the rate of flow of the sewage and thus reduce surcharging and/or overflow from sewers. The tests showed that sewage flow could be increased by a factor of two or more by adding 45-200 ml of polymer per litre. The concentration required depended on the additive used, the concentration of sewage, the flow increase desired, and the temperature. Experiments showed that the additives used did not have an adverse effect on sewage bacteria or fish and did not encourage algal growths in receiving streams. They tended to improve the rates of sedimentation and sludge dewatering in the sewage works. Economic analyses showed that, for a given example, the cost of eliminating overflow from a constriction by use of additives was less than half the cost of installing an additional sewer. However, there are certain limits to the use of additives as a long-term solution to such problems.

136
INCREASING SEWAGE FLOW VELOCITY BY USING CHEMICAL ADDITIVES,

J. L. Overfield, J. K. Baxter, Dr. H. R. Crawford, and I. W. Santry
Paper presented at Water Pollution Control Fed—41st Annual Conference, Sep 22-27, 1968.

Descriptors: *Sewers, *Flow rates, *Cost analysis, *Flow characteristics,

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*Additives.
Identifiers: *Sewer hydraulics, *Chemical additives.

It is possible today to increase the flow of sewage in an existing sewer without increasing the fluid head. This increase can be made by the addition of selective chemicals. The flow in an overflowing sewer may be increased to the extent that sewage does not back up in the sewer manhole and overflow into streams and house basements. By using these chemicals, it is possible for a community to relieve sewer lines of their periodic peak loads without resorting to expensive relief sewers. Data measured during an extensive test program show that flow can be increased approximately 2.5 times original flow. Measurements were made on a test facility utilizing six-inch sewer pipe (plus auxiliary equipment required to operate the test facility). Biochemical tests were conducted on sewage, sewage bacteria, fish, and algae to determine adverse effects of chemical additives to sewerage or receiving streams. No significant adverse effects were found. A cost/effectiveness analysis showed that, for a sample case, it cost less than one half as much to use chemicals to relieve an overflowing sewer than to put in a relief line. Development of improved flow characteristics was based upon work performed by The Western Company, in improving its oil field servicing activities.

137
HYDRAULIC DESIGN OF SELF-CLEANING SEWAGE TUNNELS,

Discussion by A. S. Paintal
Am Soc Civil Engrs, Vol 95, No SA6, pp 1182-1184, Dec 1969.

Descriptors: *Hydraulic design, Sewers, Bed loads.
Identifiers: *Sewer hydraulics, *Capacity, *Sewage tunnels.

The author contends that: 1) the main concern in the design of sewage tunnels is the transportation of incoming grit and sewage material; 2) the transporting capacity of water is important because of its bearing upon the possible clogging of sewers; 3) the minimum traction assumed in the design of sewer tunnels must be adequate to keep it thoroughly flushed; and, 4) the application of existing bed load formulas to fixed bed channels is not desirable.

138
TURBULENT FRICTION IN ECCENTRIC ANNULAR CONDUITS,

James M. Robertson
ASCE Combined Sewer Separation Project, Univ of Illinois, T and AM Report No 310, Mar 1968. 13 fig, 3 tab, 48 ref. FWPCA Program No. 11020 EKO.

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Descriptors: *Flow around objects, *Head loss, *Pressure conduits, Data collections, Flow rates.
Identifiers: *Annular pipes, *Hangers, Eccentricity, Sewer-in-sewers.

Following a general review of the analytical and experimental information on the friction loss encountered by fluids flowing in annular pipes, with particular regard to the influence of eccentricity of the inner member, experiments are described on an evaluation of the friction of water in a steel annular pipe of diameter ratios 5.8 and 3.2 in the Reynolds number range of ten to the fifth power to ten to the sixth power. It is found that on a discharge basis, for the same head loss in a given length, with the diameter ratio of 5.8 the flow capacity of the pipe line is decreased 12.7% in the concentric situation but only 4.5% with full eccentricity. The latter decrease is not greatly different from the 3% reduction in area due to the inserted smaller pipe. An analysis is included showing that for the simple insert at full eccentricity the near-full-flow capacity of a sewer is little affected. The effects of hangers such as might be employed to support inserts in sewers is found to have an appreciable effect on the flow capacity of a full-flowing sewer.

139
INFILTRATION IN SEWERS,

W. J. Robertson and A. W. Bird
Australian Civil Eng, Vol 10, No 4, pp 44-47, Apr 1969.

Descriptors: *Investigations, *Infiltration, Sewers.
Identifiers: *Australia.

Extensive investigations carried out by the Melbourne and the Metropolitan Board of Works, where the problem of entry of extraneous water into the sewerage system was studied, is discussed. Factors affecting wet weather infiltration are enumerated.

140
EXPERIMENTAL ESTIMATION OF DETENTION IN STORM SEWER SYSTEM,

T. Sueishi and A. Katsuya
Trans Japan Soc Civ Engrs, Vol 151, pp 47-57, Mar 1968.

Descriptors: *Storm runoff, *Investigations, *Flow characteristics, Rational formula, Floods.
Identifiers: *Storm sewers, *Capacity, Sewer hydraulics.

Results of an experimental study on storm runoff in an urban area showed that the phenomena called as flow detention, retardation, storage and flooding were hydraulically identical phenomena. These experiments were made for sewer slopes of 1/200 and 1/1000. The control structures had

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negative effects on the capacity of dynamic storage except when flooding in the lower area was concerned or when the drainage pump capacity was designed to be depressed. Flooding does not always occur by increasing the return period, because the maximum rate of runoff becomes a steady state when calculated by the rational method.

141
PEAK FLOWS OF SEWAGE FROM INDIVIDUAL HOUSES,

Donald H. Waller
ASCE Combined Sewer Separation Project, Technical Memorandum No 9, Jan 1, 1968. 117 p, 45 fig, 23 tab, 15 ref. FWPCA Program No 11020 EKO.

Descriptors: *Peak discharge, *Water demand (household), Data collections, Plumbing.
Identifiers: *Sewage flow (household), Louisville, Kentucky, Sampling stations, Capacity.

Sewage flows and water demands measured at two household observation stations, as well as water and wastewater flows from individual fixtures and appliances are used to estimate upper limits of pump and storage capacities for a storage-grinder-pump unit for individual homes and to examine the relationship between peak rates of sewage flow and corresponding water demand rates. For individual fixtures, combination of rate, duration, and frequency of discharge that will produce maximum hydraulic loading conditions are selected. Single-fixture hydrographs are combined to produce synthetic hydrographs of peak period sewage discharge, from which combinations of storage and pump capacities are derived. Peak sewage flows and simultaneous water demands for a fourteen day period at one house are presented and analysed.

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4a. Combined

142
SEPARATE AND COMBINED SEWERS,

Water Wastes Eng, Vol 5, No 12, p22, Dec. 1968.

Descriptors: *Sewerage, Structural design, Systems analysis, Separation techniques.
Identifiers: *Combined sewers, Sewer hydraulics.

This round table discussion describes the general picture of the storm and sanitary sewerage systems, including the ranges and sizes of each of the types of sewers, of the cities the participants represent. Each participant also relates his city's problems in regard to the effect of combined sewers on treatment plants and under conditions of storm flow. Three of the cities have implemented separate sewers, while three others have not undergone separation because of its high cost. Our city has proposed a less costly plan of eliminating ground water seepage into sewers, and the last city (the only one located in Canada) has not yet estimated the cost of separation.

143
SEPARATE AND COMBINED SEWERS

Water Wastes Eng, Vol 5, No 7, p 26, Jul 1968.

Descriptors: *Sewers, *Methodology, *Separation techniques, Surveys, Comparative costs.
Identifiers: *Combined sewers, Sewer-in-sewers.

Replies by six spokesmen from various regions of the United States are given in relation to the following areas of questioning: 1) mile of sewers in the areas investigated; 2) ranges of sizes of each of the sewer types; 3) population serviced by the system; 4) effect of combined sewers on treatment plant operations; 5) surcharging; and, 6) plans on sewer separation and costs.

144
REPORT ON PRESSURE SEWERAGE SYSTEM, SUMMER STREET SEPARATION STUDY AREA, BOSTON, MASSACHUSETTS,
Am Soc Civil Engrs, New York; and Camp, Dresser and McKee, Boston, Mass. Combined Sewer Separation Project, Report, Sept 1968, FWPCA Program No 11020 EKO.

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Descriptors: *Cost analysis, *Design, Pressure conduits.
Identifiers: *Building plumbing separation, *Sewer separation, Boston, Massachusetts, Gravity sewer, Sewage flow variations.

The report studies the design, estimated costs, and evaluates the feasibility of the hypothetical application of the ASCE Project Scheme of pressure sewers for separation in representative combined sewer areas from layouts by the Project staff. The Boston study researched the 53-acre gently sloping, heterogeneous commercial Summer Street Separation Study Area. The report describes the separation of building plumbing in detail in a typical three-quarter century old five story and basement commercial building 65-ft. by 145-ft. in plan, and estimates the cost of plumbing separation. Four alternative pressure sewer collection systems are indicated with plans and hydraulic profiles. Some systems included in-line main pumping stations. The least expensive complete pressure system, which did not include a main pumping station, is estimated to cost $4,700,000. Both costs include costs of building plumbing separation, $4,000,000 for the pressure system including communitors, wet walls and non-clog pumps, and 2,000,000 for the gravity systems.

145
COMBINED SEWER SEPARATION PROJECT, REPORT ON MILWAUKEE STUDY AREA, Am Soc Civil Engrs, New York; Greeley and Hansen, Chicago, Ill.

ASCE Combined Sewer Separation Project Report, Dec 1968, FWPCA Program No 11010 EKO.

Descriptors: *Annual costs, *Cost analysis, Design, Pressure conduits.
Identifiers: Building plumbing separation, *Sewer separation, Gravity sewer, Milwaukee, Wisconsin, Sewage flow variations, Storage-grinder pump.

The report covers the design, estimate costs and evaluate the feasibility of the hypothetical application of the ASCE Project scheme of pressure sewers for separation in representative combined sewer areas from layouts by the Project staff. The Milwaukee study researched the 157-acre mainly dense residential, moderately sloping Prospect Avenue Study Area. The report describes methods of building plumbing separation and indicates two alternative arrangements of pressure sewers with plans and a profile. Estimates of construction cost of each are compared with that of a conventional gravity system of separation designed by the consultant. Plumbing separation, is estimated to cost $912,000 for the gravity alternative and $971,000 for the pressure alternatives, not including storage-grinder-pump units.

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146
COMBINED SEWER SEPARATION USING PRESSURE SEWERS,
Am Soc Civil Eng

Prepared for FWPCA, Program No 11020 EKO, Contract No 14-12-29, Oct 1969. 198 p.

Descriptors: *Separation techniques, *Sewers, *Pressure conduits, *Design, *Systems analysis, Storm runoff, Snowmelt.
Identifiers: *Combined sewers, *Interceptor sewer, *Sewer-in-sewers, *Sewer hydraulics.

The feasibility, selection of systems components, and the development of a new method for separating community wastewaters and runoff from rainfall and snowmelt in areas served by combined and intercepting sewers are reported on the basis of information drawn from 25 projects' reports and technical memoranda whose abstracts are appended in this final compilation. The general concept involves pumping ground waste-water from buildings through pressure tubing connected to street pressure conduits discharging in turn into interceptors. The tubing and conduits would be contained within existing combined sewers, thus allowing runoff from rainfall and snowmelt to be removed from the community unencumbered by wastewaters. Pressure conduits suspended inside combined sewers can be entered by workmen, but generally this system will cost more than new gravity systems.

147
SEPARATION OF COMBINED WASTEWATER AND STORM DRAINAGE SYSTEMS, SAN FRANCISCO STUDY AREA,
Brown and Caldwell,

ASCE Combined Sewer Separation Project Report, FWPCA Program No 11020 EKO.

Descriptors: *Cost analysis, *Design, Pressure conduits.
Identifiers: *Building plumbing separation, *Sewer separation, Gravity sewer, Plumbing code, San Francisco, Calif., Storage-grinder pump.

The report studies the design, estimated costs, and evaluates the feasibility of the hypothetical application of the ASCE Project Scheme of pressure sewers for separation in representative combined sewer areas from layouts by the Project staff. The San Francisco study researched the 323 acre predominantly residential, steeply sloping, Launa Street Sewer Service District. The report describes methods of building plumbing separation and indicates two alternative arrangements of pressure sewers, with plans and profiles. Estimates of construction cost of each are compared with that of a conventional gravity system of separation designed earlier by the City. Plumbing separation, is estimated to cost about $5,400,000 for the gravity method and about $4,400,000 for the pressure method not including storage-grinder-pump units.

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148
FINAL REPORT TO THE AMERICAN SOCIETY OF CIVIL ENGINEERS ON TASK 7 AND TASK 9 OF THE COMBINED SEWER SEPARATION PROJECT,

Robert N. Bowen and John G. Havens
National Sanitation Foundation, ASCE Combined Sewer Separation Project, Dec 1967. 55 p, 18 fig, 4 tab, 14 ref. FWPCA Program No 11020 EKO.

Descriptors: *Construction materials, *Materials testing, *On-site tests, *Pressure conduits, *Specifications, Installation.
Identifiers: *Fittings, *Plowing method, *Sewer-in-sewers.

Assistance was provided in connection with special field trial installations of flexible tubing inserted in building sewers. Materials were proposed for pushing or pulling through a building sewer and a methodology and necessary attachments and tools were recommended. Polyethylene and polybuthylene tubing are recommended for use inside building sewers, and copper tubing for use in open trenches. A saddle type of connection is recommended for connecting pressure tubing to street pressure conduits. Cast iron, PVC, asbestos cement, or ductile iron are recommended for pressure conduits. Experience with the plowing of a pressure pipe is reviewed. Reference is made to the standard practice for trench installations, street crossings, and thrust blocking. Two methods of cleaning hose pressure tubing are proposed. Six possible layouts of pressure conduits are discussed in terms of operation and maintenance. All six arrangements provide for routine rerouting of flow by exploiting a dual conduit configuration.

149
WATER-POLLUTION ABATEMENT,

F.C. DiLuzio
Am City, Vol 82, No 12, p 21 and 29, Dec 1967.

Descriptors: *Sewers, Pollution abatement.
Identifiers: Holding tanks, Treatment processes, Combined sewers.

The FWPCA is searching for more effective and less expensive means than physical sewer separation to solve combined-sewer problems. A combination of holding tanks and treatment processes is one method being tested; other alternatives are being examined.

150
COMBINED SYSTEM--SEPARATE SYSTEM,

W.V.D. Emde
Oesterr Wasserwirtsch (OSWAAI), Vol 19, No 7/8, pp 125-130, 1967.

Descriptors: *Investigations, *Sewers, *Sewerage, *Hydrograph analysis, Design.

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Identifiers: *Combined sewers, *Separate system.

In a paper presented at a seminar on canalization held at Raach, Austria, in 1967, the author gave details of investigations into the efficiency of sewerage systems, and outlined the advantages and disadvantages of separate systems as compared with combined systems. Describing the design and construction of each system he emphasized that neither could be regarded as the more efficient, and stressed the need for graphical and hydrographical surveys when sewerage systems are planned and that the final decision must depend on the purposes which the sewerage system is to serve. For small communities, housing estates, and small hotels the combined system can be of advantage, provided the discharge of rainfall and runoff is controlled and the quality of the receiving waters is not affected. Where future plans require extensions of sewerage systems, the separate system is more suitable, as long as operational control and plant maintenance are carried out regularly.

151
STUDY OF APPROXIMATE LENGTHS AND SIZES OF COMBINED SEWERS IN MAJOR METROPOLITAN CENTERS,

Dasel E. Hallmark and John G. Hendrickson
ASCE Combined Sewer Separation Project, Technical Memorandum No 4, May 1, 1967. 9 p, 2 tab, FWPCA Program No 11020 EKO.

Descriptors: *Sewers.
Identifiers: *Combined sewers, *Sewer sizes, *Combined sewer lengths, Walk-through sewers.

A tabulation is given for give major cities of mileage and percentage of combined sewers with heights: greater than 48 inches; equal to or less than 48 inches; and equal to or less than 24 inches. An average of 72 percent of the sewers are smaller than 24 inches. Heights of 54 inches and larger, classified as walk-through sewers, account for an average of about 15 percent of the total combined sewer mileage.

152
STORM-WATER TANKS IN COMBINED SEWERAGE SYSTEMS,

D. Londong
Ber Abwassertech Ver (BABVAD), Vol 19, pp 195-210, 1968.

Descriptors: *Design, *Application methods, *Flow control.
Identifiers: *Storm tank, Combined sewers.

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The author discusses the important role of stormwater tanks used to prevent and retard the discharge of sudden and heavy rainfalls from combined sewerage system to reveiving waters, and he gives details of design calculations for these tanks and their application.

153
STORM-WATER TANKS IN COMBINED SEWERAGE SYSTEMS,

D. Londong
Staedtehyg (STDHAT), Vol 17, No 9, pp 199-206, 1966.

Descriptors: *Flow control, *Analysis, *Pollution abatement, *Rainfall disposition, Flow rates.
Identifiers: *Storm tank, Germany

Rainwater, discharged from combined or separate systems, can have severe polluting effects on receiving waters especially in industrial areas. Discussing the methods used for reducing such pollution, the author refers to German specifications for three standard types of stormwater retarding tanks, designed to prevent the direct discharge of the first flush of rainfall and to restrict the flow from being carried forward to receiving waters or sewage works. Various methods of calculations for stormwater retarding tanks in sewerage systems are reviewed and compared as to their accuracy. Illustrated details are given of a revised method in which different rates of flow at varying durations of rainfall can be calculated using different parameters.

154
MALLING RDC REGIONAL DRAINAGE SCHEME,

D. Love
Surveyor, Vol 82, No 3971, pp 29-33, Jul 12, 1968. 5 fig, 1 tab.

Descriptors: *Sewage treatment, *Sewers, *Treatment facilities, *Sewage disposal, *Design, *Construction.
Identifiers: *Combined sewers, *Great Britain, Trunk sewer.

Owing to restrictions on the choice of available sites, unusual design and construction techniques were required to build a sewage treatment works which forms part of the £ 3 million Snodland-Ightham regional drainage scheme in a rural district of Kent. The Snodland area was mostly sewered on a partially combined system to a totally inadequate sewage disposal works, and the Ditton area's disposal works was heavily overloaded. The basis of the new sewerage system is a trunk sewer laid from a new sewage disposal works. Into this main trunk system flow from area villages will be brought by either pumping or gravity. Solutions to each town's problems will be implemented through the use of inter-

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cepting sewers, pumping stations, pumping mains, etc. Aspects concerning site selection for the new sewage works are discussed, and then the design of the works is detailed. Construction problems and solutions to these problems are explained in regard to both the regional sewerage scheme and the sewage disposal works.

155
WASTEWATER SYSTEM FOR THE METROPOLITAN CORPORATION OF GREATER WINNIPEG,

A. Penman
J. Water Pollution Control Fed, Vol 39, No 3, pp 373-383, Mar 1967.

Descriptors: *River regulation, *Sewerage, Future planning (projected), Recreation, Urbanization.
Identifiers: *Separate system, *Investigations.

The Metropolitan Corporation recognized its duties in restoring the rivers to the requirements of the urban area so that the citizens could use these rivers for recreational purposes. This necessitated the expansion of the existing facilities and the addition of new facilities. Sewer rentals and industrial wastes were two major areas investigated. A separate sewer system was looked into by both city and consulting engineers. It was decided that the $200 million plus cost of intercepting the old combined system was not feasible; however, future development of areas along the Red and Assiniboine Rivers will be based on separate sewer systems.

156
STORM AND COMBINED SEWER DEMONSTRATION PROJECTS, JANUARY 1970,

William A. Rosenkranz
Federal Water Pollution Control Administration Research Series Report DAST-36, Jan 1970. 121 p, 3 fig, 1 tab, 24 ref.

Descriptors: *Urbanization, *Storm drains, Sewage treatment, Overflow, Sewage disposal, Cities, Research and development, Grants, Federal Government, Water pollution control.
Identifiers: *Combined sewers.

Studies sponsored by FWPCA of combined storm and sanitary sewers, and treatment of combined wastes are listed. Abstracts of completed reports are presented, and active projects are described in information sheets. Subjects needing more research are also listed and described. Equipment, data methods, and criteria for urban drainage projects are outlined.

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157
ASSESSMENT OF COMBINED SEWER PROBLEMS,

Richard H. Sullivan
In: Combined Sewer Overflow Abatement Technology. Water Pollution Control Research Series, Report 11024--06/70, pp 107-121, Jun 1970. 8 fig.

Descriptors: *Storm runoff, *Overflow, *Storm drains, *Surveys.
Identifiers: *Combined sewers.

This article is a final report on an inventory of combined sewer facilities in the United States. 641 jurisdictions, or 46% of the communities with 94% of the population and 84% of the area served by combined sewers, were interviewed directly. The results of the survey indicated that 36,236,000 people, living on 3,029,000 acres were served by combined sewers. This total indicates that approximately 29% of the nations total sewered population is served by combined sewers. The types of problems incurred, regulator devices, and infiltration control are discussed.

158
PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS,

R. H. Sullivan
J Water Pollution Control Fed, Vol 41, No 1, pp 113-121, Jan 1969.

Descriptors: *Surveys, *Effects.
Identifiers: *Combined sewers.

The author summarizes and discusses some of the principal points found during a survey, carried out by the Federal Water Pollution Control Administration, on the problems caused by combined sewers.

159
OPERATION OF SEWERAGE WORKS FOR BUDAPEST,

M. Szilagyi
Paper presented at a conference on the Construction of Complex Supply Installations at Budapest, 1968, Theme No 4.4.

Descriptors: *Sewerage, *Sewers, *Surveys.
Identifiers: *Hungary.

The built-up area of Budapest covers 23,700 ha, of which 9400 ha are connected to the sewerage system. In 1966 the length of the sewer network has about 2000 km. There were 32 sewage works and pumping stations, and the quantity of sewage and rainwater discharge amounted to over 300 million m^3. The annual volume of sludge removed from the sewer amounted to 60,000 m^3.

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160
PRESSURE TUBING FIELD INVESTIGATION,

L. Scott Tucker
ASCE Combined Sewer Separation Project, Technical Memorandum No 5, Aug 15, 1967. 29 p, 19 fig, 2 tab, 1 ref. FWPCA Program No 11020 EKO.

Descriptors: *On-site tests, Conduits, Cost analysis, Trenches, Pressure conduits.
Identifiers: *Sewer-in-sewers, Copper tubing, Plastic tubing, Washington, D.C.

Three methods of installing pressure tubing from houses or small buildings, and of connecting the tubing with street pressure conduits, are described and discussed. One would be the installation and connection of pressure tubing and conduit in trenches by traditional water distribution methods. Field trials were conducted to indicate the feasibility of inserting tubing in building sewers. Tubing was pushed through an 86-foot long 4- 5-inch diameter building lateral, which included three 45 degree bends, from a specially dug pit at the upstream end into a 4-foot diameter combined sewer. The forward end of the tubing was guided by a special leader device. Three fourths-, 1-, and 1 1/2-inch polyethylene tubing could be pushed. Polybutylene and copper tubes could not be pushed because they buckled or crimped. A Kellums grip and swivel on the end of a rope were used to pull tubing from the combined sewer to the upstream pit. Three fourths-, 1-, and 1 ¼-inch polyethylene and 3/4- and 1-inch polybutylene could be pulled. Three fourths-inch copper tubing could not be pulled because of its stiffness. The third method, tested in the field, combined the insertion of tubing with a street main in the trench. Cost estimates were made for the latter two methods.

161
COMBINED SEWERS MAY BE AN ADVANTAGE,

Frank I. Vilen
Am City, Vol 85, No 1, pp 68-70, Jan 1970.

Descriptors: *Sewers, *Design, Storm runoff, Biological treatment, Separation techniques.
Identifiers: *Kenosha, Wisconsin, *Combined sewers, Sludge treatment plants.

An alternative to separation, which utilizes combined sewers in conjunction with activated sludge treatment plants, is being put into operation in Kenosha, Wisconsin through a FWPCA grant. The plant employs the biological-adsorption process and can treat up to 20 mgd of combined sewage. Details of how the system works are included as well as a flow sheet dia-

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gram of the plant. The plant will save the city at least $6 million over sewer separation and during dry weather portions of the system can supplement normal plant operations. The plant will treat flow from only 70-80% of the storms, but because of the "first flush" action of storm runoff, the greatest bulk of BOD and suspended solids will be captured. Parameters to be measured and evaluated to determine the efficiency of the system are listed.

162
COMBINED SEWERS IN CANADA,

D. H. Waller
Eng J, Vol 52, No 6, pp 22-30, Jun 1969.
Paper presented at the Annual General Meeting of the Engineering Institute of Canada, May 29-31, 1968.

Descriptors: *Sewers, *Surveys, Overflow, Separation techniques.
Identifiers: *Combined sewers, *Canada.

The author presents a survey of combined sewers in Canada similar to the one he undertook in 1967 on the same subject in the United States. Even when combined sewers are large enough to carry peak storm flows in addition to domestic sewage, they do not provide the higher velocities in dry weather that are needed to prevent solid deposition. Thus, up to 1/3 the annual production of solids and BOD may be overflowed during storms and held back from treatment. Problems such as these necessitated this study which provides information in four main areas: 1) the extent and distribution of Canada's combined sewers; 2) the prevailing attitudes and policies in regard to combined sewers; 3) factors influencing these attitudes and policies; and 4) descriptions of methods proposed and adopted to diminish overflows from combined sewers. A majority of the population surveyed considered combined sewer overflows to be a nuisance. Separation is too expensive to warrant institution in most communities. Some combined systems have not yet developed to the point where they include overflow, and in some areas the pollution from this source is not considered to be a problem. More information is needed regarding less-costly alternatives to separation. Separation should be implemented without delay for flood relief, when combined sewers are replaced and in new construction, or in plumbing for new buildings. These programs are not overly expensive, and they leave open the option of instituting alternatives which future technology may uncover.

163
AVONMOUTH INDUSTRIAL ESTATE—UNUSUAL DRAINAGE SCHEME,

K. J. West
J Inst Munic Engrs, Vol 95, No 12, pp 363-367, Dec 1968.

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Descriptors: *Drainage systems, *City planning, Urbanization, Sewerage, Separation techniques.
Identifiers: *Great Britain, *Combined sewers.

Systems of drainage considered for the City of Bristol, England include: a separate system with stormwater draining to rhines; a separate system with stormwater draining through pipes to existing outfall culverts; and, combined systems. The combined sewerage system was adopted for a major part of the estate.

4b. Sanitary

164
STOKE SEWER RENEWED AFTER CRUDE SEWAGE OVERFLOW,
Surveyor, Vol 85, No 4049, pp 38-39, Jan 16, 1970. 1 fig.
Descriptors: *Sewerage, *Sewers, *Treatment facilities, *Control structures, Control systems, Contracts, Construction.
Identifiers: *Great Britain.

A sewerage reconstruction program in the Burslem area of Stoke-on-Trent involves a four-stage renewal of the sewer system and reconstruction of the water pollution control works. Old sewers were in poor structural and hydraulic condition, and several sections of the main outfall sewer upstream of the treatment works collapsed causing crude sewage to overflow and form a large lake of sewage. Two contracts provided a sanitary sewer from the works plus a surface water culvert connecting with a feeder to the River Trent. A third contract provided a separate storm and sanitary system connecting the old sewer network with the sewer and culvert constructed previously. Other structures built under the contract are described.

165
OUTLINE DESCRIPTION OF ASCE PROJECT ON 'SEPARATION OF SANITARY SEWAGE FROM COMBINED SYSTEMS OF SEWERAGE',
Am Soc Civil Engrs, New York.

ASCE Combined Sewer Separation Project, Technical Memorandum No 1, Feb 21, 1966, FWPCA Program No 11020 EKO.

Descriptors: *Pressure conduits, Separation techniques.
Identifiers: *Combined sewers, *Sanitary sewage, Comminuted sewage.

Descriptions of the project separation scheme, project goal and project background are given. The general concept of the ASCE Project scheme is to pump comminuted sanitary sewage from individual buildings and building complexes through relatively small pressure tubing laid in existing building connections and thence into new pressure conduits suspended in existing street sewers. Potential advantages of the scheme are discussed. The project wishes to develop feasible designs and operations and to

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test them in actual systems. The immediate objective is to examine and evaluate both the feasibility and probable cost. The background of the project is reviewed. An appendix summarizes the need for separation of combined sewerage systems and the national scope of the problem.

166
MASSIVE SEWER INFILTRATION,

Thomas E. Llewellyn
Am City, Vol 83, No 10, pp 90-91, Oct 1968.

Descriptors: *Maintenance, *Repairing, Infiltration.

The North Tahoe Public Utility District instituted a massive sewer repair program after it discovered that sewage flows were highly excessive. Snow Creek and Lake Tahoe were becoming polluted, 200 manholes were leaking and permitting entrance of surface and ground water, and many lateral sewers were causing infiltration. Smoke bombs employed to pinpoint offenders disclosed storm inlets connected to sanitary sewers. Methods used to correct violations and sewer defects are described.

167
DOMESTIC SEWAGE FLOW CRITERIA FOR EVALUATION OF PROJECT SCHEME TO ACTUAL COMBINED SEWER DRAINAGE AREAS,

Murray B. McPherson
Combined Sewer Separation Project, Technical Memorandum No 8, Nov 17, 1967. 19 p, 2 fig, 3 tab, 9 ref. FWPCA Program No 11020 EKO.

Descriptors: *Design criteria, *Water demand (household), Data collections.
Identifiers: *Domestic water use, *Peak demands, Demand variations, Sewage flow.

Residential sewage flow criteria are developed for use in design of pressurized sanitary sewers for hypothetical applications of the ASCE Project scheme. In a typical combined sewer area, data on domestic water demands is the most that can be expected to be available. On the basis of a study of winter water demand data it is concluded that projection of such observed demands for a service area to the end of the design period is the preferred basis of design. Data for California and the northeastern United States are presented separately. For each region, design curves represent the variation, as a function of the number of dwelling units served, of flow for the minimum 24 hours, for the peak hour of the minimum day, and for the maximum peak hour of any day, expressed as ratios to the annual average rate.

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168
MINIMUM TRANSPORT VELOCITY FOR PRESSURIZED SANITARY SEWERS,

Murray B. McPherson, L. Scott Tucker, and M. Floyd Hobbs
Combined Sewer Separation Project, Technical Memorandum No 7, Nov 16, 1967. 23 p, 4 fig, 2 tab, 8 ref. FWPCA Program No 11020 EKO.

Descriptors: *Deposition (sewage sediments), *Pressure conduits, *Scour, Data collections, Design criteria, Regression analysis, On-site tests.
Identifiers: *Sand concentration, *Sewage analysis, *Transport velocity, Comminution, Grinding, Sanitary sewage.

Raw sewage, with and without particle-size reduction by comminution, was pumped through 2-in. to 8-in. clear plastic pipe. Extensive observation indicated rather conclusively that the material last to be scoured and first to be deposited was predominantly sand. For all tests, the sewage was salted with ground egg shells but these were always moved at lower mean flow velocities than the sand, which was in low concentrations, viz., 8 to 78 ppm. No discernable difference was noted in the minimum transport velocities for comminuted and uncomminuted sewage, and the difference between minimum scouring velocities and maximum depositing velocities was small. Test results were blended with those from sand transport experiments elsewhere for general representation. Exploratory open channel tests were made with the 8-in. pipe for a firmer correlation with sand tests. Results are presented in terms of dimensionless parameters. Limited tests were made on 8-in. spiral corrugated pipe.

4c. Storm

169
RACE TO PLUG BURST MAIN BEFORE RAINS CAME,
Eng Contract Record, Vol 82, No 12, pp 44-45, Dec 1969.

Descriptors: *Damages, *Remedies, *Repairing, Estimated costs.
Identifiers: *Storm sewers.

The article describes how a municipal storm sewer section, solidly plugged with a mixture of mud and water, ruptured and was repaired. Three steps were taken to correct the damage: 1) temporary lines were laid along the surface and the mains were pumped through these surface lines; 2) drop manholes were constructed at two sides of the threatened area; and, 3) three pumps were used to by-pass the plugged section of the line. The emergency measures for the public are related, and the theoretical causes for the break are included. The cost of repair for this unexplained occurrence is given.

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170
DROP INLET REPAIRS STORM DAMAGE TO SEWER SYSTEM,

Eng Contract Record, Vol 82, No 2, p 26, Feb 1969.

Descriptors: *Damages, *Repairing, *Intakes, *Construction materials, *Sewers, *Construction equipment.
Identifiers: *Storm sewers, *Medary, Wisconsin.

In Medary, Wisconsin, a storm sewer, washed out by heavy rainfall, was repaired in twelve days. The Wisconsin Culvert Co. recommended that the now exposed area, which had previously held a 750 foot-long piece of a 72 inch diameter storm sewer pipe, be contained by fabricating a 96 inch diameter drop inlet constructed of 8-gage corrugated galvinized steel, closely riveted and caulked. The drop inlet would connect to the existing 72 inch line by means of a watertight 84 inch diameter, 8-gage galvinized steel pipe, close riveted and caulked, outlet connected at the base of the drop inlet would run 400 feet along the gouged ditch line. The method was approved and immediate fabrication of sections of the drop inlet began followed by trucking of these sections to the site and their installation.

171
WISCONSIN SANITARY SEWER WON BY 2.3%,

Eng News-Record, Vol 182, No 14, p 43, Apr 3, 1969. 1 tab.

Descriptors: *Costs, *Bids, Construction materials, Drainage systems.
Identifiers: *Storm sewers, West Allis, Wisconsin.

Unit prices and quantities of materials proposed for a 3-branch storm sewer contract in West Allis, Wisconsin are tabulated and discussed for the two lowest bidders for each branch. Branch A includes three reinforced concrete storm tunnels and a corrugated metal culvert arch. Branch B and C will relieve severe flooding conditions in this area of Wisconsin.

172
CHICAGO SEWER DRAIN PROJECT,

Eng News-Record, Vol 182, No 10, p 41, Mar 6, 1969. 1 tab.

Descriptors: *Contracts, Drainage systems, Flood control, Concrete construction, Cost comparisons.
Identifiers: *Chicago, *Sewer relieving.

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Detailed statistics are given concerning bids for a contract to construct sewer drains extending the sewer system in a section of Chicago. Consolidated Construction Co., Inc. won this contract, and it will undertake the project to provide flood relief from a storm of five frequency or less. Inadequate smaller sewers will be replaced, and a number of trunk sewers and siphons will be relieved. The project will be constructed in open cut, and reinforced concrete will be the principal material used. Prices from the two lowest bidders are tabulated for each of the items to be included in the project.

173
MICHIGAN SEWER AND ROAD JOB,

Eng News-Record, Vol 182, No 9, p 43, Feb 27, 1969. 1 tab.

Descriptors: *Bids, Construction materials, Concrete pipes, Backfill.
Identifiers: *Port Huron, Michigan, *Storm sewers.

Unit prices and quantities of materials proposed for a Port Huron, Michigan paving, storm sewer, and water main contract are tabulated and described for the two lowest bidders. Reinforced concrete will be used for storm sewer piping. The contractor will excavate and backfill over existing sewers because of the formerly poor backfill.

174
STORM SEWER CHANNEL IN NEBRASKA,

Eng News-Record, Vol 181, No 2, p 69, Jul 11, 1968. 1 tab.

Descriptors: *Construction costs, *Bids, Concrete pipes.
Identifiers: *Omaha, Nebraska, *Storm sewers.

Bids for constructing a channel section of a storm sewer in Omaha are compared, and prices for quantities of materials are tabulated for the two lowest bidders. A long riprapped, flat-bottom ditch will be filled with reinforced concrete piping. The proposed length of the channel was shortened due to difficulties in obtaining easements. The project will improve alignment and flow capacity to prevent property damage by erosion.

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175
ADDITIONAL INFORMATION-FAILURE OF STORM SEWER SYSTEM,

Water Sewage Works, Vol 117, No 6, p 191, Jun 1970.

Descriptors: *Sewers, *Decision making, Overflow.
Identifiers: *Storm sewers, *Medary, Wisconsin.

A description of the storm sewer system situation in Medary, Wisconsin prior to the overflow in June 1968 is given. The article states that the failure of the sewer line in Medary was not due to the design of the storm sewer system, the installation of the pipe, or the type of pipe used. Two reasons are given as to the cause of the overflow: modifications to the storm sewer without informing the consultant engineer; and, lack of knowledge or consideration of hydraulic principles.

176
RX FOR . . .,

Water Sewage Works, Vol 116, No 12, pp 464-465, Dec 1969.

Descriptors: *Construction materials, *Sewers, Storm runoff, Steel.
Identifiers: *Storm sewers, *Medary, Wisconsin.

Failure of a concrete storm sewer system in Medary, Wisconsin during a heavy rainfall resulted in property damage and threatened disaster for two major arterial highways. With weather forecasts predicting more storms, officials ordered the construction and installation of a large corrugated, galvanized steel storm sewer. Dimensions and details are given of the system which was installed and operating in 12 days--an unlikely feat to perform using other conduit materials.

177
SUBURB MEETS URBANIZATION HEAD-ON,

Water Wastes Eng, Vol 4, No 11, pp 47-49, Nov 1967.

Descriptors: *Sewerage, *Design, Costs, Michigan.
Identifiers: *Storm sewers, Expenditures.

The city of East Lansing, Meridian Township Board, and Michigan State University jointly agreed to provide a municipal sewer system for the fast-growing college and recreational area in Ingham County, Michigan. The original septic tanks were connected to storm sewer systems which led to a newly constructed sewage treatment plant. Financial problems and an itemized list of expenses are discussed.

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178
SEWERAGE,
British Standards Inst, The Council for Codes of Practice

British Standard Code of Practice CP2005, 1968.

Descriptors: *Design, *Construction, *Sewers, Legislation.
Identifiers: Storm overflows, Tidal outlets, Trade effluents, Great Britain.

The Civil Engineering Code of Practice (No. 5, 1950), entitled DRAINAGE has been completely revised to incorporate new methods for the design and construction of sewers and auxiliary works. Recommendations are made regarding materials and components, basic data requirements, general design and construction of sewers, discharge of trade effluents, manholes, storm overflows, siphons, pumping stations and mains, and tidal outfalls. The relevant legislation is indicated, and methods for calculating rates of runoff are appended.

179
MODEL STUDIES OF STORM SEWER DROP SHAFTS,

Sigurd H. Anderson
St. Anthony Falls Hydraulic Laboratory, Minneapolis, Technical Paper No 35, Series B, pp 1-61, Dec 1961.

Descriptors: *Hydraulic structures, *Laboratories, *Model studies.
Identifiers: *Drop shafts, *Storm sewers.

The Department of Public Works of the City of St. Paul, Minnesota, presently engaged in a program of enlarging their storm sewer system, is developing a drop-shaft design which will reduce the possibility of impact damage to the structure and also insure stable flow conditions in the underground interceptors. It was found that past designs required frequent inspection and maintenance at the base of the shaft to prevent failure of the structure. An experimental study led to the development of an impact-cup type of drop structure which could be effectively used to convey storm runoff waters from the surface to subterranean collecting systems with a minimum of air entrainment and a reduction in possible damage at the base of the drop. Pictures and measured sketches of the designs are included.

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180
STORM DRAINAGE PRACTICES OF THIRTY-TWO CITIES,

Colby V. Ardis, Kenneth J. Dueker, and Arno T. Lenz.
J Hydraul Div, Am Soc Civil Engr, Vol 95, No HY1, pp 383-408, Jan 1969. 26 p, 13 fig, 12 tab, 12 ref, append.

Descriptors: *Drainage, *Storm drains, *Drainage water, *Waste water disposal, *Waste water treatment, Wisconsin, Urbanization, Runoff, Storm runoff, Cost analysis, Drainage systems, Water pollution control, Design, Rational formula.
Identifiers: Urban hydrology, Municipal engineering, Storm sewers.

Wisconsin cities with populations of 7,500 to over 60,000 are developing comprehensive plans with all storm sewer designs done by registered professional engineers. Storms with 5 to 10 yr frequency are used in design. Two-foot inlest depressed one in., 12-in. minimum pipe size, and pipe velocities of 2 to 15 fps are common. Urban drainage designers who provided current practice, policy, procedure and cost information for a typical 15-acre, 6-block area indicated wide diversity in results when using the Rational Method to compute flows. Only 6 of 23 cities which contributed sample designs used variable intensities correctly in the Rational Method. Errors in the use of the runoff coefficient C were common. Total project costs varied from $8,000 to $65,000 for this sample area. The need for narrower guide lines for design is suggested.

181
PLANNING STANDARDS FOR STORM DRAINAGE,

Myron D. Calkins
Urban Planning Devel Div, Am Soc Civil Engrs, Vol 96, No UP1, pp 53-58, Mar 1970.

Descriptors: *Storm runoff, *Storm drains, Design, Standards.
Identifiers: *Storm sewers, Design criteria.

The construction of facilities for the control and containment of storm water runoff is advocated. Some historical background concerning the organization of interested engineers is given. Two publications were issued in 1966 containing: 1) the standard design criteria for storm sewers and appurtenances; and, 2) storm sewer construction specifications. The former document proved to be more valuable and is outlined.

182
UNDERWATER INSPECTION--SEEING IS REVEALING,

Tom Davey
Water Pollution Control, Vol 107, No 11, pp 16-17 and 31, Nov 1969.

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Descriptors: *Outlets, *Storm runoff, Sewage effluents.
Identifiers: *Storm sewers, Toronto.

On one underwater diving job, two consulting engineers inspected storm water outfalls near the lakeshore in Toronto. They were lowered into manholes, and inside they found accumulations of silt and domestic and industrial sewage debris even though these were storm sewers. As a result of these obstructions, storm flow had become more restricted over the years.

183
URBAN RENEWAL IN WHITE PLAINS, NEW YORK,

J. Michael Divney
Civil Eng, Vol 39, No 9, pp 69-72, Sep 1969.

Descriptors: *Urban renewal, Storm drains.
Identifiers: *White Plains, New York.

In an urban renewal program in White Plains, N. Y., a scatter housing plan was developed. A scheme employing pairs of one-way streets and at-grade intersections was used. The Davis Brook storm drain (84 in. diameter, 3000 ft. long) will divert the route of the David Brook culvert from the center of the project to the Bronx River, along the southern boundary of the project. The pipes were jacked under the commuter rail line, and gravel was pumped into the voids, thus stopping the track settlement.

184
POLLUTION ABATEMENT THROUGH SEWER SYSTEM CONTROL,

W. T. Eiffert and P. J. Fleming
J Water Pollution Control Fed, Vol 41, No 2, pp 285-291, Feb 1969.

Descriptors: *Waste water treatment, *Pollution abatement, Sewers, Sewerage.
Identifiers: *Storm sewer pollution, *Dayton, Ohio

Concurrent with a major wastewater treatment plant expansion program in Dayton, Ohio, for effluent release into the Great Miami River, a four point program has been initiated to eliminate pollution from storm sewers. Although Dayton has a separate sewer system, untreated industrial plant wastes and municipal by-passes must be eliminated to insure the 90 to 95 percent pollution reduction required by water quality standards.

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185
SOME ASPECTS OF DEEP SEWER MAINTENANCE,

L. Goodhew
Water Pollution Control, Vol 68, No 2, pp 217-221, Mar 1969.

Descriptors: *Sewers, Weirs.
Identifiers: *Storm sewage, *Deep sewers.

The design and construction of deep sewers which are described are drawn from the Rochester, Chatham and Gillingham Joint Sewerage Board. It is advised to restrict the admission of storm sewage and to install storm overflow weirs only on the branch sewers. The maintenance of deep sewers as well as safety precautions, and cleaning and inspection methods are explained. For the first flush of storm sewage into the trunk sewer, a long and narrow chamber, with an overflow weir at the upstream end and an outlet into the trunk sewer from its downstream end, is constructed at a point where a branch sewer enters a trunk sewer.

186
ORGANIZING AND PLANNING FOR SEWER MAINTENANCE,

Glen J. Hopkins and Don Hurlbert
J Water Pollution Control Fed, Vol 39, No 2, pp 230-239, Feb 1967.

Descriptors: *Maintenance, *Repairing, Sewerage, Gate control.
Identifiers: Storm sewer valves, Sewer separation, Kansas City, Missouri.

The sewer maintenance program devised by the Maintenance Division of the Department of Pollution Control, Kansas City, Mo., is geared toward public service in the quick repair of damaged sewers, whatever the cause. This program also deals with sewer and catch basin cleaning, sewer malfunctions and connections, and preventive maintenance. The sewer system includes a number of gate and sluice gate valves on storm sewers that must be closed in times of flooding. In the case of overloaded sewers, if storm-water lines are found to be connected to sanitary sewers, the Maintenance Division requests that the two lines be disconnected.

187
STORM DRAINAGE PRACTICES OF THIRTY-TWO CITIES,

Discussions by Richard A. Rogers, and Kenneth R. Wright and Elmer L. Claycomb
J Hydraulics Div, Am Soc Civil Engrs, Vol 95, No 6, pp 2195-2196, Nov 1969.

Descriptors: *Design criteria, *Storm drains, Rational formula.
Identifiers: *Urban Storm Drainage Criteria Manual.

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Wright and Claycomb state that the Denver Regional Council of Governments (DRCOG) commissioned the preparation of an Urban Storm Drainage Criteria Manual in 1967. The related findings indicate that the Rational formula is often misused. They also mention that extensive research has been conducted on the subject of practical storm sewer design by the University of Missouri.

188
RATIONAL "RATIONAL" METHOD OF STORM DRAINAGE DESIGN,

R. A. Rogers
J Irrigation Drainage Div, Am Soc Civil Engrs, Vol 94, No IR4, pp 465-480, 1968.

Descriptors: *Storm drains, *Drainage systems, *Design, *Rational formula, *Non-uniform flow, *Computer programs, Runoff Pipes.

Identifiers: *Submerged systems.

The method of a storm drainage system design is presented which utilizes the Rational Formula with a modification to allow for nonuniform runoff. The system is designed for critical periods when flow in a system or parts of a system is maximum as determined from a hydrograph of the runoff. This method is particularly suited for the design of submerged systems, and therefore, it was computerized. The results of a sample problem show larger pipe sizes than would be found when using the conventional method which adds times of flow in lines to concentration time at some arbitrary starting point.

189
DUNFERMLINE PAST, PRESENT AND FUTURE,

William G. Stephenson
J Inst Munic Engrs, Vol 96, pp 53-60, Feb 1969.

Descriptors: *City planning, Drainage programs.
Identifiers: *Dunfermline, Scotland, *Storm sewers, Combined sewers.

The highways, drainage works, water supply, and lighting of Dunfermline are discussed. The overloading of combined sewers since the last war has necessitated extension of storm relief sewers. Two projects will begin to ameliorate the situation. Menawhile, all new drainage projects have been laid on the separation system.

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190
MULTI-MEANS EFFORT FOR URBAN FLOOD CONTROL,

Kenneth R. Wright
Paper presented at International Conference on Floods: Their Protection and Defense of the Soil, held by the academia Nazionale Dei Lincei, Rome, Italy, Nov 1969.

Descriptors: *Flood control, *Planning, *Drainage systems, *Drainage engineering, Storm drains, Storm runoff, Drainage programs, Hydraulic structures, Water policy.

Urban drainage is usually very localized, although it is believed that damages due to urban drainage problems are equal to report flood losses.

An effective way to deal with this problem is by a multiple means effort based on a basic urban drainage policy. Such a policy should be formulated in lieu of various inputs, principles of urban drainage, hydrology and hydraulics of small urban basins, and accurate knowledge of urban drainage law. Urban drainage policy must also recognize that urban drainage is directly related to the total urban system. The planning process is based on the concept of two urban drainage systems. The initial drainage system, typically storm sewers, is designed to handle storm runoff expected to occur once every 2-10 years. The major drainage system is the area which must accomodate the 100-year runoff and includes both natural and artificial elements. Other specific aspects of urban drainage planning discussed are functions of storm sewers and streets, hydraulic structures, inlets and culverts, storage and floodproofing.

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Section 5

STORMWATER - QUALITY, QUANTITY, AND POLLUTION
a. Caused from combined overflows
b. Caused from storm runoff

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5a. Caused from combined overflows

191
OHIO STORMS BURST TWO RESERVOIRS,

Eng News-Record, Vol 183, No 3, p 13, Jul 17, 1969.

Descriptors: *Ohio, *Damages, Storm runoff, Storm drains.
Identifiers: *Storm overflows, Storm sewage.

Severe storms in northern Ohio caused serious damage to 23 counties in the state. In four sections of Bellevue, the heavy rains raised the water table so high that sewage-filled water rose out from the limestone channels of the underground storm drainage system. Residents spent days pumping water off to ditches draining Lake Erie. The flooding also destroyed much of Bellevue's $4.5-million sewage interceptor and treatment plant in addition to damaging reservoirs, bridges, etc. in other Ohio areas.

192
WATER FOR PEACE, VOLUME 3, WATER SUPPLY TECHNOLOGY,

Int Conf on Water for Peace, May 23-31, 1967.

Descriptors: *Water management (applied), *Pipelines, Water quality, Water conservation.
Identifiers: *Water quantity forecasting.

The third volume includes 97 papers dealing with water supply problems associated with the management of groundwater resources. Water pipeline design, materials, and construction are explained. Water quantity forecasting and water conservation techniques are examined. Water quality considerations such as water pollution, and methods of water quality maintenance are discussed.

193
WATER FOR PEACE, VOLUME 4, WATER SUPPLY TECHNOLOGY,

Int Conf on Water for Peace, May 23-31, 1967.

Descriptors: *Water pollution control, *Standards, Filtration, Water quality, Data storage and retrieval, Water resources development.
Identifiers: *Treatment processes.

The fourth volume includes 103 papers dealing with water pollution control and research work carried out to improve water analysis, filtration,

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and treatment techniques. Water quality standards, and methods and instrumentation for hydrologic data collection and retrieval are discussed so they may be used for water development and water programs.

194
WATER FOR PEACE, VOLUME 8, PLANNING AND DEVELOPING WATER PROGRAMS,

Int Conf on Water for Peace, May 23-31, 1967.

Descriptors: *Waste water treatment, *Pollution abatement, *Quality control, *Water utilization, *Cost analysis.

The eighth volume includes 78 papers dealing with the development of water programs, in various countries, associated with water and wastewater treatment, water pollution abatement, and water quality control. Water utilization for multiple agricultural and industrial purposes, and for electric power requirements are explored. Financing considerations, involved in the planning, organization, management, and design of public water supplies are studied.

195
WATER POLLUTION ASPECTS OF URBAN RUNOFF; The Causes and Remedies of Water Pollution From Surface Drainage of Urban Areas,
Am Public Works Assoc

Prepared for FWPCA, Contract No WA 66-23, Jan 1969. 272 p.

Descriptors: *Water pollution, *Water pollution sources, *Storm runoff, *Water pollution effects, Solid wastes, Data collections, Watersheds (basins), Runoff, Pesticides.
Identifiers: *Environmental pollution, *Storm sewers, *Combined sewers, *Urban drainage.

The environmental pollution factors and their potential pollutional effects resulting from the water-wastes interfacial contracts during precipitation and runoff have been analyzed based upon collected field data and theoretical calculations. The surface urban environment factors studied included, street refuse and litter, catch basins, environmentally used chemicals, contributions from air pollution and its control, and sewer solids deposition. It was found that street refuse could present a significant pollution load. It is estimated that a pollution load - measured in terms of BOD - of a) 1% of the total raw sewage or 5% of the total secondary treatment effluent in terms of average daily load, and

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b) 160% of the raw sewage and 800% of the secondary effluent load, expressed in terms of the shock pollution load on the receiving body of water results from the dust/dirt fraction of street litter. Summary-form findings and recommendations, raw data collected, survey questionnaires, and a comprehensive set of ordinances govering a wide sampling of possible sources of urban storm water pollution are compiled in this report.

196
WATER QUALITY CRITERIA: REPORT OF THE NATIONAL TECHNICAL ADVISORY COMMITTEE TO THE SECRETARY OF THE INTERIOR,

U.S. Federal Water Pollution Control Admistration, 245p.

Descriptors: *Water quality control, *Standards.
Identifiers: *Water quality criteria.

To assist State and Federal agencies in establishing water quality standards, as required by the Water Quality Act of 1965, the first National Technical Advisory Committee on Water Quality Criteria has collected into this volume a basic foundation of water quality criteria with individual sections on: recreation and aesthetic aspects; public water supplies; fish, other aquatic life, and wildlife; agricultural uses; and, industrial water supplies. Tabulated numerical data, appended references for each section, and a subject index are included.

197
NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION: NINETEENTH AND TWENTIETH ANNUAL REPORTS ON INTERSTATE WATER POLUTION CONTROL, 1966 AND 1967,

Descriptors: *Standards, *Water quality, *Classification, *Sewage treatment, *Waste water treatment, *Planning, *Operations, Legislation.

These reports outline the activities and accomplishments of the Commission, and the signatory states, in the improvement of water quality. Tables are included showing the 1967 revision of the scheme used for classification of water according to the intended uses and the corresponding physico-chemical and bacteriological standards. Each state has been classifying the interstate streams, and subsequent to approval of the classification by the Commission, each state will undertake establishing a program for treatment of sewage and waste waters to meet the appropriate standards. Progress in the planning and construction of treatment plants is summarized for the individual states, and some individual states, and some individual plants are described and illustrated. Research has included studies on the legal aspects of water right and

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on the identification and solution of major operational problems at sewage works. Attention has also been given to the training of operators for waste water treatment plants particularly in view of the requirements of the 600 new plants which have been proposed for the near future. Federal and state legislation is also summarized.

198
OHIO RIVER VALLEY WATER SANITATION COMMISSION: SEVENTEENTH, EIGHTEENTH, NINETEENTH, AND TWENTIETH YEARBOOKS,

28 pp, 165; 44 pp, 1966; 40 pp, 1967; 44 pp, 1968.

Descriptors: *Water quality, *Control structures, *Ohio River, *Water management (applied), Monitoring, Geological surveys, Hydroelectric plants.
Identifiers: *Water quality criteria, Hydrological surveys.

Progress in cooperative work on the management of water quality in the Ohio River valley is reviewed. The 18th yearbook contains the criteria which have been recommended for water quality. Since the Water Quality Act of 1965 required the establishment of water quality standards for the individual states, a major problem is the reconciliation of standards, especially where different standards are applied to the same stretch of river bordering two states. Other projects include: expansion of the system for monitoring water quality, appraising river conditions, and forecasting impending changes some days in advance; development of automated forecasting procedures for management of water quality using a mathematical model; geological and hydrological surveys to determine the potentialities and limitations of deep wells for the disposal of difficult or toxic waste waters; assessment of changes in aquatic life; and, investigations on the enrichment of oxygen in rivers by various methods of operation at hydroelectric power facilities. Each yearbook includes data on the individual water quality characteristics in the Ohio River and its tributaries, and on the present status of municipal and industrial pollution control facilities. The 20th yearbook also contains an article by R. H. Leach, reviewing the accomplishments of the Commision during the 20 years since its establishment.

199
SEWER MAINTENANCE IN A COLD CLIMATE,

F. E. Ayers
J Water Pollution Control Fed, Vol 41, No 3, pp 418-423, Mar 1969.

Descriptors: *Runoff, *Hydrology, *Water pollution sources, Storms, Infiltration.
Identifiers: *Sewer maintenance, *Canada, Combined sewers.

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Sewer maintenance problems in Ottawa include threatened explosions due to improper sewer ventilation during snow and sleet storms, the entrance of granular street materials into catch basins and then the sewer systems, and the handling of excess runoff during spring thaws. The problem caused by the entrance of sand and peastone traction materials into the sewer system is greatest in the city's combined sewer district where pipes are older and laid on flatter grades than those of the newer separate system. Means of combating Ottawa's sewer maintenance problems are discussed. Two programs adopted are the crash maintenance program during spring to remove grit in flat sewers, thus allowing sewers maximum capacity for spring runoff; and the development of detained sewer maintenance records which are made available to crews handling sewer problems.

200
PROPOSED PROCEDURE FOR DETERMINING QUANTITY AND QUALITY OF STORM FLOW,

M. B. Fielding
Water Resources Commn, Div Res Pap No 2002, 1966.

Descriptors: Measurement, Flow, Planning.
Identifiers: *Storm sewage, Suspended solids.

The author outlines a suitable procedure for measuring the flow of storm sewage and for collecting samples for the determination of BOD and suspended solids. A graphical form is proposed for reporting the results.

201
URBAN EFFECTS ON QUALITY OF STREAMFLOW,

E. Gus Fruh
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Oct 1968, p 255-282, University of Texas Press, Austin and London, 1969. 28 p, 22 fig, 5 tab, 15 ref. NSF Grant GU-1963, and Texas Water Quality Bd Contract No 68-69-281.

Descriptors: *Reservoirs, *Urbanization, *Water quality, *Stratification, *Texas, Water pollution sources, Water pollution effects, Dissolved oxygen, Aquatic bacteria, Algae, Colorado River.
Identifiers: Austin, Texas.

The effects of impoundments and urbanization on the water quality of the Colorado River ot Texas were studied in the reservoirs near Austin, Texas. Lake Travis, upstream from Austin, is large and deep and has no significant input of pollution. Lake Austin, the next reservoir downstream, is much smaller and shallower, and receives some recreational and urban

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runoff pollution. Town Lake, in Austin, is small and narrow and receives some urban runoff pollution. Oxygen concentration/water depth data for the 3 reservoirs are tabulated. In Lake Travis, even in the winter, the temperature varied with depth. During the summer, the oxygen first became depleted at the thermocline region. Throughout the fall, various depths of Lake Travis became reaerated, but oxygen-depleted waters were still passing through the penstocks in November. In winter, oxygen was present at all depths. In Lake Austin, the summer oxygen concentration in the epilimnion varied around saturation. Dissolved oxygen decreased steadily in the hypolimnion during the summer and was consistently lower above the sediments. After autumn turnover, oxygen remained uniform from top to bottom. High numbers of total and coliform bacteria were found in Lake Austin during the spring following periods of intensive rainfall. The urban stream, Barton Creek, had significantly higher concentrations of solutes, nutrients, and bacteria than Town Lake above the stream's entrance, particularly during the spring rainfall period. All of Austin's urban streams enter Town Lake and Lake Austin, with the streams from the more highly developed areas entering Town Lake.

202
URBAN PLANNING ASPECTS OF WATER POLLUTION,

Sigurd Grava
Columbia University Press, New York, 1969. 232 p.

Descriptors: *City planning, *Water quality control, *Urban renewal, *Urbanization, Water pollution control.

This study, strictly limited to water-borne wastes and water quality control, represents a synthesis of experience and thought on water pollution as it applies to urban planning and is intended as a guide and source of information for urban planners and community decision makers. Although non-technical in nature, the work includes data, financial and administrative considerations, and reference material.

203
COMBINED SEWER CONSIDERATIONS BY PHILADELPHIA,

Carmen F. Guarino, Joseph V. Radziul, and William L. Greene
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA1, pp 1-14, Feb 1970.

Descriptors: *Pollution abatement, *Water quality, Sewage Treatment, Instrumentation, Application methods.
Identifiers: *Philadelphia, Sewer overflows.

The City of Philadelphia's experience and study of the combined sewer overflow pollution problem are described. Water quality legislation and

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pollution abatement philosophies are considered. The needs for problem definitions are delineated along with pertinent constraints of existing methodology and measuring instrumentation. Costs and economic analysis of some abatement schemes are evaluated. Complete separation of storm-water and sanitary wastes, storage in conduit or detention basins, a total systems concept and microstraining, chlorination, and ozonation of discharges are some of the principles reported for the control and treatment of combined sewer overflows. The authors basically recommend partial separation in certain areas of the City and alternate methods or the continuance of combined sewerage for the remaining areas. However, further knowledge is needed regarding all types of sewerage systems and treatment.

204
EVALUATION OF WATER-QUALITY MONITORING IN THE ORANGE COUNTY WATER DISTRICT, CALIFORNIA,

Joe A. Moreland and John A. Singer
Geological Survey Open-file report, 1969. 27 p, 5 fig, 3 tab, 12 ref.

Descriptors: *Water quality, *Monitoring, *Groundwater, *California, Data collections, Saline water, Water pollution sources, Irrigation water, Municipal water.
Identifiers: Orange County, California.

Water samples for chemical analysis are collected periodically from 272 wells in the Orange County, California Water District by 16 agencies. Many other wells are sampled at infrequent intervals by these and other agencies. The efficiency and completeness of the entire network are evaluated, and changes in standards for the network are suggested. Complete chemical analysis of a water sample is not always necessary. Selective analyses suggested for obtaining specific types of data include: (1) Chloride determination and electrical conductivity measurements on samples from aquifers susceptible to intrusion of sea water; (2) sulfate, bicarbonate, and nitrate determinations on samples from aquifers underlying the forebay area; and (3) sodium, sulfate, chloride, and boron determinations and electrical conductivity measurements on samples from aquifers used as a source of irrigation water.

205
THE MAGNETIC SPHERULES IN SEDIMENTS OF LAKE MENDOTA, WISCONSIN,

Jerome O. Nriagu and Carl J. Bowser
Water Res, Vol 3, No 11, pp 833-842, Nov 1969. 5 tab, 4 graphs, 12 ref.

Descriptors: *Industrial wastes, *Domestic wastes, *Water pollution sources, *Wisconsin, *Influent streams, *Sediment distribution.
Identifiers: *Lake Mendota, Urban runoff.

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Magnetic microspherical particles which occur in the bottom muds of Lake Mendota have been analysed chemically and mineralogically. The data suggest that these spherules are flue products derived from industrial and domestic activities and are being supplied to the lake either through the action of washing the atmosphere or as the detrital load of the influent streams and urban runoff.. These particles are apparently unaffected by diagenetic changes and since the chronological pattern of the lake sedimentation is well documented, the distribution of these microspherical particles has been used to evaluate the role of man in the trophic evolution of the lake.

206

WATER QUALITY: COST BENEFITS OF IRREDUCIBLES,

Ralph Stone, William Garber, and Helen Friedland
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA3, pp 691-697, June Jun 1970. 4 tab, 2 ref.

Descriptors: *Reasonable use, *Beneficial use, *Surveys, Water

The ASCE Committee on Sewerage and Sewage Treatment distributed a questionnaire to members of the Sanitary Engineering Division in order to determine the attitudes and opinions of members in regard to existing and future research and development, the social and economic value of alternate beneficial uses of the Nation's water, and to demonstrate an algorithmic technique for quantifying probabilistic or nondeterministic data. Results of the questionnaire are listed and interpreted. Respondding engineers generally indicated that sewer and storm drain design would benefit least from existing or future research and development work. The authors conclude that it is possible and desirable to quantify qualitative factors relating to engineering decisions. Also, as algorithmic methods are used increasingly, future technical refinements may be expected.

207

WATER AND WASTE WATER, AND WATER POLLUTION CONTROL IN AUSTRALIA,

D. K. B. Thistlethwayte
Water Pollution Control, Vol 68, No 3, pp 256-274, 1969.

Descriptors: *Water sources, *Water utilization, *Sewerage, *Sewage treatment, *Water pollution, *Water pollution control, *Surface runoff, Biocontrol, Legal aspects.
Identifiers: *Australia.

The author outlines the sources and use of water in Australia, the development of sewerage facilities and of water and sewage treatment, and the problems of pollution and pollution control. Although sewage from most large communities receives full biological treatment, there is growing

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pollution of surface waters by urban runoff and from agricultural sources; and little attention has so far benn given to reclamation and reuse of water. The control of pollution is the responsibility of various agencies, and differs from state to state.

5b. Caused from storm runoff

208
QUALITY OF SURFACE WATERS OF UNITED STATES, 1960--3,4,
U.S. Geological Survey

Water Supply Paper 1742, 1968. 309 p.

Descriptors: *Ohio River, *St. Lawrence River, *Watersheds (basins), *Water quality, Chemical analysis, Temperature, Rainfall.

Records of chemical analysis, suspended sediment, and temperature for surface waters serve as a basis for determining the suitability of waters which were examined for all uses in the Ohio River and the St. Lawrence River basins. The discharge of stream and chemical quality are related to variations in rainfall and other forms of precipitation. The records are arranged by drainage basins in downstream order.

209
WATER QUALITY MONITORING FIELD STUDIES,

Bruce R. Barrett
Paper presented at the Calif Water Pollution Control Assoc 42nd Annual Conference, Sacramento, Calif, April 29 to May 1, 1970.

Descriptors: *Monitoring, *On-site investigations, *Instrumentation, Water pollution, Water quality.

Continuous water quality monitors have been used by the Technical Services Program of the Robert S. Kerr Water Research Center, Ada, Oklahoma, in a variety of field water pollution studies and for various purposes. Two commercially available types of monitors have been used. Monitors were used in the James River Project along with recording flow gages to determine the relationship between stream quality and storm runoff. In a before-and-after type study to determine differences in quality due to navigation impoundments, monitors were used to establish the existing quality of the waterway. In a research study of a refinery waste treatment plant, a monitor was used to study the various unit processes for purposes of treatment control and overall refinery waste monitoring. The sample taking capability of the monitors was indispensable in an enforcement case involving a mine waste.

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210
FECAL COLIFORM CONCENTRATIONS IN STORMWATERS,

Robert A. Buckingham and Roger P. Betson
Paper present at the Am Geophys Union, Fifty-first Annual Meeting, 1970.

Descriptors: *Storm runoff, *Coliforms, *Overland flow, *Water quality, *Water pollution sources, *Testing.
Identifiers: *Fecal coliforms, *Tennessee Valley.

Recent limited stormwater bacteriological water-quality sampling in the Tennessee Valley indicates that high fecal coliform loads are common in stormwater runoff. In clean residential areas sustained high fecal coliform loads were observed uring stormwater runoff. The source of these loads was associated with overland flow, and it appears that staggered contributing times account for the sustained high loads. High fecal coliform counts were also measured in stormwaters originating from agricultural areas and forested watersheds. The consistency with which fecal coliform counts in excess of accepted standards are commonly found further substantiates the need for a reappraisal of this test as an indicator of pathogenic organisms. These data also point to the importance of recognizing the streamflow regime in the analysis of water-quality sampling data since observations taken during storm periods usually in high bacteriological loads.

211
STORM WATER POLLUTION FROM URBAN LAND ACTIVITY,

Jerry G. Cleveland, Ralph H. Ramsey, and Paul R. Walters
In: Combined Sewer Overflow Abatement Technology. Water Pollution Control Research Series, Report 11024--06/70, pp 1-55, Jun 1970.

Descriptors: *Storm runoff, *Water pollution, *Water pollution sources, *Investigations, *Urbanization, *Pollutants, *Sampling, Cities.
Identifiers: *Tulsa, Oklahoma.

An investigation of the pollution concentrations and loads from storm water runoff in an urban area was conducted in Tulsa, Oklahoma during the period from October 1968 to September 1969. The scope of the project included a field assessment of the storm water pollution by obtaining samples of the water resulting from rainfall and surface runoff from test sites in the metropolitan area; development of an analytical procedure for correlation of storm water pollution with defined variables of land uses, environmental conditions, drainage characteristics, and rainfall; and development of an abatement plan for pollution in urban areas. Runoff samples were analyzed in terms of quality standards for BOD, COD, TOC, organic kjeldahl nitrogen, soluble orthophosphate, chloride, pH,

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solids, total coliform, fecal coliform, and fecal streptococcus pollutants. Results of this investigation are detailed herein.

212
SEASONAL VARIATIONS IN SURVIVAL OF INDICATOR BACTERIA IN SOIL AND THEIR CONTRIBUTION TO STORMWATER POLLUTION,

D. J. Van Donsel, E. E. Geldreich, and N. A. Clarke
Appl Microbiol, Vol 15, No 6, pp 1362-1370, 1967.

Descriptors: *Streptococcus*, *E. coli*, Bioindicators.
Identifiers: Seasonal survival study.

A three-year study was made on the survival of selected strains of *Escherichia coli* and *Streptococcus faecalis* in shaded and exposed outdoor soil plots. The soils were dosed periodically, and subsequent reductions in survival are shown graphically as seasons variate. Periods for 90-per cent reduction of *Esch. coli* ranged from 3.3 days in summer to 13.4 days in autumn and for *S. faecalis* from 2.7 days in summer to 20.1 in winter. During the fall, the survival periods for the organisms were the same, but in spring and winter *Streptococcus* survived longer. Both organisms could be isolated from runoff during period of heavy rainfall in spring; however, isolation during summer and autumn months was sporadic. On account of these results and other factors, it was considered that *Esch. coli* was the better indicator of pollution.

213
CONCEPTS OF FECAL STREPTOCOCCI IN STREAM POLLUTION,

E. E. Geldreich and B. A. Kenner
J Water Pollution Control Fed, Vol 41, No 8 pp R336-R352, Aug 1969.

Descriptors: Storm runoff.
Identifiers: Fecal coliforms, Fecal streptococci, Stream pollution.

Results of an intensive study on the occurrence and strain distribution for 12, 536 fecal streptococcus strains found in warm-blooded animal feces and numerous water sources from a wide geographical area reveal several new factors that must be understood for a proper interpretation of the sanitary significance of this bacterial group in water pollution studies. These studies were conducted in streams, agricultural waters, recreational and public water sources, and on domestic wastewater and stormwater and food processing wastes. The ubiquity of *Streptococcus faecalis* var. *liquifaciens* in the water environment and the occasional occurrence of an atypical *S. faecalis* associated with vegetation shows the need for including the fecal coliform examination in recreational water quality measurements. Applications of the fecal streptococcus indicator system in stream pollution are the development of fecal coliform to fecal

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streptococcus ratios that will further define possible sources of the fecal discharge into the stream; and the detection of the *S bovis* and *S. equinus* subgroup which was not found in human feces and may be considered a specific indicator of non-human animal pollution.

214
THE BACTERIOLOGICAL ASPECTS OF STORM-WATER POLLUTION,

E. E. Geldreich, L. C. Best, B. A. Kenner, and D. J. Van Donsel
J Water Pollution Control Fed, Vol 40, No 11, pp 1861-1872, Nov 1968.

Descriptors: *Water pollution sources, *Pollutant identification, Remedies.
Identifiers: *Fecal coliforms.

The bacteriological composition of stormwater from a variety of areas was compared and seasonal differences noted. Higher numbers of organisms appear to persist during winter than during summer. The fecal coliform segment of the total coliform population for all stormwater samples averaged 8.6 percent; however, 21.1 percent fecal coliforms were observed in stormwater taken in autumn from a suburban business district. Evidence indicates that fecal contamination in separate stormwater systems originates from cat and dog deposits on soil and from rodent deposits in urban areas. Thus, regulations to prohibit pets on public beaches and improved garbage control plans to discourage rodent proliferation are recommended. Also, diversion of storm drains and land drainage away from beaches and reservoirs would aid in reducing bacterial contamination.

215
RESEARCH REGARDING SEDIMENT AND URBANIZATION,

Harold P. Guy
J Hydraulics Div, Am Soc Civil Engrs, Vol 93, No HY6, pp 247-254, Nov 1967.

Descriptors: *Sedimentation, Urbanization, Streamflow, Water resources, Storm runoff.
Identifiers: Sediment pollution, Storm drainage.

Sediment derived from construction in areas of urban growth has profound impact on downstream channels and water resources. Such sediment pollution is usually much more dynamic and intense than sediment derived from rural areas. Research needs concerning urban drived sediment are similar to those already underway in rural areas; however, new emphasis must be given to exposed subsoils, to problems in existing stream channels, to pollution of existing and future water resources, and to more effective

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planning and phasing of construction. Storm drainage, that flows through existing and new channels that are later complicated by urban changes, is a foremost topic of urban hydrology; and it is discussed in this article. Some of the needed soils and stream channel research can be accomplished in laboratories, but much needs to be done on small areas at the construction sites. Although many urban research methods can be adapted from related rural programs, consideration must be given to the fact that the extent and location of the exposed subsoils in the drainage basin will change rapidly and that extremely high and variable sediment loads will be imposed upon the stream channels. Better planning and legal backing will make research findings more useful.

216

ON SIGNIFICANCE OF *PSEUDOMONAS AERUGINOSA* IN SURFACE WATERS,

A. W. Hoadley
J. New Eng Water Works Assoc, Vol 82, No 2, pp 99-111, Jun 1968.

Decriptors: *Pseudomonas, *Drainage, Indicators.
Identifiers: **Pseudomonas aeruginosa.*

Although sewage discharges represent major potential sources of *P. aeruginosa* in the environment, storm drainage from municipal areas contributes continuous inoculum to surface waters. Farm drainage also can contain small numbers of bacteria under certain conditions. Relatively heavy populations of *P. aeruginosa* in streams below sewage outfalls decrease rapidly as they progress downstream. The usefulness of this organism as an indicator of the possible presence of enteric pathogens is therefore limited.

217

THE OCCURRENCE AND BEHAVIOUR OF *PSEUDOMONAS AERUGINOSA* IN SURFACE WATERS,

A. W. Hoadley
Thesis, University of Wisconsin, 1967, 224 pp; Diss Abstr, Vol 28B, pp 459-460, 1967.

Descriptors: *Pseudomonas, *Indicators, *Storm runoff, *Water pollution sources, *Surface waters, Drainage, Sewage.
Identifiers: **Pseudomonas aeruginosa.*

Studies on the ecology of *Pseudomonas aeruginosa* in surface and tap waters and on its usefulness as an indicator of pollution showed that *Pseudomonas* probably does not occur in waters unaffected by the activities of man and domestic animals. Although farm drainage and storm runoff from urban areas

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contribute small numbers of *Pseudomonas*, sewage discharges probably represent the major source of these organisms entering streams, particularly discharges of crude sewage which may contain up to 7 x 10^5 organisms per 100 ml. Although secondary sewage treatment reduces the number of *Pseudomonas* in domestic sewage by about 99 per cent, growth of the organism has been observed during treatment of slaughterhouse wastewaters. Populations of less than 100 per 100 ml occurred in surface waters near areas of human activity but not directly receiving sewage discharges; however, populations of about 100 per 100 ml were detected in public bathing waters in the Madison lakes, Wis., and very much greater populations were observed in waters recently contaminated with sewage. Although some sterile natural waters supported growth of *Pseudomonas* in the laboratory, populations of viable *Pseudomonas* were reduced rapidly in natural surface waters, with reductions of more than 90 percent in three hours. It is concluded that *Pseudomonas aeruginosa* is a sensitive indicator of pollution of surface waters by sewage and by runoff from urban areas and farmyards.

218
QUALITY OF SURFACE WATERS OF UNITED STATES, 1960-7,8,
U S Geological Survey
S. K. Love
Water Supply Paper 1744, 1968.

Descriptors: *Mississippi River Basin, *Water temperature,, *Suspended load, *Water quality.
Identifiers: *Gulf of Mexico Basin, *Chemical analysis, *Stream quality.

Records of chemical analysis, suspended sediment, and temperature for surface waters given in this volume serve as a basis for determing suitability of waters examined for all uses in the lower Mississippi River Basin and the Western Gulf of the Mexico Basin. Discharge of stream and chemical quality are related to variations in rainfall and other forms of precipitation.

219
DESCRIPTION OF THE DRAINAGE OF STREET FLUSHING WATERS,

N. A. Pravoshinskiy
Soviet Hydrol: Selec Pap, Issue No 2, p 168-170, 1968. 2 tab, 8 ref.

Descriptors: *Water pollution sources, *Roads, *Urbanization, *Drainage systems, Storm drains, Municipal wastes, Organic wastes, Sediments.
Identifiers: *USSR.

The quality and quantity of runoff from street washing operations in Minsk were measured to study the contribution of street washing to water pollution. Data from earlier studies in Moscow and Leningrad are included

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for comparison. The BOD of street cleaning runoff is 6–223 mg/liter, petroleum products are up to 110 mg/litter, and coliforms are nearly as abundant as in wastewater. These waters, unless they are treated, can be a major source of pollution.

220
CALCULATION OF WATER POLLUTION BY SURFACE RUNOFF,

N. A. Pravoshinskiy and P. D. Gatillo
Water Res, Vol 2, No 1, pp 24-26, Jan 1968.

Descriptors: *Surface runoff, *Water quality, Data collections, Evaluation.
Identifiers: *Surface runoff pollution, *USSR.

The extent of surface runoff pollution was calculated in the Minsk and Soligorsk districts using the five-day BOD as the main index. Other data were accumulated to determine the variations in the quality of the water when compared with the type of storm, the length of the previous dry weather period, the season, the surface of the region, and the amount of transport and pedestrian traffic. With these results, evaluations can be made of the influences of the pollutants and of the effects of measures such as catch basins, settling basins, storm sewers, and increased sewer capacity, on the maintenance of sanitary pond conditions.

221
ASSESSING THE QUALITY OF URBAN DRAINAGE,

Walter Viessman, Jr.
Public Works, Vol 100, No 10, pp 89-92, Oct 1969.

Descriptors: *Urbanization, *Runoff, *Water quality, Storm runoff, Pollutant identification.
Identifiers: *Sediment.

Recommendations are made for further study in the area of identifying sources and constituents of urban runoff through the development and testing of urban water quality models and through the national collection of urban water quality data. Possible sources of pollutants and constituents of stormwater runoff are described with emphasis on a primary pollutant, sediment. Approaches to the development of water quality models are discussed.

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SURVEYS, POLICIES, AND REPORTS

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222
ENVIRONMENTAL QUESTIONS THAT NOBODY LIKES TO HEAR,

Am City, Vol 85, No 3, p 8, Mar 1970.

Descriptors: *Water pollution, *Costs, Storm runoff, Overflow.
Identifiers: Storm sewers, Sewer separation.

This short review summarizes environmental problems in the United States such as water pollution, refuse collection and disposal, mineral depletion, and air pollution. Under water pollution, it is noted that $48 billion is required to separate sewers in the U.S. in order to correct effects of stormwater overflow. Grim predictions concerning the environment are made, and immediate action to improve conditions is advocated.

223
MOLE TUNNELING RESEARCH ADVOCATED,

Civil Eng, Vol 37, No 8, pp 48-49, Aug 1967. 1 diag.

Descriptors: *Tunneling, *Tunnels, *Comparative costs.
Identifiers: *Viewpoint, *Mole.

Dr. Walter Hibbard, Jr., Bureau of the Mines Director, recently emphasized the need for more research and development on mechanized tunneling. There is a growing demand for tunnels for the following purposes: subways, utilities, transmission lines, mining, and urban freeways. Needs in each of these areas are discussed as are advances already made with the mole borer. Savings in the billion-dollar range are possible with advanced tunneling procedures. In addition to perfecting moles, guidance control, placement of lining, and methods for the transportation of muck out of the tunnel must be developed.

224
THE TIDAL THAMES 1967,

Effluent Water Treat J, Vol 8, No 9, pp 463-465, Sep 1968.

Descriptors: *Pollution abatement, *Design, Sewerage, Estuaries, Storm runoff.
Identifiers: Thames River, Storm sewage, Great Britain.

The article concerns aspects of pollution control along the tidal

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river. The greatest effect of the discharge from the Greater London Council sewage works on the tidal Thames originated from the outfall works at Beckton. A scheme for reduction in storm sewage discharges from the sewerage system leading to the Beckton works was being examined. New trunk sewers, a pumping plant, and storm sewage tanks would be most likely involved in the scheme. The cost of the Beckton improvements was estimated at 21 million pounds, and of the improvements of the sewerage and storm sewage disposal systems at 22 million pounds.

225
SAIGON'S SEWER NEEDS STUDIED,

Eng News-Record, Vol 183, No 5, p 16, Jul 31, 1969.

Descriptors: *Investigations, *Water pollution sources, *Drainage systems, Storm runoff, Sewerage, Water pollution control, Sewers.
Identifiers: *Saigon River.

The Agency for International Development (AID) is conducting a 15-month, $800,000 study to discover the most efficient and economic sewer system for the disposal of Saigon's sewage and stormwater runoff. The present system is almost entirely non-functioning and as a result, the waterways of the city, including the Saigon River, are highly polluted with human waste and refuse. One plan to be explored is a drainage canal system for stormwater that would double as a transportation system. The results of the study will be used to support requests for financial assistance for reconstructing Saigon's sewers.

226
WHAT TO DO WITH SEWAGE WHEN IT RAINS HARD,

Eng News-Record, Vol 178, No 16, pp 30-31, Apr 20, 1967.

Descriptors: *Tunnel construction, *Tunnels, Storm runoff, Water treatment, Control systems.
Identifiers: *Chicago.

Chicago is building a $14.4-million deep tunnel system to carry spillages from combined storm and sanitary sewers during rainfall. The FWPCA has indicated four main areas related to stormwater runoff problems which require further study and demonstration: drainage area control; collection system control; external discharge control, including treatment of both combined sewer overflow and stormwater run-off;

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and a miscellaneous area, consisting of the economic feasibility of substituting separate sewers for combined sewers and local for central treatment facilities, better hydrologic analyses, new management procedures, construction materials and methods, and the development of performance criteria for standards of water quality.

227
WATER MONEY NEEDS REQUIRE MORE THAN PROMISES,

Environ Sci Technol, Vol 4, No 4, pp 278, Apr 1970.

Descriptors: *Pollution abatement, *Water treatment.
Identifiers: Waste treatment costs, Sewered population statistics.

S. 3472, the program for water pollution cleanup, calls for $10 billion for construction of municipal waste treatment plants. Among spokesmen at the 4th Annual Legislative Seminar concerned with the continuing cleanup is James R. Ellis who states that cities are in a catch-up situation. According to Ellis, 35% of the sewered population in the United States received 5% of the federal dollar during the period 1965 - 1969. Some of Ellis' suggestions are cited. John L. Salisbury, a Maine spokesman, contends that the need for secondary treatment is being challenged.

228
WATER POLLUTION -- COAST TO COAST,

Environ Sci Technol, Vol 3, No 9, pp 804 - 805, Sep 1969.

Descriptors: *Municipal wastes, *Pollution abatement, Sewage disposal, Thermal pollution.
Identifiers: *Combined sewers, *Water pollution.

A report on the FWPCA's regional review notes includes: the municipal problem and the pollution abatement activities; industrial sources of water pollution abounding in the Northeast, Great Lakes, and Ohio regions; agricultural activities; the Northeast problem of combined sewer discharge with 90% of the United States population served by combined sewers located in this area; thermal pollution problems; and salinity. Statistics are given.

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229
URBAN RUNOFF ADDS TO WATER POLLUTION,

Environ Sci Technol, Vol 3, No 6, p 527, Jun 1969.

Descriptors: *Runoff, *Data collections, *Cost analysis, *Surveys, *Separation techniques, Rainfall, Overflow, Biochemical oxygen demand.
Identifiers: *Urban runoff, *Chicago, Combined sewers.

An APWA survey indicated that: 1) urban runoff constitutes approximately 1% of the raw sewage load which amounts to 5% of the BOD discharged from the area's secondary waste treatment facilities; 2) water pollution from this urban source occurs creating a shock pollution load on receiving waters; 3) the most determinable measure of pollution potential of street litter is the BOD load of the soluble dust and dirt fraction; 4) an estimated expenditure of $48 billion would be needed to separate sanitary and storm waters; and, 5) $15 billion would be needed for alternate control methods for abatement of combined sewer overflows.

230
REVIEW OF LITERATURE OF 1968 ON WASTEWATER AND WATER POLLUTION CONTROL,

J Water Pollution Control Fed, Vol 41, No 6, pp 873-1251, Jun 1969.

Descriptors: *Water pollution control, *Chemical analysis, *Sewage treatment, *Storm runoff, Publications, Estuaries.

This review covers 1968 literature on analytical methods (analysis of anions, cations, and gases; and instrumentation), biological filters, activated sludge, detergents, anaerobic processes, sludge treatment, disinfection, water reclamation and reuse, storm flow, facility evaluation, kinetic models, physical and chemical wastewater treatment, effects of pollution on aquatic life, eutrophication, thermal pollution, microbiology, oxygen sag, groundwater, marine and estuarine pollution, economics of treatment, standards, and industrial wastes (paper, fermentation, meat, dairy, canning, coal, tannery, steel, petroleum, plating, chemical, and radioactive). Included under topics on "Disinfection," are the results of Elliassen's studies evaluating the efficiency of chlorination of stormwater overflows from combined sewers in Boston. He found that chlorination of overflows appreciably reduced numbers of coliform organisms in the Charles River basin, and it substantially impeded regrowth of such organisms. In the "Wastewater and Stormflow Treatment" section, advances, present techniques, and

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problems relating to sewer construction and operation are discussed. Recent literature on the stormwater disposal problem is also explored including solutions to the problem other than separation. Various treatment procedures described include the use of stabilization-retention basins, chlorination, and sedimentation.

231
A REVIEW OF THE LITERATURE OF 1967 ON WASTE WATER AND WATER POLLUTION CONTROL,

J Water Pollution Control Fed, Vol 40, No 6, pp 897-1219, 1968.

Descriptors: *Water pollution control, *Sewage treatment, *Analytical techniques, *Waste treatment, *Sludge, *Water pollution effects, Estuaries, Standards, Legislation.
Identifiers: *Storm sewage.

A review, with bibliographies, is given of literature published during 1967, dealing with sewage and trade waste treatment, and the control of pollution. Subjects dealt with include methods of analysis; biological, physical, and chemical methods of sewage treatment; detergents; anaerobic processes; treatment, disposal, and utilization of sludge; disinfection of effluents; reclamation and re-use of water; sewerage and treatment of storm sewage; effects of various pollutants on aquatic life; microbiology of polluted waters; oxygen sag and self-purification; effects of pollution on surface and ground waters; bottom deposits; marine and estuarine pollution and its effects; pollution control legislation; surveys of polluted waters; stream standards; and treatment of waste waters from various industries, including radioactive waste waters.

232
PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS, 1967,

U.S. Federal Water Pollution Control Administration, Publ No WP-20-11, 1967.
Public Works, Vol 99, No 12, pp 130, 132-133, and 138, 1968.

Descriptors: *Sewers, *Statistics, *Surveys, Overflow, Water pollution sources.
Identifiers: *Combined sewers.

The report of a national survey by the APWA, of communities and other jurisdictional entities served wholly or partly by combined sewers, is summarized. The population served by separate sewers is approximately half of that served by combined sewers, and the latter systems are

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concentrated mainly in the north-east, the region of the Great Lakes, and the Ohio River basin. Statistical information is given of the numbers and types of overflows in the U. S. and regulation devices used in combined sewer overflows, which represent 75% of all overflow sources. The survey confirms that combined sewer overflows contribute a significant part of the water pollution problem in the U. S.

233
OHIO TOWN GETS SEWERAGE SYSTEM AFTER 20 YEARS,

Water Sewage Works, Vol 116, No 6, pp 218-221, Jun 1969. 4 fig.

Descriptors: *Sewerage, *Treatment facilities, Installation, Construction, Joints (connections).
Identifiers: *Middleport, Ohio.

This article describes the twenty-year struggle that evolved in Middleport, Ohio over the construction of a sewerage system and treatment plant. Without such a system, Middleport's sewage was dumped raw into the river. A combination of a lack of funds, the granting of numerous six-month sewage dumping permits, and village councils' opposition tactics prevented installation of the system until September 1968. Factory-made compression joint pipe was used to minimize infiltration when the river level is above the pipe's level. This vitrified-clay pipe contains patented O-ring joints.

234
ENVIRONMENTAL RESEARCH IN S E ASIA,

Water Waste Treatment, Vol 12, No 12, pp 392-396, Mar/Apr 1970.

Descriptors: *Storm runoff, *Sewage treatment, *Water pollution, *Foreign research.
Identifiers: *Thailand.

The Thailand government's decision to plan for drainage and sewerage in Bangkok has led to increased research at the Asian Institute of Technology in Bangkok. Studies relating to stormwater collection, river pollution, and sewage treatment have been made in cooperation with interested authorities; and the results are applicable not only to Bangkok's project but also to other tropical regions. Topics of pertinent research projects include: (1) the anaerobic treatment of tapioca starch waste; (2) characteristics of treatment of Bangkok septic-tank sludge; (3) a Bangkok runoff hydrograph; (4) the ecology

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of polluted canals in Bangkok; (5) a study of photosynthetic oxygen production in the Chao Phya River; (6) pollution of the Chao Phya River, Bangkok; and (7) oxygen balance in the Chao Phya River estuary. Research is also proceeding on industrial waste treatment in Southeast Asia including studies on design criteria for waste stabilization ponds and sludge drying beds, and the progress of biological assimilation of wastes in a tropical climate. Water treatment is another area currently being investigated.

235
MEMORANDUM OF EVIDENCE TO THE MINISTRY OF HOUSING AND LOCAL GOVERNMENT WORKING PARTY ON SEWAGE DISPOSAL,
Committee from the Institute of Water Pollution Control.

Water Pollution Control, Vol 68, No 6, pp 603-609, 1969.

Descriptors: *Water pollution control, *Sewage disposal, *Deterioration, *Sewage treatment, *Treatment facilities, Planning, Storm runoff.
Identifiers: *Separate system, Storm sewage, Great Britain

The Institute of Water Pollution Control gives evidence on and makes suggestions relating to sewage disposal for a Memorandum to the "Jeger" Working Party. Topics discussed are divided into five categories: (1) public health, (2) amenity, (3) economic effects, (4) sewage treatment and disposal processes, and (5) administration and standards. Under the section on amenity, the Institute notes that with regard to the amenities of rivers, the major cause of deterioration is the generally inadequate provision for sewage disposal integral with residential and industrial expansion. Even where adequate sewage treatment facilities exist, storm-sewage discharges often impair river amenities. Separate sewer construction is recommended. Methods of sewage treatment are discussed such as: sewage sludge utilization after heated digestion, plus quaternary processes for de-nitrification, de-salination, and phosphate removal. Other topics covered are: trade effluent control, planning authorities, coastal pollution, settling tank design, and suggestions for investigational research.

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HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS,

Am Iron Steel Inst, New York, N.Y., 1967. 382 pp.

Descriptors: *Drainage, *Construction, *Design data, *Design, *Steel, *Steel structures, *Installation, *Application methods, Construction materials, Construction equipment.

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The main purpose of this handbook is to aid engineers in overcoming problems involved in highway, railway, municipal, agricultural, and industrial drainage and construction. The text aims to present engineering practices based on sixty years of practical experience compatible with existing technology. Design data and designer aids are cited extensively, while theory is kept at a minimum. The design and application of flexible steel underground conduits, plus good installation practices, are described in the first two parts of the book. The third part concerns other steel products for related construction. The first part on general design considerations includes chapters on: product details, strength design, service life, hydraulics, cost factors, couplings and fittings, and installation instructions. Part II on applications covers the following subjects: culverts, sewers, subdrainage, airport drainage, erosion prevention, dam and levee drainage, tunnels, shafts, caissons, underpasses, and service tunnels. The book also contains a glossary of terms, a list of symbols, conversion tables, general tables, and gage/height-of-cover tables.

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HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION: CHAPTER 1 - PRODUCT DETAILS,

Am Iron Steel Inst, New York, N.Y., pp 10-37, 1967. 14 fig, 22 tab, 14 ref.

Descriptors: *Underground structures, *Conduits, *Steel, *Analysis, Steel structures, Design, Surface drainage, Subsurface drainage, Bypasses.
Identifiers: Storm sewers.

This chapter studies product details involved in design of flexible steel underground conduits. Design factors are listed, and the book elects to begin with an analysis of the required strength factor of the conduit wall. The background of corrugated steel conduits is given as well as specifications in common use; a description of corrugations, sectional properties, pipe seams, and shapes of conduits; data on structural plates that are field assembled, and on bolts and nuts, and arch channels. The following three principal types of underground conduits are introduced: (1) conduits for surface drainage, such as culverts, storm sewers, and stream enclosures; (2) conduits for subdrainage for controlling underground water; and (3) conduits for traffic underpasses, and service passes.

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HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION: CHAPTER 2 - STRENGTH DESIGN,

Am Iron Steel Inst, New York, N.Y., pp 38-63, 1967. 18 fig, 5 tab, 20 ref.

Descriptors: *Design, *Underground structures, *Design criteria, *Strength of materials, Design data, Operation and maintenance.

Design methods discussed in this chapter are based on more than sixty years satisfactory field experience with buried flexible structures. The new design approach explained considers overall needs of the drainage structure--environment, service demands, and strength requirements under dead and live loads. Computer analysis is practical and is an anticipated future development when sufficient research evaluates the influence of different soils and compactions on the structure. The following topics are treated in the chapter in the same sequence in which decisions are made in designing buried structures: (1) computation of loads; (2) culvert structural design; (3) earth backfill design; (4) foundation preparation; (5) minimum cover; (6) end treatment; and (7) maintenance.

239
HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 3 - SERVICE LIFE,

Am Iron Steel Inst, New York, N.Y., pp 64-81, 1967. 20 fig, 2 tab, 10 ref.

Descriptors: *Drainage systems, *Steel structures, *Economic feasibility, Inspection.
Identifiers: Soil conditions, Water conditions.

This chapter confirms that corrugated steel drainage structures can be economically designed for either normal conditions or for highly corrosive industrial and sanitary sewers and for mining, salt water and other difficult service conditions. The first section deals with inspection methods and results, including parts on: destructive forces; methods of determining durability; laboratory tests; highway culvert inspections; sewer inspections, air force base drainage inspection; air port drainage; and levee culverts and sewers. Section II concerns the influence of various types of soil and water conditions, and Section III discusses design for service life, including topics such as: the amount of durabil-

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ity needed; service conditions; base metals; galvanized coatings and their service life; non-metallic coatings and linings; pavements in pipe; California service life determination; and miscellaneous products and conditions (subdrainage, steel end sections, steel retaining walls, liner plates, sheeting, and guardrail).

240
HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 4 - HYDRAULICS,

Am Iron Steel Inst, New York, N.Y., pp 82-141, 1967. 47 fig, 18 tab, 22 ref.

Descriptors: *Hydraulic design, *Drainage structures, *Culverts, *Design data, *Runoff forecasting, Open channels, Sewers, Design flow.

Identifiers: *Sewer hydraulics.

This chapter explores the hydraulics of various drainage structures such as open channels, culverts, storm drains, and sanitary sewers, with the emphasis placed on culverts. Section I includes methods of hydrologic design and factors in drainage design. Section II involves the estimation of runoff from small areas and discusses the rational method, watershed characteristics, time of concentration, drainage area, and the Talbot and Burkli-Ziegler formulas. The hydraulics of open drainage channels such as ditches, gutters, and median swales is treated in the next section. Section IV discusses the hydraulics of sewers, including: design flow of sanitary sewers and of stormwater; hydraulic considerations for sewers; transitions, bends, and junctions; pipe friction formulas; values of n -- the roughness coefficient in the Manning equation; determining storm sewer sizes; and the hydraulics of subdrains.

241
HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 5 - COST FACTORS,

Am Iron Steel Inst, New York, N.Y., pp 142-150, 1967. 5 fig, 4 tab, 4 ref.

Descriptors: *Maintenance costs, *Cost analysis, *Cost trends, *Cost comparisons, Costs, Economic prediction.

Cost per year of service depends on durability, maintenance, ease of replacement, and factors influenced by local conditions. Recent trends

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show an increase in pre-engineered and prefabricated structures with consequent reduction of on-the-job labor. This has the following three-way effect: (1) promotes factory-controlled quality under more ideal working conditions; (2) by reducing design and inspection time, it permits the engineer to concentrate on the whole job rather than its details; and (3) although product cost may be higher, installed cost is usually less. Subsections of this chapter discuss: (1) price vs. cost; (2) cost items included; (3) material cost; (4) hauling and handling; (5) excavation and backfill; (6) installation; (7) replacing the traffic surface; (8) detours, slow orders; (9) supervision, overhead, contingencies insurance; (10) engineering costs; (11) unstable foundation conditions; and (12) the cost end of treatment.

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HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 6 - COUPLINGS AND FITTINGS,

Am Iron Steel Inst, New York, N.Y., pp 151-159, 1967. 16 fig.

Descriptors: *Steel pipes, Joints (connections), Installation, Design data.
Identifiers: *Couplings.

Shop-fabricated corrugated steel pipe and pipe-arches are delivered in lengths convenient for shipping and handling. For longer installed lengths, standard connecting bands or special field joints are used. Joint selection criteria covered in this chapter include strength, joint tightness, simplicity, and economy of installation. Also treated are design features of couplings, standard and special fittings, fabrication details, and field installation of fittings.

243
HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 7 - INSTALLATION INSTRUCTIONS,

Am Iron Steel Inst, New York, N.Y., pp 160-183, 1967. 22 fig, 3 ref.

Descriptors: *Steel structures, *Installation.
Identifiers: *Corrugated steel, *Installation methods, Installation procedure.

Because of their strength, light weight, and resistance to fracture, corrugated steel structures can be installed rapidly, easily, and with the least expensive machinery. The first part of this chapter outlines the importance of good installation and the advantages of using corru-

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gated steel in installation procedures. Other subsections discuss: preparation of the base, assembly of pipe culverts and sewers, vertical elongation of corrugated steel pipe, and backfilling. Entire sections are devoted to jacking, boring, lining, and bridge filling.

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HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 9 - SEWERS,

Am Iron Steel Inst, New York, N.Y., pp 202-211, 1967. 9 fig, 4 ref.

Descriptors: *Sewers, *Design standards, *Treatment facilities, Sewerage, Steel, Equipment, Control systems, Control structures.
Identifiers: *Sewer design, Steel structures, Storm sewers, Combined sewers, Sanitary sewers.

This chapter defines terminology associated with sewers and sewerage and explains basics involved in the following areas: sewer system design, corrugated steel sewers, storm sewer inlets, standard and special fittings, manholes, sewer joints and outfalls, sewage treatment plants and lagoons, septic tanks, water control gates, and sewer maintenance and repair. Definitions include: sewer, sewage, storm sewer, sanitary sewer, combined sewer, industrial wastes, half-soling, threading, and tunneling.

245
HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS: CHAPTER 11 - AIRPORT DRAINAGE

Am Iron Steel Inst, New York, N.Y., pp 240-247, 1967. 4 fig, 2 tab, 4 ref.

Descriptors: *Surface runoff, *Drainage systems, *Controlled drainage, *Design standards, *Standards, *Drainage practices, *Rainfall-runoff relationships.
Identifiers: *Airport drainage.

The purpose of airport drainage is to remove water which may hinder any activity necessary for the safe and efficient operation of the airport. Artificial facilities are needed to collect surface runoff, dispose of excess groundwater, lower the water table, and protect slopes. Characteristics of airport drainage are summarized, and a list is presented of information needed prior to designing the drainage system. Requirements of airport drainage differ from those of culverts, storm drains,

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and subdrainage of highways, railways, industrial areas, agricultural, urban, and suburban areas; and these differences are reviewed, especially in regard to rainfall-runoff computations. Four types of drainage appearing on airports are mentioned, and Federal Aviation Agency recommended standards are listed. Remaining sections of the chapter concern the size of conduits, the selection structures, and storm drains.

246
COMBINED SEWER OVERFLOW ABATEMENT TECHNOLOGY,

A Compilation of Papers Presented at the Federal Water Quality Administration Symposium on Storm and Combined Sewer Overflows, Chicago, Illinois, June 22-23, 1970. 336 p.

Descriptors: *Storm runoff, *Overflow, *Conferences, Sewage treatment, Treatment facilities, Water pollution control.
Identifiers: *Combined sewers, *Demonstration projects.

This compilation of papers has been prepared based on a discussion of several demonstration projects. Material from these projects to be highlighted include: 1) alternatives to storm and combined sewer pollution in a small urban area, 2) screening and air flotation for solids removal, 3) underflow deep tunnel system concept, 4) urban erosion and sediment control, 5) sewer monitoring and remote control, 6) combined sewer overflow regulators, 7) use of fine mesh screens, and 8) land use and urban runoff pollution. Each of the papers is abstracted separately.

247
DRAINAGE MASTER PLAN FOR THE CITY OF FORT WORTH, PUBLIC WORKS DEPARTMENT, STORM DRAINAGE CRITERIA AND DESIGN MANUAL,

Knowlton-Ratliff-English, Consulting Engineers, 1967. 74 p.

Descriptors: *Drainage engineering, *Design criteria, *Drainage programs, *Drainage practices, *Storm runoff, *Surface drainage, *Storm drains, *Flood control, Rainfall-runoff relationships, Hydrology, Hydraulic structures, Hydraulics, Intakes, Open channels, Storage, Culverts.
Identifiers: *Fort Worth, Texas, Nomographs, Gutter flows.

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The purpose of this drainage manual is to establish standard criteria, principles, procedures, and practices for the design of storm drainage facilities within the City of Fort Worth, Texas. The manual constitutes the first phase of the development of a master plan for storm drainage to guide the design and construction of storm sewers and channels in the City and its anticipated growth area. The following eight sections give a logical development to the solution of storm drainage problems.

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SECTION I, INTRODUCTION; SECTION II, DETERMINATION OF DESIGN DISCHARGE; SECTION IX, APPENDIX.

In: Drainage Master Plan for the City of Fort Worth Public Works Department, Storm Drainage Criteria and Design Manual, Knowlton-Ratliff-English Consulting Engineers, 1967. 19 p.

Descriptors: *Watersheds, *Time of concentration, *Runoff coefficient, Bibliographies.
Identifiers: *Glossary, Drainage, Computation forms.

Section I is an introduction explaining the purpose and arrangement of the manual. Division of the urban area into defined watersheds, drainage areas, and drainage sub-areas and a system of coding these elements of the drainage system are also presented. Section II sets forth six conditions which should govern the design of a storm drainage system. This section also treats methods for determining the amounts and rates of runoff using the Rational Method and the Unit Hydrograph Method. The Rational Method is specified for watershed areas up to 1,000 acres. Above this area, computations using both methods are specified and the greater discharge is to be used for design of the elements of the system. The use of planimetrictopographic maps of the area is recommended for determining the size and shape of watersheds. Runoff coefficients and graphs of rainfall intensity vs. duration and frequency are included as being representative of the Fort Worth area. A nomograph for computing 'time of concentration' is presented. Section IX constitutes an appendix which includes a glossary of terms, bibliography, and forms for use in making engineering computations.

249
SECTION III, FLOW IN GUTTERS; SECTION IV, STORM DRAIN INLETS,

In: Drainage Master Plan for the City of Fort Worth Public Works Department, Storm Drainage Criteria and Design Manual, Knowlton-Ratliff-English, Consulting Engineers, 1967. 56 p.

Descriptors: *Hydraulic structures.
Identifiers: *Inlets, Drainage design computations, Computation aids.

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Section III presents information, a nomograph, and curves to facilitate making computations required in designing the various hydraulic properties of street gutters and roadway ditches. The nomograph and curves greatly simplify the solutions for depth of flow of drainage runoff in gutters and the lateral spread of the water into traffic lanes. The nomograph and figures, which are graphical solutions of Manning's Equation for uniform flow, are developed for streets of different widths and roughness coefficients, and for streets with straight cross slopes and others with various size parabolic crowns. Section IV presents sketches, criteria and examples to illustrate design procedures, standards and techniques for determining hydraulic capacities and required dimensions of storm drain inlets. Three major classifications of inlets are treated; namely, (1) inlets in sumps, (2) inlets on grade without gutter depression, and (3) inlets on grade with gutter depression.

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SECTION V, FLOW IN STORM DRAINS AND THEIR APPURTENANCES; SECTION VI, DESIGN OF CLOSED STORM DRAINAGE SYSTEM; SECTION VII, DESIGN OF OPEN CHANNELS,

In: Drainage Master Plan for the City of Fort Worth Public Works Department, Storm Drainage Criteria and Design Manual, Knowlton-Ratliff-English, Consulting Engineers, 1967. 29 p.

Descriptors: *Hydraulic design, *Pipe flow, *Closed conduit flow, Channel flow, Concrete pipes, Metal pipes, Drainage systems, Mannings equation, Joints, Head loss, Hydraulic gradient, Roughness coefficient.

Section V presents criteria, procedures, formulas, and roughness coefficients for use in designing the hydraulic elements of storm drains and appurtenances to storm drainage systems. A minimum mean flow velocity of 2.5 ft. per sec. is specified, as are minimum grades for various sizes of concrete pipe and corrugated metal pipe. Charts for facilitating hydraulic computations based upon the Continuity Equation and Manning Formula are included. Tables of design coefficients are included for calculating head losses at inlets, manholes, junctions, bends, obstructions and size changes. The hydraulic grade line is required to be 2 ft. or more below ground or streets. Section VI presents the overall drainage system design procedure, step-by-step, applying the criteria, techniques, formulas, coefficients, and charts presented in the preceding sections of the manual. Section VII presented procedures for designing the hydraulic elements of lined and unlined open channels, rectangular and trapezoidal in cross-section, and natural ditches. The Manning Formula is the basis of design.

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SECTION VIII, DESIGN OF CULVERTS,

In: Drainage Master Plan for the City of Fort Worth Public Works Department, Storm Drainage Criteria and Design Manual, Knowlton-Ratliff-English, Consulting Engineers, 1967. 34 p.

Descriptors: *Drains, *Outlets, *Hydraulic design, Pipes, Roads, Concrete pipes, Metal pipes, Head loss, Roughness coefficient, Culverts.
Identifiers: *Highway drainage, Pipe culverts, Culvert sizing, Nomographs.

Section VIII defines the functions of drainage culverts, presents design criteria, establishes the method of flow determination, and sets forth design formulas, coefficients, and procedures for sizing various types of culverts. It is specified that the quantity of flow shall be determined by the Rational Method or the Unit Hydrograph Method. All designs are to be based on a 50-year storm frequency. Formulas are specified for hydraulic computations under various culvert flow depths and various degrees of submergence at the entrance and inlet. Nomographs are included for use in simplifying computations associated with the hydraulic design of culverts.

252
REPORT OF COMMISSION TO INQUIRE INTO ALLEGED NUISANCES IN AUCKLAND METROPOLITAN DRAINAGE DISTRICT,

New Zealand House of Representatives, 1965. 32 p.

Descriptors: *Sewage treatment, Evaluation, Remedies.
Identifiers: *New Zealand.

This report, on the investigation of nuisances caused by midges and offensive odors at the Mangere sewage works of the Manukau Sewerage Scheme, Auckland, deals with the causes of these nuisances, possible methods of elimination, and the necessity for legislation. Since much of the nuisance is attributable to the sewage reaching the works in a stale condition, it is recommended that the Orakei combined sewerage system be cleaned at least once a year, regular sampling be carried out during periods of low flow, provision be made for the injection of compressed air at each pumping plant to minimize septic conditions in the pressure mains, and the inverted siphons be flushed at least once a week during the dry season. Certain modifications are also recommended at the sewage works, including the covering of preliminary aeration and primary sedimentation tanks, the use of percolating filters to

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regulate the load on the oxidation ponds, and the reduction of recirculation of effluent to increase the period of sedimentation and the amount of sludge digested. In view of the increasing population, the design load of the works for a population of 800,000 will possibly be reached by 1986; and since the existing oxidation ponds cannot be extended economically, investigations are necessary to determine the best process for the extensions. It is proposed to consider the activated-sludge process.

253
URBAN WATER RESOURCES RESEARCH; SYSTEMATIC STUDY AND DEVELOPMENT OF LONG - RANGE PLANS, FIRST YEAR REPORT, SEPTEMBER, 1968,
ASCE - Urban Hydrology Research Council

Office of Water Resources Research Contract No 14-01-0001-1585, various paging, 1968.

Descriptions: *Rainfall-runoff relationships, *Urbanization, *Systems analysis, *Drainage engineering, Data collections, Storm runoff, Urban sociology, Community development.
Identifiers: *Urban hydrology.

The first year emphasis was on subjects requiring earliest consideration, such as urban storm drainage. An assessment is given of the potentials, liabilities, and available knowledge of the rainfall-runoff-water quality process; and model requirements for process simulation are detailed. Immediate research needs with regard to damage evaluation are given; and the utilization of storage to ameliorate flooding is outlined. The principal non-hydrologic aspects of urban water are listed, and include administration of works, economics of planning and operation, financing of systems, recreational facilities, planning and operation, and sociological problems. The report contains 11 appendices, each with technical papers dealing with the appendix subject.

254
COMBINED SEWER OVERFLOW SEMINAR PAPERS; Compilation of Technical Papers and Discussions Presented at a Seminar at Hudson-Delaware Basin FWQA Office, Edison, New Jersey,

Water Pollution Control Research Series, Report DAST-37, 1970. 199 p.

Descriptors: *Overflow, *Conferences, Storm runoff, Sewage treatment, Water pollution control.
Identifiers: *Combined sewers.

This report is a compilation of twelve papers dealing with various aspects of combined sewer overflows, such as: storage and treatment of

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combined sewage as an alternate to separation, polymers for sewer flow control, treatment methods, microstraining with ozonation and chlorination of combined sewer overflows, a simulation technique for assessing storm and combined sewer systems, and the Boston deep tunnel plan. Each of the papers is abstracted separately.

255
MASTER PLANNING FOR STORM RUNOFF FOR NEW NORTH/SOUTH RUNWAY AND ENVIRONS --STAPLETON INTERNATIONAL AIRPORT,
Wright-McLaughlin Engineers, Denver, Colorado

Report given to the City and County of Denver, Depart of Public Works, Nov 1969. 39 p. 13 fig, 5 tab.

Descriptors: *Storm runoff, *Ponding, *Airports, *Detention reservoirs, *Drainage, *Drainage engineering, *Drainage programs, *Runoff, Pondage, Flood control.

Identifiers: *Denver, *Stapleton International Airport, Storm sewers.

This engineering report is unique because it incorporates new and unconventional concepts in planning drainage facilities for removal of storm-water runoff. The master plan for providing storm-water drainage at Stapleton Airport emphasizes detention and slow discharge of runoff at outlet points. Conventional designs usually embody high discharge rates at outlets which promotes downstream flooding. The drainage of Stapleton Airport has been complicated by the construction of a new highway and a new runway, both of which combined to block overland drainage and discharge to Sand Creek. In addition, new land development nearby and the probability of constructing another runway further complicates the drainage problem. The engineers propose the development of unconcentrated overland flow planes as well as swales and grass-lined open channels on flat grades to convey runoff slowly to existing and proposed detention ponds and outlets. Rooftop ponding is recommended for new buildings proposed on and near the airport. Undersized storm sewers are recommended to force overland flow during intense storms—thereby reducing discharge rates and downstream flooding.

256
URBAN STORM DRAINAGE CRITERIA MANUAL,
Wright-McLaughlin Engineers, Denver, Colo

Work performed for the Denver Regional Council of Federal Governments. Vols I and II, Mar 1969.

Descriptors: *Drainage engineering, *Design criteria, *Drainage programs, *Drainage practices, *Storm runoff, *Surface drainage, *Storm

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drains, *Flood control, Rainfall-runoff relationships, Hydrology, Hydraulic structures, Water law, Administration, Watershed management, Hydraulics, Intakes, Open channels, Storage, Culverts, Drainage systems.
Identifiers: *Denver, *Storm drainage policy, Street drainage, Curb and gutter design.

The manual was written to suggest techniques, methodology, and guidelines to facilitate the implementation of a new and more thorough approach to storm drainage problems in Metropolitan Denver. The authors recommend adoption of the manual by government agencies in Metropolitan Denver, and that the Denver Regional Council of Governments provide coordinate drainage activities. The following eight chapters are a review of the most comprehensive treatment of urban storm drainage design criteria available.

257
DRAINAGE POLICY, (CHAPTER 1)
Wright-McLaughlin Engineers, Denver, Colo

In: Urban Storm Drinage Criteria Manual, Vol 1, Mar 1969. 54 p.

Descriptors: *Design criteria, *Water policy, *Drainage programs, *Drainage practices, *Drainage engineering, *Storm runoff, *Watershed management, *Flood control, Design standards, Flood plains, Design storm, Storage, Watersheds (basins), Surface runoff, Drainage, Surface drainage, Drainage systems, Drainage water, Hydrology, Ponding, Rational formula.
Identifiers: *Denver, *Storm drainage policy.

This chapter recommends the adoption of this manual by government agencies. Storm drainage is presented as a 'space-allocation' problem demanding planning and integration on a regional basis. A set of policy statements, based upon underlying principles, technical criteria, and data is recommended to provide direction for planning, providing, and operating drainage facilities. These statements call for the initiation of flood plain management programs and a program for collecting and analyzing stormwater runoff and flood data. Stormwater drainage master plans, based upon the criteria in this manual and consistent with the comprehensive plan, are encouraged for adoption by each urbanized drainage basin. Coordination by the Denver Regional Council of Governments is suggested. The report includes recommendations for participation by governmental units in the National Flood Insurance Act of 1968. Design criteria discussed relate to storm frequency, initial and major drainage system considerations, natural drainage-ways, water quality control, and runoff computation. Emphasis is placed upon coordinating drainage planning with transportation and open space planning.

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SUMMARY OF COLORADO DRAINAGE, (CHAPTER 2), AND PLANNING (CHAPTER 3), Wright-McLaughlin Engineers, Denver, Colo

In: Urban Storm Drainage Criteria Manual, Vol 1, Wright-McLaughlin Engineers, Mar 1969. 43 p.

Descriptors: *Water law, *Legal aspects, *Legislation, *Natural flow doctrine, *Administration, *Watershed management, *Flood routing, *Water resources planning, *Riparian rights, Water rights, Judicial decisions, Obstructions to flow, Drainage programs, Flood control.
Identifiers: *Denver.

Chapter 2 presents the responsibilities and legal liabilities of municipalities relating to planning, constructing, operating, maintaining, and repairing drainage improvements. The importance of obtaining all pertinent facts and developing a plan before initiating a proposed improvement is stressed. Municipalities proceeding in this manner can be relatively assured of no legal complications and should be able to use any of several different means to finance proposed improvements. Specific legal actions are cited and briefed. Chapter 3 cites drainage systems as being subsystems of the total urban system, affecting orderly growth and development. Planning should include consideration of multiple-uses and additional benefits which can result from well planned drainage systems. Emphasis is placed upon adopting plans which incorporate undisturbed natural swales and waterways. Other aspects discussed include drainage management measures, master planning, flood plain planning, initial and major systems, transportation facilities relationships, open space, and planning and sizing storm sewer systems.

259
RAINFALL FOR THE DENVER REGION, (CHAPTER 4), AND RUNOFF (CHAPTER 5), Wright-McLaughlin Engineers, Denver, Colo

In: Urban Storm Drainage Criteria Manual, Vol 1, Wright-McLaughlin Engineers, Mar 1969. 77 p.

Descriptors: *Rainfall, *Runoff, *Rainfall disposition, *Rainfall intensity, *Hydrology, *Rainfall-runoff relationships, *Storm runoff, *Design criteria, *Drainage engineering, Design storm, Duration curves, Hydrograph analysis, Unit hydrograph, Rational formula, Flood forecasting, Frequency analysis.
Identifiers: *Denver.

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The chapter on 'Rainfall' suggests a rainfall analysis technique similar to that employed by the U.S. Weather Bureau. The chapter includes several key rainfall-frequency maps making it possible to determine any combination of return-period from one to 100 years and durations from 5 minutes to 24 hours. Chapter 5 describes in detail the following three methods of calculating runoff applicable to Metropolitan Denver: (1) Rational Method, for sewers draining areas less than 200 acres; (2) Colorado Unit Hydrograph Procedure, for sewers draining basins in excess of 200 acres; and (3) Statistical Analysis, for streams upon which future urbanization will have little effect on runoff inflow. Two statistical methods are illustrated: (1) Log-Pearson Type III, and (2) Index Flood. Flood Plain Information Reports, prepared by the Corps of Engineers for delimiting flood hazard areas and stream surface profiles, are cited. Users are urged to allow for anticipated urbanization.

260
STORM SEWERS (CHAPTER 6); STREETS AND INTERSECTIONS (CHAPTER 7); AND STORMWATER INLETS (CHAPTER 8),
Wright-McLaughlin Engineers, Denver, Colo

In: Urban Storm Drainage Criteria Manual, Vol 1, Wright-McLaughlin Engineers, Mar 1969. 252 p.

Descriptors: *Storm drains, *Drainage systems, *Design criteria, *Hydraulic design, *Intakes, Design standards, Surface drainage.
Identifiers: *Street drainage, *Street design criteria, *Stormwater inlets, Curb and gutter design, Storm sewers.

The chapter on 'Storm Sewers' presents criteria intended for use by engineers in designing systems of storm sewers for collecting and conveying stormwater runoff to points of discharge in the major drainage system, including conduits, channels, inlets, bends, junctions, manholes, outlets, pressure systems, and the related hydrologic aspects of rainfall and runoff. Chapter 7 presents criteria and suggested procedures and standards for street design. Drainage design of streets is approached from the standpoint of providing systems to drain streets and, secondarily, using streets as integral parts of local drainage systems. Chapter 8 discusses the various types of inlet devices used for providing openings to drain stormwater from streets into sewers. Design criteria and inlet capacity graphs are treated in detail. Several examples of typical designs of storm sewers, streets, and stormwater inlets are presented.

261
PILOT PLANNING STUDY FOR AREA WIDE STORM DRAINAGE PLANNING,
Wright-McLaughlin Engineers, Denver, Colo

Pilot Planning Study for Area Wide Storm Drainage Planning, Vol II, April 1969. 76 p.

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Descriptors: *Planning, *Water management (applied), *Flood control, *Drainage, Drainage systems, Flood plain zoning, Methodology, Estimated costs, Legal aspects, Multiple-purpose projects, Regional analysis, Hydrograph analysis, Unit hydrograph, Detention reservoirs, Channels, Conduits.
Identifiers: *Boulder, Colorado, *North Boulder, Colorado, *Environmental design.

This pilot planning study includes: (1) the development of a methodology for the preparation of an area wide storm drainage plan, (2) a study of alternate solutions to the North Boulder, Colorado major drainage problems, (3) preparation of storm drainage master plans for five North Boulder waterways, and (4) development of a financing strategy and a practical test of the recently completed Urban Storm Drainage Criteria Manual. North Boulder was chosen as a pilot study because it represented most of the urban drainage problems found in the Denver region and because it had no flood plain management program, policy, or regulation ordinances. Field and office studies to develop all practical alternates and to study these alternates using a qualified environmental design team approach defined the problem. Economics, comprehensive plans and programs of the city and county, open space needs, greenbelt requirements, and legal aspects of urban storm drainage were all taken into consideration when evaluating alternates. A detailed discussion of the Colorado Urban Hydrograph Procedure, which was used in determining flood magnitudes was given. The report is contained in two volumes: Volume one contains the text of the report and Volume two contains thirty detailed drawings of the proposed Wonderland Creek Drainage.

262
LANCASHIRE RIVER AUTHORITY. FIRST AND SECOND ANNUAL REPORTS FOR THE PERIOD 15TH OCTOBER 1964 TO 31ST MARCH 1966 AND THE YEAR ENDED 31ST MARCH 1967,

Descriptors: *Water quality, *Water pollution sources, *Water pollution control, *Standards, *Storm runoff, *Design, Effluents, Estuaries, Evaluation.
Identifiers: Storm sewage.

The Lancashire River Authority has taken over the functions of the former Lancashire River Board in regard to land drainage, fisheries, and pollution prevention; and it also exercises new functions relating to the conservation and management of water resources. The annual reports contain sections on all these aspects of the work, and tabulated analytical data are appended for various rivers. In the first report, a summary is given of the features influencing the quality of water in rivers and streams in the area. A map has been prepared indicating the general level of water quality in the various streams. The sources of

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pollution and remedial action are outlined. Standards for sewage effluents are based on those of the Royal Commission except in a few cases where more stringent or extended standards are necessary owing to local conditions. Wherever possible, permission is given for discharge of storm-sewage flows in excess of 3 times the normal flow receiving complete treatment, with no limitation on BOD and a relaxed standard of 100 mg per litre for suspended solids. Under certain circumstances storm flows exceeding about 300 gal per head per day may also be discharged after removal of coarse solids. The Authority encourages discharge of trade effluents to the sewers, but where this is impossible the standards applied are similar to those for sewage effluents. Discharge of effluents to underground strata is discouraged owing to the possibility of contamination of ground water; however, this is not considered to include the disposal of small volumes of sewage effluent via subsurface soakaway systems and this method of disposal is advocated wherever practicable. Preliminary work has been undertaken on the water demands and resources of the area, and a hydrometric scheme has been prepared. As an alternative to the Morecambe bay barrage, it has been suggested that small barrages be constructed at Arnside on the Kent estuary and Greenodd on the Leven estuary. Consideration is being given to the establishment of minimal acceptable flows for the inland waters and suitable data are being collected. A technical note is appended to the second report, describing the operation of dissolved-oxygen recorder on the River Calder at Whalley. Information was obtained showing the effects of climatic and storm conditions on the dissolved-oxygen concentration in the river. Although the dissolved-oxygen concentration is usually above 75 per cent saturation, it decreases while the initial wave of storm runoff is passing downstream. In the absence of an increased runoff from the Ribble catchment to compensate, conditions harmful to migratory fish might occur in the Ribble below the Calder confluence.

263
WATER RESEARCH: MAJOR RESEARCH PROBLEMS IN HYDROLOGY AND ENGINEERING,

William Ackermann
The Johns Hopkins Press, Baltimore, Maryland, pp 495-501, 1966. 11 ref.

Descriptors: *Information retrieval, *Planning, *Water resources, Engineering geology, Dams.
Identifiers: *Water resources information, Urban hydrology.

Sources of information on water resources problems in general are discussed, such as government publications and publications of activities of professional organizations like the American Geophysical Union. Research problems on hydrology and engineering cited as needing special

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attention are: river forecasting for water resource management, urban hydrology, the engineering and geology of dams, evaporation and transpiration, and prime water resources. (See abstract number 292).

264
LAKE COUNTY ADOPTS CLEAN LAKE POLICY,

R. E. Anderson
Water Sewage Works, Vol 115, No 11, pp 412-415, Nov 1968.

Descriptors: *Sewage effluents, *Sewage treatment, *Water pollution control, Hydraulics.

Identifiers: *Lake County, Illinois, *Storm sewage, Capacity.

Effluents from sewage works of the North Shore Sanitary District, Lake County, Illinois, will be discharged into the Des Plaines river instead of into Lake Michigan, thus reducing pollution of the lake. Those works giving primary treatment only will be abandoned, and their services absorbed in expansion programs of other works. The capacity for storm sewage flows is to be increased, so that storm sewage will not enter the lake but will be pumped to works for treatment after the storm.

265
A STORM DRAINAGE AND OPEN SPACE MASTER PLAN FOR HAMILTON COUNTY, OHIO,
Hamilton County, Ohio Regional Planning Commission
Ralph G. Berk
Urban Planning Project, Ohio, P-53, Dec 1966. 77 p. 13 fig, 2 plates.

Descriptors: *Drainage systems, Storm runoff, Sewers, Urbanization, Surface runoff.
Identifiers: *Hamilton County, Ohio.

A planning study of Hamilton County, Ohio which provides a complete inventory and location of all streams, culverts, and bridges having drainage areas greater than 300 acres is presented. The complete physical characteristics of the drainage structures and the intervening reaches of their streams are given. A method is developed for determining flood flows. Flow quantities to be considered for design purposes are established, as well as indications for improvement of inadequate flows. The study provides accurate information about present and future flood hazards, their location and extent; the erosion and siltation problems; and open space needs. Provided are suggestions for subdivision regulations for the enabling and enforcing of protective measures. Guidelines for legislation necessary for carrying out any plans selected by decision makers are supplied. Suggestions for the financing and administering of public improvement programs are also made.

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266
A LONG-TERM PLAN FOR SEWERAGE DEVELOPMENT IN THE JOHANNESBURG REGION,

V. Bolitho
Water Pollution Control, Vol 69, No 1, pp 79-91, 1970.

Descriptors: *Waste water treatment, Water resources, Overflow, Hydrology.
Identifiers: *Sewer hydraulics, Outfall sewers, Storm sewage, Combined sewers, Johannesburg, South Africa.

The present-day Johannesburg waste water scheme is described along with long-term planning needs for expansion of water resources systems. Population forecasts are used in considering water usage and its effect on sewer flows. Present problems of outfall sewer designs are discussed including the imperfect separation of storm and sewage flows and the obsolence of outfall sewers due to overload from combined sewage and storm overflows. The capacity of existing treatment works is also considered as well as developments in treatment technology and recommendations for the enlargement of sewers to meet future demands. Financial implications of the development plans are included.

267
THE COST OF SEWAGE TREATMENT,

R. M. Bradley and Peter C. G. Isaac
Water Pollution Control, Vol 68, No 4, pp 368-402, Jul 1969.

Descriptors: *Costs, *Sewage treatment, Cost analysis.
Identifiers: *Sewer hydraulics, Great Britain.

A detailed report on capital and operational costs with data for 79 works situated in areas of England, Scotland, and Wales, all of which were commissioned after 1952, is presented. Graphs of costs in relation to specific problems are shown as well as cost analysis charts. Some works had a record of the total flow entering the works in various time periods, but few were able to differentiate between the flows receiving full treatment and those diverted to storm treatment. Because of the lack of reliable flow data, operating cost data is presented on a population basis.

268
FINANCING CONSTRUCTION OF A MAJOR DRAINAGE IMPROVEMENT,

Peter M. Callihan
Public Works, Vol 100, No 6, pp 105-106, Jun 1969.

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Descriptors: *Storm runoff, *Construction costs, Drainage systems, California.
Identifiers: Drainage improvements

Rohnert Park, Sonoma County, and the Sonoma County Flood Control District have developed a new method of financing major drainage channels. One channel, which served as a major drainage facility to accomodate storm flows from the anticipated high density development area, could not be improved because of costs. A policy requiring land developers to improve all major drainage ways was adopted and the problem was solved. A large drainage area plan is discussed along with problems of financing its improvements.

269
ON WATER POLLUTION CONTROL POLICY,

Thomas R. Camp
Eng News-Record, Vol 181, No 7, pp 22-23, Feb 12, 1970.

Descriptors: *Pollution abatement, *Regulation, Storm drains, Sewer separation.
Identifiers: *Construction grants, *Combined sewers, *Viewpoint.

The author criticizes the FWPCA's new policy of refusing construction grants for projects that provide less than 85% removal of five-day BOD, because this requirement does not cover the oxygen demand of ammonia (derived from human urine) or of combined sewer overflows. This policy would eliminate aid to most communities since many areas have combined sewer overflows. Big cities are cited as having the worst water pollution problems because they utilize storm drains as combined sewers, and street congestion hinders sewer separation. Chicago's alternate solution of underground deep rock storage tunnels for sewage is described and praised. The following recommendations are made towards achieving pollution abatement: (1) authorization for grants-in-aid to solve combined sewer problems; (2) mandatory heavy chlorination of sanitary sewage; (3) water pollution control authorities to manage watersheds; and (4) FWPCA's promotion of further legislation required to carry out the above aims.

270
PLAN AND PROGRAM FOR THE BRANDYWINE,

Robert J. Coughlin, John C. Keene, Benjamin H. Stevens, and Ann Louise Strong
Pennsylvania Univ, Inst for Environmental Studies, Oct 1968.

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Descriptors: *Urbanization, *Drainage systems, *Land use, *Water resources development, Storm runoff, Real property, Legislation.
Identifiers: *Conservation easements, Brandywine, Pennsylvania, Chester County, Pennsylvania.

The Plan is a proposal for the wise use of the water and land resources of the Upper East Branch of Brandywine Creek, Chester Co., Pa. The Plan was developed for the Chester Co. Water Resources Authority by the Institute for Environmental Studies, University of Penna; Regional Science Research Inst.; United States Geological Survey; and their consultants. The aim of the Plan is to prevent deterioration of the water resources and thus to retain the amenities of related land when urbanization occurs in the Brandywine watershed. The Plan recommends 3 types of action; public purchase of conservation easements or other less than fee interests on flood plains, stream and swale buffers, steep slopes, and forests; development and adoption of detailed water supply and sewage disposal plans in advance of urbanization; and enactment of strong local regulations for erosion and storm runoff control.

271
WATER RESEARCH: SOME OBSERVATIONS ON RAINFALL AND RUNOFF,

Norman H. Crawford
The Johns Hopkins Press, Baltimore, Maryland, pp 343-353, 1966. 10 fig, 5 ref.

Descriptors: *Runoff, *Runoff forecasting, *Rainfall-runoff relationships, Synthetic hydrology, Volumetric analysis.
Identifiers: *Volume-time distribution.

This paper's purpose is to explain the complex processes involved in finding the volume and time distribution of runoff; two factors basic to the study of the rainfall-runoff relationship. Illustrations of the role of various basic hydrologic processes are made using digital synthesis models (Standford Watershed Model IV). A schematic description of a watershed, presented in the first section, provides background for concepts and terms which follow. The second section discusses volume of runoff, and the third illustrates timing and runoff distribution. The conclusion comments on education in the response of watersheds to rainfall and on the application of synthesis methods of investigation to water resources studies in general. (See abstract number 292).

272
KNOWLEDGE OF SEDIMENTATION IN URBAN ENVIRONMENTS,

David R. Dawdy
J Hydraulics Div, Am Soc Civil Engrs, Vol 93, No HY6, pp 235-245, Nov 1967.

Descriptors: *Sediment yield, Drainage effects, Geomorphology, Urbanization.
Identifiers: Sedimentation data.

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The two types of sedimentation data are associated with: 1) gross drainage basin sediment yield; and, 2) time variability of sediment yield. For a given basin, the greater the forested area the smaller the sediment yield, and the effects of urbanization may influence the base condition of a given area. Geomorphic changes may be induced by the increased variability of flow caused by urbanization and highway construction.

273
FEDERAL GRANTS FOR MUNICIPAL WASTE TREATMENT--THE NEED FOR POLICY CHANGE,

James R. Ellis
J Water Pollution Control Fed, Vol 42, No 5, Part 1, pp 679-684, May 1970. 1 tab, 2 ref.

Descriptors: *Separation techniques, *Grants, *Pollution abatement, Overflow.
Identifiers: *Abatement facilities, *Combined sewers, *Policy change.

The article cites the federal government's neglect of big city's water pollution abatement needs. Recommended are federal grants for construction of combined sewer overflow abatement facilities, since this pollution problem is not solved by installation of wastewater treatment plants. Either sewer separation or stormflow storage is needed before treatment, and such projects are not now eligible for federal grants. Other suggestions include: (1) authorization of incentive grants for new big-city projects until recipients receive the level of federal support they deserved since 1956; (2) making federal grant committments reliable and adequate as to dollars; (3) strengthening the market for local bonds by renouncing abortive efforts to tax municipal bonds; (4) implementation of regulatory standards encouraging towns to correct their worst problems and to achieve the most pollution abatement for each federal and local tax dollar; and (5) encouraging local use of sewer service by offering a federal grant incentive, but prohibit an industry from destroying any stream for a fee.

274
ON THE CONCEPT OF MUNICIPAL SEWERAGE SYSTEMS,

H. Fathmann
IWL Forum 66/1, pp 1-23, 1966.

Descriptors: *Sewage treatment, *Costs, *Drainage systems, *Equipment, Design.

The author deals with various problems which are encountered in the design and operation of sewage works for local communities. Particular

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reference is given to the cost of drainage systems and mechanical treatment plants, the control of storm sewage overflows, the operation of screens, detritus, sedimentation and humus tanks, and the advantages of percolating filters and activated-sludge plants.

275
STATUS AND PROPOSED CONTROL OF POLLUTION IN BOSTON HARBOR AND ITS TRIBUTARIES,

John J. Flaherty
J Boston Soc Civil Eng, Vol 55, No 4, pp 221-230, Oct 1968.

Descriptors: *Pollution abatement, Sewerage, Discharge, Overflow, Storm runoff.
Identifiers: *Boston, Separate system, Deep tunnel plan, Combined sewers.

Stormwater overflows from combined sewerage systems and from industrial wastes is the principal cause of river pollution in the Boston area. About 100 outlets into the Harbor and its tributaries are affected by Boston storm overflows and combined sewer discharges from neighboring communities. Four principal alternative methods of pollution abatement for the area are: 1) complete separation of all sanitary sewerage and storm drainage systems, 2) construction of chlorination detention tanks, 3) construction of surface holding tanks, and 4) implementation of the deep tunnel plan. Engineers recommend the construction of sanitary sewers and storm conduits wherever existing principal design flows or runoff from 15-year frequency design rainstorms. The governmental agencies responsible for pollution control, as well as various studies and approaches to alleviation and abatement methods are listed. Results indicated that the most positive method of collecting and disposing overflows of mixed sewage and stormwater is the deep tunnel plan.

276
WATER RESEARCH: MAJOR RESEARCH PROBLEMS IN WATER QUALITY,

Ernest F. Gloyna
Johns Hopkins Press, Baltimore, Maryland, pp 479-493, 1966. 3 tab, 19 ref.

Descriptors: *Water pollution, *Water quality, *Pollutants, Water quality control, Research and development.
Identifiers: *Urban drainage.

This section describes the nature of pollution, some dimensions on quality, the current status of water renovation, and research needs. Considerable background information is provided. Types of pollution discussed are: disease-causing pollution, and conservative and non-

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conservative pollution. Factors which influence water quality are examined, namely: usage, natural pollution, agricultural and urban drainage, waste-solids disposal practices, recreation, and certain political implementations. The following are areas related to water quality which need the most research: improvement of treatment processes, translation of theory to design, optimization of water quality management, development of stream use criteria, groundwater quality management, and improvement of marine disposal systems. (See abstract number 292).

277
ARCTIC HEATED PIPE WATER AND WASTE WATER SYSTEMS,

J. W. Grainge
Water Res, Vol 3, No 1, pp 47-71, Jan 1969.

Descriptors: *Sanitary engineering, *Sewerage, Pipes.
Identifiers: *Canada.

Sanitation problems of communities in Northern Canada are discussed, and some environmental conditions are evaluated. Improvements in sanitation in small Canadian communities by providing piped water and sewage services have been proposed. Two original, relatively inexpensive, all-weather systems suitable where pipes may not be buried on account of soil conditions are described. Ideas and suggestions for planning water and sewerage systems are given.

278
DRAINAGE OF ROADS AND PAVED SURFACES,

M. J. Hamlin and F. D. Hobbs
Inst Public Health Engrs, Vol 69, Part 2, pp 122-141, Apr 1970.

Descriptors: *Rainfall intensity, *Storm drains, Hydraulic design, Roads.
Identifiers: *Stormwater inlets.

Factors to be considered in designing stormwater inlets for roads are discussed utilizing hydraulic requirements rather than a purely empirical viewpoint. Rainfall intensity is one determining factor since, theoretically, rainfall intensity is a function of the area to be drained. The intensity of rainfall and the period for which it lasts varies across the country, and therefore, this factor must be carefully evaluated before designing stormwater inlets.

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WATER SUPPLY AND WASTE DISPOSAL,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., 1960. 513 p.

Descriptors: *Water supply, *Waste disposal, *Sanitary engineering, *Design, *Operations, *Industrial wastes, *Water treatment.

This volume presents the theory and practices relating to the interrelationship between the basic problems of water supply and waste disposal. The authors provide an integrated treatment of the fundamentals common to both of these areas of sanitary engineering. Detailed are the design and operation of systems for water supply and waste disposal. Problems in water supply caused by over-population and expansion plus unusual disposal dilemmas created by increased amounts of industrial waste products are described, and some solutions are proposed. The first nine chapters concern basic principles of water supply and waste disposal including: water use and sewerage volume, piping for water and sewage systems, and the collection and storage of water. The last fourteen chapters relate to either problems or solutions such as: water treatment by screening and sedimentation; control of corrosiveness, taste, and odor; sludge treatment and disposal; filtration and disinfection of water; removal of dissolved minerals from water; the activated sludge process; and primary and secondary sewage treatment.

280
WATER SUPPLY AND WASTE DISPOSAL - CHAPTER 1 - THE WATER-SEWAGE CYCLE,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., pp 1-7, 1960. 4 fig, 6 ref.

Descriptors: *Water supply, *Sewage disposal, *Storm drains, *Sewage treatment, *Water treatment, Separation techniques.
Identifiers: *Storm sewers.

This chapter enumerates the functions of water supply and sewage disposal systems and discusses terminology, financing, and other elements of each system. A section on storm drainage recommends the provision of separate sewage and stormwater systems when sewage treatment is required. General information on water and sewage treatment is also included in this chapter. (See abstract number 279).

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281
WATER SUPPLY AND WASTE DISPOSAL - CHAPTER 2 - QUANTITY OF WATER FROM RAINFALL,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., pp 8-39, 1960. 13 fig, 6 tab, 11 ref.

Descriptors: *Rainfall, *Snowfall, *Runoff, *Streamflow, *Measurement, *Water yield, *Surface waters, *Water quality, *Rainfall disposition, *Storm drains, *Design, *Rational formula, *Runoff forecasting, Groundwater, Percolation, Evaporation, Absorption.

The first three sections of this chapter involve rainfall and snowfall, rain measurement, and rain making. Next, runoff is described with a method for measuring streamflow. Other sections discuss the estimation of watershed yield, empirical formulas for runoff of water supply, an investigation of the source for yield, and the quality of surface water. Rainfall-runoff proportions, along with rainfall rate and duration, are cited as important criteria for designing storm drainage facilities. Techniques for computing these three elements are given including the Rational Method and the Burkli Zeiger empirical formula for determining runoff. Other topics treated in the chapter include: percolation and absorption, evaporation, and groundwater. (See abstract number 279).

282
WATER SUPPLY AND WASTE DISPOSAL - CHAPTER 4 - HYDRAULICS OF WATER AND SEWAGE CONDUITS,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., pp 59-72, 1960. 5 tab, 3 fig, 2 ref.

Descriptors: *Pipe flow, *Pipes, *Sewers, Mannings equation.
Identifiers: *Sewer hydraulics.

General formulas describing the flow of water in pipes are used to compute pipe sizes. Such formulas and other aspects of flow in water pipes are presented in this chapter. Flow in sewers is described specifically with reference to the Manning Formula and other formulas. Additional topics discussed are: limiting velocities in sewers, and the design of full and partly filled sewers excluding circular sewers. (See abstract number 279).

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283
WATER SUPPLY AND WASTE DISPOSAL - CHAPTER 5 - PIPING FOR WATER AND SEWER SYSTEMS,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., pp 73-98, 1960. 22 fig, 3 tab, 10 ref.

Descriptors: *Water supply, *Construction, *Construction materials, *Sewers, Design, Piping systems (mechanical).
Identifiers: Pipe construction.

Requirements for the construction of water supply and sewer pipes are listed, and descriptions of the most commonly-used materials are included. Cast-iron, asbestos-cement, concrete, and steel are discussed in terms of their use in water supply pipe construction. Vitrified-clay, concrete, and asbestos-cement are described for sewer pipes. Other topics in this chapter are: service pipes, electrolysis, water hammer, the thickness of metal pipe, appurtenances for water systems (valves, meters, hydrants) and for sewers (manholes, drop manholes, inlets, catch basins, flush tanks, diverting weirs, inverted siphons, and outlets), junctions of large sewers, loads on pipes in trenches, and the testing of sewer pipe strength. (See abstract number 279).

284
WATER SUPPLY AND WASTE DISPOSAL - CHAPTER 8 - COLLECTION AND TRANSPORTATION OF SEWAGE,

W. A. Hardenbergh and Edward B. Rodie
International Textbook Company, Scranton, Pa., pp 161-190, 1960. 3 tab, 8 fig, 4 ref.

Descriptors: *Sewerage, *Sewers, *Storm drains, *Design standards, *Specifications, Runoff, Time of concentration, Construction, Measurement.
Identifiers: *Storm sewers, *Capacity, Combined sewers, Curved sewers.

Subjects discussed in this chapter include: the layout of a sewerage system, the position of the sewer in the street, the procedure for establishing layout, and the design of sanitary sewers. Also described is the design of a storm drainage system including information of the inlet time or time of concentration, runoff, sizes and gradients of storm sewers, and inlet capacity. Combined sewers, noted to be rarely-built, follow the same design as that for storm sewers although their shape may be modified. Sewer construction, infiltration measurement, records, and curved sewers are additional topics explored. (See abstract number 279).

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TARGET DATES FOR SECONDARY TREATMENT AND STORMWATER SEPARATION ON LOWER MISSOURI AND MISSISSIPPI RIVERS,

Glen J. Hopkins
Paper presented at the annual meeting of the Missouri Water Pollution Control Association, Jefferson City, Missouri, February 23, 1970.

Descriptors: *Water pollution sources, *Pollution abatement, Missouri River, *Mississippi River, *Surface runoff, Water pollution, Sewage treatment, Separation techniques, Overflow.
Identifiers: *Agricultural land runoff, Combined sewers.

The author discusses sources and effects of pollution in the lower Missouri and Mississippi Rivers, and explains his reasons for opposing secondary treatment and storm sewer separation for this area. He states that sufficient pollution abatement has already taken place in these rivers and that communities need not waste tax dollars supporting federal grants for further pollution prevention facilities. According to Mr. Hopkins, the Missouri River can assimilate wastes properly with the treatment that is presently offered. He also asserts that sewered wastes, municipal and industrial, and combined sewer overflows cause far less pollution to the rivers than does surface runoff from agricultural lands upstream. Cost of sewer separation for this area is estimated to exceed $250 million.

286
BUILDING PLANS AS A BASIS FOR THE DESIGN OF WATER AND SEWAGE WORKS,

E. Hornig
Gas Wasserfach (GAWFAN), Vol 107, pp 32-36, 1966.

Descriptors: *Planning, *Hydraulic engineering.
Identifiers: *Germany.

The federal German building plan of 1960 can also be applied to hydraulic engineering. The number of future inhabitants per 103 sq. m. for town and country planning is calculated by statistical analyses and also represents an overall basis for the future requirements of water supplies and sewage treatment facilities. This plan takes into consideration the average rainfall and the pollution potential of the population.

287
MASTER WASTEWATER COLLECTION AND TREATMENT PLAN FOR BOGOTÁ, COLUMBIA,

D. R. Horsefield
J Water Pollution Control Fed, Vol 48, No 8, pp 1443-1458, Aug 1968.

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Descriptors: *Sewage disposal, *Design, Construction costs, Sewerage.
Identifiers: *Bogotá, Columbia, *Interceptor sewer, Stormwater disposal, Combined sewers.

Bogota has a population of 1,700,000 and an average wastewater flow of 88.2 mgd, both of which are expected to increase substantially by 1985. A Master plan for the disposal of domestic and industrial wastes, and stormwater through a multi-stage program consisting of canal and intercepting sewer construction is presently in the first stage and total costs are estimated at $85,000,000. Separation of existing combined sewer areas is not recommended because of cost and public inconvenience. Graphs concerned with water consumption trends, wastewater, sanitary sewage discharges, rainfall-runoff, and costs are included; and canal designs are pictured. Problems encountered, methods used, and design criteria are discussed.

288
THE INFLUENCE OF SALTS APPLIED TO HIGHWAYS ON THE LEVELS OF SODIUM AND CHLORIDE IONS PRESENT IN WATER AND SOIL SAMPLES,

Frederick E. Hutchinson
Maine University Water Resources Center Project Completion Report, Jun 1969. 18 p, 2 fig, 9 tab, 6 ref.

Descriptors: *Saline soils, *Maine, *Chlorides, *Saline water, Pollutant identification, Water pollution sources, Highways, Soil-water-plant relationships, Infiltration, Leaching.
Identifiers: Highway icing.

This research project was conducted to determine the effect of salt applications to de-ice highways on the sodium and chloride levels in 1) streams and rivers, 2) private water supplies contiguous to highways, and 3) soils bordering highways. Analysis of seven rivers in Maine from six samplings over a two-year period indicate that sodium and chloride concentrations are not affected by highway salting, since the level of both ions remained consistent throughout the period. Although the concentrations of both ions tended to increase from the headwaters to the mouth of the rivers the average concentrations for 27 sites were 3.4 and 1.5 ppm for sodium and chloride respectively. Semi-annual analyses of 100 randomly selected wells along Maine highways indicate that levels of sodium and chloride are much higher than normal, averaging 69 and 162 ppm respectively. 25% of the wells were unfit for potable supplies because they contained in excess of 250 ppm of chloride. Sodium and chloride levels in soils contiguous to highways bear a direct relationship to the length of time over which highways have been salted. In areas where salt has been applied for 20 years the sodium levels have risen over a distance of 60 feet from the edge of the highway, and to a depth

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of 18 inches. Sodium saturation of the soil approaches 15% at some sites, and chloride levels in the soil-water system ranged from 10 to 2525 ppm, thereby producing the equivalent of an "alkali" condition.

289
WATER AND METROPOLITAN MAN,

Stifel W. Jens and D. Earl Jones, Jr.
Rep of 2nd Eng Found Conf on Urban Water Resources Res, Aug 12-16, 1968, 1969.

Descriptors: *Water resources development, *Planning, *Urbanization, Systems analysis, Mathematical models, Social aspects, Legal aspects, Economics, Management, Water management (applied).
Identifiers: Water resources research, Sociology.

The second conference on urban water resources research stressed the interdisciplinary and systems analysis approaches to solving urban water and pollution problems. Recommendations were made for action and for further research in communication, planning, social impacts, regulation, data collection, precipitation, storage, urban design, and systems analysis.

290
DIVISION OF COST RESPONSIBILITY FOR WASTEWATER SYSTEMS,

James A. Johnson
J Water Pollution Control Fed, Vol 42, No 3, Part 1, pp 341-353, Mar 1970.

Descriptors: *Cost-benefit analysis, *Waste water treatment, Construction costs.
Identifiers: Combined sewers, Storm sewers.

The paper describes the level and trends of wastewater facility costs and the methods currently used to meet them; groups of beneficiaries of sewerage service; formulas for dividing costs among the groups; and it examines the differences in the formulas. Specifically, ideas are presented as to how combined sewers should be termed so as to determine who should pay the cost. In the case of separate storm sewers, the problem involves the amount of responsibility placed on the property owner.

291
PREDICTION MODELS FOR INVESTMENT IN URBAN DRAINAGE SYSTEMS,

John W. Knapp and Walter J. Rawls
Water Resources Research Center Bull No 24, Virginia Polytechnic Instit, p 1-55, April 1969.

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Descriptors: *Mathematical models, *Investment, *Drainage systems, *Decision making, *Cost-benefit analysis, Design criteria, Planning, Economic feasibility, Geographical regions, Engineers estimates.

Linear models were developed and used to study the significant factors controlling costs of conventional urban drainage systems. The objective of the study was to find decision making tools which engineers and planners could employ for estimating the cost of alternative sizes of drainage facilities and the degree of protection to be afforded; and for judging the potential for development. Techniques of factor, component, and non-linear analysis were performed with data collected from 100 municipal agencies around the country. The study revealed that design practices as well as geographic areas were important. Physical features, although most important, were usually the fixed, uncontrollable variables. Design factors, on the other hand, were important in both degree and kind. The analysis explained the differences in the design methods and led to the development of equations to predict the cost for various levels of design.

292
WATER RESEARCH,

Allen V. Kneese and Stephen C. Smith, editors
Papers presented at Seminars in Water Resources Research, sponsored by Resources for the Future and the Western Resources Conference, at Colorado State University, July 1965. The John Hopkins Press, Baltimore, Md., 1966. 526 p.

Descriptors: *Water resources, *Water resources development, *Planning, *Water Resources Research Act, Water management (applied), Evaluation.

These conference papers reflect years of research activity on problems of planning and managing water resources. The following developments over the past decade are highlighted in the papers: (1) clarification and far-reaching applications of economic concepts to water development and use; (2) emphasis on cross-disciplinary research; (3) use of high-speed electronic computers in water management research; (4) emphasis on problems of recreation, water quality, and management of water-associated land used; (5) more research on political, administrative, and institutional factors; (6) the new role of federal agencies in water management research; and (7) the impact of the Water Resources Research Act of 1964. The papers are divided into areas including: (1) issues in theoretical economic analysis; (2) case studies of water management; (3) research on evaluation problems; (4) studies of water reallocation; (5) political and administrative studies; (6) research on hydrology and engineering; and (7) major research programs and needs.

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HYDROLOGICAL ASPECTS OF WATER MANAGEMENT,

Gy Kovacs
2nd Int Postgrad Course on Hydrol Method for Develop Water Resources Manage, Jan-July 1968, Manual No 2, 1968.

Descriptors: *Water management (applied), *Water resources development, *Hydrologic aspects, Government, Planning, Urbanization, Water conservation, Flood control, Channel improvement, Irrigation, Water supply, Sewage, Waste disposal, Hydroelectric power, Economics.
Identifiers: Textbook, Technical manuals.

Water management is defined and the hydrological aspects of water management are discussed in the introductory section of a text written for an international post-graduate course in water resources management. The topics introduced are flood control, river training, water control on the catchment, irrigation, water supply and sewage problems, water power, and economics. The objectives of water management and the needs for data of the various branches of water management are outlined and summarized. Various national water management organizations and policies are briefly described.

294
A SIMULATION TECHNIQUE FOR ASSESSING STORM AND COMBINED SEWER SYSTEMS,

John A. Lager
In: Combined Sewer Overflow Seminar Papers, Edison, N.J., Nov 4-5, 1969. Water Pollution Control Research Series, Report DAST-37, pp 151-170, Mar 1970. 5 fig, 4 tab, 11 ref.

Descriptors: *Simulation analysis, *Assessments, *Computer programs, *Storm runoff, Water pollution control.

This paper describes work in progress to develop an assessment technique for comparing alternate solutions through a comprehensive computerized program capable of "representing urban stormwater runoff phenomena, both quantity and quality, from the onset of precipitation on the basin, through collection, conveyance (both combined and separate systems), storage, and treatment systems to points downstream from outfalls which are significantly affected by storm discharges". The program is intended for use by municipalities, government agencies, and consultants as a tool for evaluating the pollution potential of existing systems, present and future, and for comparing alternate courses of remedial action.

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295
A PLAN FOR ENDING LAKE ERIE POLLUTION,

James C. Lamb
Public Works, Vol 100, No 6, pp 79-82, Jun 1969.

Descriptors: *Pollution abatement, Storm runoff, Sewage treatment, Separation techniques.
Identifiers: *Lake Erie, *Water quality programs, Combined sewers.

Sources and effects of pollutants in Lake Erie are described along with plans and recommendations for the elimination of poliution from the lake. Urban runoff and combined sewer overflows are major sources of pollution contributing BOD, bacteria, and nutrients--especially phosphorus. Detroit, Cleveland, and Toledo are the largest offenders in the area of storm water runoff. Suggested state water quality programs are outlined in addition to areas requiring research and development such as: tertiary treatment, nutrient removal, sediment evaluation, pesticide pollution, radioactive and thermal pollution, industrial sludge disposal, oxygen deficient zones, and eutrophication. Expensive separate sewerage systems are recommended only where feasible, such as in redevelopment projects. However, where combined sewers exist, overflows should be disinfected before being discharged to a body of water, and future plans for storage and treatment should be made.

296
POLLUTION OF THE CHAO PHRAYA RIVER,

R. E. Leffel
J Sanit Eng Div, Am Soc Civil Engrs, Vol 94, No SA2, pp 295-306, Apr 1968.

Descriptors: *Foreign research, Estuaries, Waste water treatment.
Identifiers: *Chao Phraya River, Thailand.

Programmed sampling and tests of the Chao Phraya River Estuary show that its pollution-receiving capacity is limited. No sewage collection system presently exists in Bankgok, but separate wastewater and storm-water systems are being planned because a combined system would undoubeedly cause further pollution of the estuary during severe rainfall. More studies must be made before the degree of oxidation of organic carbon, nitrogen, and amoniacal nitrogen can be accurately determined. Further studies are also being conducted to decide upon the necessary type of initial wastewater treatment. Such treatment must include sufficient oxidation of organic carbonaceous substances and oxidizable nitrogenous substances. This study also demonstrates the need for modifications in standard BOD measurements in addition to modifications of the parameters and equations defining DO concentrations for tropical estuaries.

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297
WATER-RESOURCES ENGINEERING,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, 1964. 654 p.

Descriptors: *Water resources, *Water resources development, *Planning, *hydrology, *Water pollution control, *Digital computers, *Water management (applied), *Engineering education, Water utilization.
Identifiers: *Textbook.

This book is basically aimed towards introducing water resources engineering to the undergraduate civil engineering student. The first five chapters present hydrology, the subject basic to water management. Chapter six involves legal aspects of water use which often constrain planning efforts. Chapters seven through twelve discuss physical works--dams, canals, pipelines, etc.--which are utilized in almost all types of water resources projects. Chapters fourteen through twenty cover principal water uses, and the last chapter summarizes the planning procedure for single and multi-purpose projects. Pollution control is stressed in regard to waste treatment, and the role of the digital computer in hydraulic engineering is thoroughly discussed.

298
WATER-RESOURCES ENGINEERING - CHAPTER 3 - QUANTITATIVE HYDROLOGY,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, pp 38-71, 1964. 18 graphs, 4 tab, 2 diag, 6 ref.

Descriptors: *Hydrologic aspects, *Runoff, *Infiltration, *Rainfall-runoff relationships, *Snowmelt, Rational formula, Estimating equations, Hydrographs.

This chapter presents examples of commonly used hydrologic procedures, some empirical, some rational. Terms relating to basin recharge and runoff are defined. Other topics discussed include: hydrograph analysis, infiltration and infiltration indices, rainfall-runoff correlations, moisture-accounting procedures, long-period runoff relations; plus topics relating to runoff from snow and techniques such as the rational method for estimating instantaneous peak-flow rates and computing complete hydrographs.

299
WATER-RESOURCES ENGINEERING - CHAPTER 10 - OPEN CHANNELS,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, pp 251-279, 1964. 18 diag, 9 tab, 1 graph, 8 ref.

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Descriptors: *Open channels, *Hydraulic properties, *Flow measurement, Canals, Tunnels, Flumes.

The open channel and the pressure conduit are the two types of conduits that convey water. The open channel may take the form of a canal, flume, tunnel, or partly filled pipe, all of which are referred to in this chapter. Open channels are characterized by a free water surface, in contrast to pressure conduits which flow full. This chapter details salient features of the hydraulics of open-channel flow including: uniform and nonuniform flow, normal and critical depth, location of the hydraulic jump, free outfall, hydraulic efficiency of channels, channel transitions, and flow around bends and steep slopes. Measurement of flow in open channels is also explained for weirs and venturi flumes. Canals, canal appurtenances, and tunnels are described in the section on types of open channels.

300
WATER-RESOURCES ENGINEERING - CHAPTER 11 - PRESSURE CONDUITS,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, pp 280-322, 1964. 31 diag, 5 tab, 11 ref.

Descriptors: *Pressure conduits, *Hydraulic properties, *Flow measurement, Construction materials, Construction equipment.
Identifiers: *Pollution potential.

A pressure conduit flows full and is often less costly than an open channel because it generally follows a shorter route. If water is scarce, pressure conduits may be used to avoid water loss by seepage and evaporation that might occur in open channels. Pressure conduits are preferable for public water supplies because of the reduced opportunity for pollution. This chapter is limited to turbulent flow in pipes, since this is what the hydraulics engineer deals with exclusively. Topics covered under the section on the hydraulics of pressure conduits include: head loss due to pipe friction, minor losses in pipelines, flow with negative pressure, flow in branching and parallel pipes, and pipe networks. Other sections discuss: measurement of flow in pressure conduits; forces acting on pipes; materials such as steel, cast-iron, and concrete for pressure conduits; appurtenances for pressure conduits such as gates, valves, and surge tanks; and inverted siphons.

301
WATER-RESOURCES ENGINEERING - CHAPTER 18 - DRAINAGE,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, pp 490-533, 1964. 18 diag, 2 tab, 2 graphs, 8 ref.

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Descriptors: *Drainage, *Storm drains, *Surface drainage, *Design, Surveys.
Identifiers: *Stormwater disposal, *Highway drainage.

The problems of drainage may be subdivided into municipal drainage, the disposal of excess stormwater from cities; land drainage, the disposal of stormwater from rural areas, and the removal of excess water from the soil; and highway drainage, the disposal of stormwater from highway rights of way. Principles governing most drainage projects are basically the same, but the differing physical problems encountered require different solutions. In describing procedures for designing storm drainage works, topics covered include: estimates of flow, gutters, inlets, grated and curb-opening inlets, manholes, and outlet works. The section on land drainage discusses: drainage ditches, underdrains, groundwater flow to drains, layout of a tile-drain system, drainage by vertical wells, and legal aspects of drainage. Topics included under highway drainage are: longitudinal and cross drainage, culverts, culvert inlets and outlets, debris barriers, culvert hydraulics, bridge waterways, and dips.

302
WATER-RESOURCES ENGINEERING - CHAPTER 19 - SEWAGE DISPOSAL AND WATER QUALITY CONTROL,

Ray K. Linsley and Joseph B. Franzini
McGraw-Hill Book Company, New York, pp 534-575, 1964. 13 diag, 4 tab, 1 graph, 17 ref.

Descriptors: *Sewage treatment, *Sewage disposal, *Sewage, *Industrial wastes, *Storm runoff, *Sewers, Infiltration, Flow rates, Construction.
Identifiers: Sewage quantity, Sewer hydraulics, Combined sewers.

In urban areas liquid wastes (sewage) which must be disposed of include domestic or sanitary sewage, industrial wastes, and storm runoff. Basic terms related to sewage disposal are defined in this chapter. The section on the quantity of sewage discusses infiltration and variations of flow. The laying of sanitary, separate, and combined sewers is described along with discussions of information on sewer construction and maintenance. Topics relating to sewage treatment are also detailed such as: screening of sewage, comminutors, grease removal, sewage sedimentation, filtration, oxidation ponds, the activated-sludge process, sludge digestion, and disposal, Imhoff and septic tanks, chlorination, and industrial waste treatment.

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THE 1969 FLOODS,

John A. McCollum
Calif Water Pollution Control Assoc 42nd Annual Conference, Apr 29-May 1, 1970, Sacramento, Calif.

Descriptors: *Damages, *Sewers, *Storm drains, *Repairing.
Identifiers: *Los Angeles, California.

This paper describes the damage to the sewer and storm drain systems in the City of Los Angeles during and subsequent to the winter rains of January and February, 1969. Emergency repair work, performed by forces of the Bureau of Sanitation of the Department of Public Works under adverse conditions, resulted in the protection of public and private property from costly damages. Steps taken to insure the health and sanitary condition of the citizenry included restoration of sewer lines, repair to channels and debris basins, and alleviation of slide potential. Damage was also experienced on a county-wide basis and a summary of events shows the interrelationships involved in emergency repair work performed.

304
ST. LOUIS FLOOD PROTECTION: INTERIOR DRAINAGE,

Herman M. McKinney
J Hydraulics Div, Am Soc Civil Engrs, Vol 93, No HY4, pp 129-147, Jul 1967.

Descriptors: *Drainage programs, Comparative costs, Storm runoff.
Identifiers: *St. Louis, Missouri, Sewer hydraulics.

The interior drainage considerations in the project authorization and basis for determinations of storm runoff, hydraulic gradients, sewer capacities, gate closing stages, stormwater ponding capacities, seepage, base flow, required pumping capacities, and sewer sizes are presented. In addition, the basis for schemes of plans considered, and comparative cost analysis and selection of plans are evaluated.

305
DESIGN OF ROUGHNESS ELEMENTS FOR ENERGY DISSIPATION IN HIGHWAY DRAINAGE CHUTES,

H. M. Morris
Nat Acad Sciences--Nat Research Council--Highway Research Rec, No 261, pp 25-37, 1969.

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Descriptors: *Energy dissipation, *Channels, *Design criteria, Investigations, Analysis.
Identifiers: *Tumbling flow.

Laboratory and field studies were conducted at Virginia Polytechnic Institute to develop design criteria for a method of energy dissipation by providing roughness elements in a channel designed to produce the phenomenon of tumbling flow in a channel. Based on test results, it is recommended that either two-dimensional square elements or cubical elements be used. Design equations are presented, along with recommendations for spacing and placement of elements.

306
CONSERVATION PROGRAMS IN THE URBAN FRINGE,

John W. Neuberger
J Soil Water Conserv, Vol 24, No 6, pp 216-618, Nov/Dec 1969. 6 ref.

Descriptors: *Conservation, *Storm drains, *Drainage, Erosion control, Runoff, Sediment control, Nebraska.

Solutions to land erosion and drainage problems caused by suburban sprawl in a Nebraska conservation district are outlined. Increased paving, roofing, and compacted soils result in erosion and flooding; therefore, the construction of major and minor storm drainage and water runoff systems is recommended. An Omaha program to reduce sedimentation from developing areas is detailed in addition to guidelines for good land resource conservation. Examples of developers' initiatives towards furthering the urban conservation program are cited.

307
STREAM POLLUTION AND ABATEMENT FROM COMBINED SEWERS AT BUCYRUS, OHIO,

Richard F. Noland and Dale A. DeCarlo
In: Combined Sewer Overflow Abatement Technology. Water Pollution Control Research Series, Report 11024--06/70, pp 291-230, Jun 1970. 16 fig, 3 tab.

Descriptors: *Water pollution effects, *Overflow, *Water pollution control, *Investigations, Storm runoff.
Identifiers: *Bucyrus, Ohio, *Sandusky River, *Combined sewers, Treatment method.

This paper contains results taken from a detailed engineering investigation and comprehensive technical study to evaluate the pollutional effects from combined sewer overflows on the Sandusky River at Bucyrus, Ohio which

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evaluated the benefits, economics, and feasibility of alternate plans for pollution abatement from the combined sewer overflows. A year long detailed sampling and laboratory analysis program was conducted on the combined sewer overflows in which the overflows were measured and sampled at 3 locations comprising 64% of the city's sewered area and the river flow was measured and sampled above and below Bucyrus. The results of the study showed that the combined sewers will overflow about 73 times each year discharging an estimated annual volume of 350 million gallons containing 350,000 pounds of BOD and 1,400,000 pounds of suspended solids. A method of controlling the pollution from combined sewer overflows is presented along with the degree of protection, advantages, disadvantages, and estimate of cost.

308
UNDERFLOW SEWERS FOR CHICAGO,

Milton Pikarsky and C. J. Keifer
Civil Eng, Vol 37, No 5, pp 62-65, May 1967. 2 diag, 2 tab.

Descriptors: *Design, *Sewers, *Overflow, *Planning, *Tunnels, Costs, Construction equipment, Computer models, Underflow.
Identifiers: *Deep tunnel plan, *Chicago, Combined sewers.

Chicago is planning an underflow sewer system consisting of a large tunnel under rivers and canals into which all combined sewers will discharge. This system, costing $400 million dollars, will eliminate the need for a $4 billion dollar conventional separate sewer because spillages from combined sewers will be directed to the underground tunnel rather than polluting surface streams. The performance of the Lawrence Ave. underflow sewers was analyzed through a computer simulation of the system. Untreated overflow into local streams was reduced from 3%/year of the sewage from combined sewers to .8% from Lawrence Ave.'s underflow sewers.

309
WATER RESOURCES AS AN ELEMENT OF URBAN PLANNING,

M. L. Rockwell
J Urban Planning Devel Div, Am Soc Civil Engrs, Vol 94, No UP1, pp 1-9, Aug 1968.

Descriptors: *Water utilization, *Storm runoff, Reservoir storage, Urbanization.
Identifiers: *Water resource problems.

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This paper examines the complex technical, legal, and administrative problems involved in northeastern Illinois' water situation and the high degree of use and reuse taking place in this area. Even stormwater runoff along with its pollutants is retained in reservoirs to be used later beneficially. Existing problems related to stormwater runoff in this area include the restriction of water infiltration and, thus, the production of increased runoff caused by the construction of impermeable surfaces (roof tops, streets, and parking lots), and the maintenance of unsightly stormwater basins in areas where water recreational facilities are needed.

310
OPENING REMARKS,

William A. Rosenkranz
In: Combined Sewer Overflow Seminar Papers. Water Pollution Control Research Series, Report DAST-37, pp 1-8, 1970.

Descriptors: *Sewers, *Storm runoff, *Federal project policy, Grants, Research and development, Water pollution control.
Identifiers: *Combined sewers, Demonstration grants.

The background and history of the FWQA's combined sewer program and methods of applying for grants under the demonstration grant program established by the Water Quality Act of 1965 are discussed. Technical areas in which the FWQA Storm and Combined Sewer Pollution Control Branch are interested include: removal of storm flow and infiltration from sanitary sewers, through elimination of illicit storm water connections; pressure or vacuum sewers as an alternate means of sewer separation; infiltration control; improved materials and construction practices for sewers; and, treating and/or controlling urban runoff.

311
ENVIRONMENTAL HEALTH AND COMMUNITY PLANNING,

J. A. Salvato, Jr.
J Urban Planning Devel Div, Am Soc Civil Engrs, Vol 94, No UP1, pp 23-30, Aug 1968.

Descriptors: *Planning, *Environmental effects, Public health.

Effects are given of a type of planning which includes land use, water system and transportation, and prevention of problems caused. The health department responsibility for the issuance of permits and approval of operational results to protect public health is emphasized.

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312
ENTERPRISING PROJECT AIMS AT BRINGING SEWER DESIGN UP TO DATE,

Mike Sumner
Water Pollution Control, Vol 107, No 1, p 25, Jan 1969.

Descriptors: *Hydraulic design.
Identifiers: *Sewer junctions.

A joint research project on hydraulic criteria is being carried out by the Borough of Scarborough and the University of Toronto. The project specifically is concerned with finding the best design modification to eliminate flooding at sewer junctions.

313
SYSTEM DESIGN,

George E. Symons
Water Wastes Eng, Vol 4, No 9, pp M3-M21, Sep 1967.

Descriptors: *Sewerage, *Sewers, *Design, *Hydraulics, *Installation, *Storage tanks, Sewage treatment, Design flow, Storm runoff, Overflow.
Identifiers: Combined sewers, Storm sewers.

This digest of information on sewerage systems includes definitions, explanations, and tabular data on a wide range of topics such as: sewer type classifications, considerations in sewer design, sanitary sewers, sewer hydraulics, storm and combined sewers, sewer appurtenances, and inplant piping systems. Conditions are enumerated under which sanitary sewers, combined sewers, or separate sewers should be installed. Storm sewers are recommended to relieve loads on existing combined sewers. Stormwater treatment is suggested unless an alternative can be employed such as sanitary wastes transport under pressure through small lines laid in existing combined sewers. The planning and design of storm and combined sewers is described including correct location and design capacity of such systems. Appurtenances relating to stormwater runoff, such as overflows and storm tanks, are defined and described. Storm tanks are more commonly used in combined systems in order that stormwater eventually be passed to sewage treatment works to avoid overflow of storm water into nearby bodies of water. Such tanks operate under gravity or pumping conditions. Tables, diagrams, and graphs in the digest include: sewer classification, sewer system layouts, population trends in the U.S., quantities of water and sewage flow in U.S. cities, amounts of hourly and daily sewage flow in a sample city, extreme flow rates as a function of population, filtration specifications, rates of flow using Bernoulli's, Manning's, and Hanzen-Williams' formulas, a sewer design slide rule, sewer hydraulic information, recommended minimum sewer grades, and design criteria for sewer appurtenances.

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314
THE SEWERAGE AND DRAINAGE PROBLEM,

A. L. Tholin
In: Environmental Engineering and Metropolitan Planning, edited by John A. Logan, Paul Opperman, and Norman E. Tucker, Northwestern University Press, pp 91-109, 1963.

Descriptors: *Sewerage, *Drainage, *Urbanization, Conduits, Construction costs, Financing, Detention reservoirs, Gaging stations, Flood damage, Planning, Water pollution, Drainage systems, Public health, Sewage treatment.
Identifiers: *Combined sewers, *Sanitary sewers, *Storm sewers, Sewer design.

Recommendations are made regarding the sewerage and drainage problem. The desirable solution of the sewerage and drainage problem should include the following action: (1) convey spent water quickly by underground conduits to the place of treatment and disposal; (2) avoid combined sewers, if possible; (3) design so as to conserve and utilize energy of flow to achieve economy of construction cost; (4) detain storm-water near the origin, where possible; (5) interpret river gagings with a critical eye; (6) find out what flow-ways we need, establish and maintain them; and (7) have a master plan. Included in the paper are: a formal comment, a discussion, and a workshop regarding the subject matter.

315
RIVER CONSERVATION AND WATER CONSERVATION WORKS: CHAPTER 9 - THE USE OF BALANCING RESERVOIRS AND FLOW REGULATING RESERVOIRS IN DEALING WITH RUN-OFFS FROM URBAN AREAS,

G. Thompson
Butterworths, London, pp 132-141, 1966. 6 fig, 5 ref.

Descriptors: *Surface drainage, *Flow control, *Regulated flow, *River systems, *Design criteria, Sewers.
Identifiers: *Urban runoff, *Flow balancing.

This chapter attacks the problem of increased runoff from a river caused by urban development and the installation of surface water drainage. Such a problem ensues wherever more paved areas are directly connected by sewers to a river. As a solution, the author recommends flow balancing, which entails passing the flow through a natural or artificial lake with a restricted outflow, or flow regulation, in which part of the river flow is passed into specially-prepared areas. These plans can be economical, and they reduce peak flows and also channel sizes farther downstream. General design factors for implementing flow balancing and regulation are discussed; and then a scheme combining the two principles, which was

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applied to the River Cray, is described. Flow balancing is possible in new or undeveloped towns; whereas, it cannot usually be implemented in a built-up area unless lakes or disused mine workings are available. In such urban areas, flow regulation is readily applicable. (See abstract number 316).

316
RIVER ENGINEERING AND WATER CONSERVATION WORKS,

Roland Berkeley Thorn, editor
Butterworths, London, 1966. 520 p.

Descriptors: *Water supply, *Water conservation, *Engineering education, Legislation.
Identifiers: *River engineering.

The editor collected articles by twenty-three authors, and these, together with his own contributions, form a comprehensive introduction to basic information needed by river authority engineers. The book also includes topics related to water supply engineering and the soil mechanics of flood embankments. With the exception of the first chapter on water conservation and water supply legislation, the emphasis is on engineering subjects and the means for solving major problems arising in river engineering and water conservation works.

317
SPECIAL REQUIREMENTS FOR A FULL SCALE FIELD DEMONSTRATION OF THE ASCE COMBINED SEWER SEPARATION PROJECT SCHEME,

Donald H. Waller
ASCE Combined Sewer Separation Project, Technical Memorandum No 13, June 3, 1968. FWPCA Program No 11020EKO. 84 p, 12 fig, 13 tab, 10 ref.

Descriptors: *Benefits, *Costs, Anaerobic conditions, Legal aspects, Measurement, Overflow.
Identifiers: *Field demonstration planning, Obstructions to flow, Interviews, Sewer separation, Storage-grinder pump.

Matters that should be considered in planning a field demonstration of the ASCE Project pressure sewer scheme are summarized. These include: importance of connecting as many buildings as possible in the demonstration project area; need for protection from overflows of building storage-grinder pump units; relationship between occurrence of overflows from buildings and given levels of public inspection, detection and control; effectiveness of alarms on storage-grinder pump units; legal agreements with property owners; importance of complete records of project costs;

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effectiveness of the project as a pollution control measure; possible benefits of elimination of infiltration from interceptors and treatment plants; detection and clearing of obstructions; use of polymer additives to reduce fluid friction; behavior of unground sewage including anaerobic decomposition; self-cleansing characteristics of flow; rate and extent of deterioration of friction factors; sewage flow variations and their relationship to water demands; handling of interruptions of service; and field tests on installations in walk-through combined sewers. The appendix is an assessment of the physical problems to be overcome in separation of plumbing on private property, with estimates of cost, based on information from officials in seven large cities having combined sewers, and from a consulting engineer and a recent American Public Works Association survey.

318
NON-MECHANICAL CONSIDERATIONS INVOLVED IN IMPLEMENTING PRESSURIZED SEWERAGE SYSTEMS,

Donald H. Waller
Combined Sewer Separation Project, Technical Memorandum No 12, May 31, 1968. FWPCA Program No 11020 EKO.

Descriptors: *Administration, *Economic justification, *Legal aspects.
Identifiers: *Interviews, Radcliff, Kentucky, Storage-grinder pump.

Installation of a storage-grinder pump unit in every home raises questions regarding: allocation of costs of the units; responsibility for malfunction of the units; arrangements for service of the units; and willingness of owners to accept the presence of units in their buildings. Twenty-five householders in Radcliff, Kentucky, whose houses are served by sewage ejector units were interviewed to obtain opinions about features of the units that appeared to represent potential sources of nuisance, inconvenience, or other liabilities. Also interviewed were the superintendent of the utility operating the Radcliff sewerage system, owners of five houses in Louisville, Kentucky, at which sewage sampling stations were located, and three consulting engineering firms who have considered schemes involving the installation of sewage pumping equipment on private properties. Opinions and practices reported reflect the view that sewage pumping equipment placed on private property as part of a public project should be purchased, installed, and serviced at public expense.

319
BRITAIN AND THE AMERICAN WATER QUALITY CRISIS

Richard Wood
Effluent Water Treat J, Vol 10, No 6, pp 316-317, 319-321, Jun 1970.

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Descriptors: *United States, *Cost analysis, *Comparative costs, Equipment, Standards, Pollution abatement.
Identifiers: *Viewpoint, *Great Britain.

The author states that Britain's shortcomings with regard to water pollution control stem from a failure of financial investments in control plants to keep pace with the changing technology of industrial processes and their effects on both domestic and mixed-municipal sewage. A comparative cost analysis between Britain and the United States concerning water pollution control is discussed including: cost percents appropriated for equipment, industrial waste treatment, municipal sewage treatment, and river pollution abatement. Basic purification standards are included as well as effluent standards. The author expands on the idea that the exportation of pollution control equipment such as instrumentation and control systems to the United States is one area in which the British may contribute their technological advances in aiding both the United States and Britain.

320
FLOOD CONTROL PROMISED MAJOR BENEFITS,

Walter J. Wood and N. Christian Datwyler
Public Works, Vol 101, No 6, pp 67-68, Jun 1970.

Descriptors: *Drainage systems, *Flood control, *Storm drains, Overflow.
Identifiers: Connecting tunnel.

The Department of Housing and Urban Development recently granted funds to the Los Angeles County Flood Control District for the construction of a storm drainage system. Such a system will eliminate problems caused by accumulated stormwater sumps along the undulating terrain of the area. Such stormwater accumulations have caused drownings and mosquito proliferation, and they sometimes overflow and flood surrounding areas or infiltrate the sewer system creating a health hazard. The project consists of a tunnel connecting storm drains to the Pacific Ocean. The new drainage system will encourage redevelopment in the area by resolving the problems presently making the region an unattractive and often-dangerous place to live.

321
ENGINEERING ASPECTS OF WASTEWATER CONTRACTS,

Samuel I. Zack
J Sanit Eng Div, Am Soc Civil Engrs, Vol 95, No SA3, pp 465-480, Jun 1969.

Descriptors: *Engineers estimates, *Sewers, Engineering.

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Engineering elements essential to the financing, construction, operation and maintenance of sewerage facilities for use by two or more parties are outlined. Contract terms, conditions and clauses in successful use which include the engineering basis for jointly sharing the capacities of sewage collection and treatment facilities, and for joint sharing of capital and annual operating and maintenance costs are covered. Definitions of engineering terms; regulations pertaining to conditions of wastewaters, both domestic and industrial, acceptable from the party being served; specific stipulations considered typical for excluding discharge of detrimental wastewaters and sewage which contains stormwater, drainage from stormwater inlets, floor drains, and from other direct sources; and how and when payments are made according to actual contracts in effect are given. The importance of scheduling payments to meet commitments is presented. Examples are cited to indicate how engineering factors and needs of a specific location affect the patterns of a contract. The fact that no lawyer should endeavor to write a contract without engineering consultation and that no engineer should write a contract without legal advice is emphasized.

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LEGISLATION AND STANDARDS

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322
MUNICIPALS WANT NEW CENTRAL BODY FOR WATER AND SEWAGE,

Surveyor, Vol 85, pp 37 and 48, Apr 1970.

Descriptors: *Future planning (projected), *Legal aspects, *Regulation, *Administration.
Identifiers: *Viewpoint.

The setting up of a central body, with much wider responsibilities than those of the present Water Resources Board, to plan, initiate, or coordinate action over the whole field of water resources and sewage purification and disposal, is proposed by the Institution of Municipal Engineers. The following points were discussed: the inadequacy of the present form of organization for the future; water supply and effluent disposal planning; standards research; and the delegation and determination in regards to responsibilities of river boards and local government bodies (i.e. surface water sewerage, positioning of surface water overflows and outfalls).

323
MERSEY RA STANDARDS FOR EFFLUENTS,

Surveyor, Vol 84, No 4039, p 98, Nov 7, 1969.

Descriptors: *Standards, *Sewage effluents, *Sewage disposal, Overflow.
Identifiers: *Effluent standards, *Great Britain, Trade effluents, Storm sewage.

The Mersey and Weaver River Authority defined effluent standards in accordance with relevant local conditions. Standards were developed for the following areas: (1) purified sewage effluents discharged to inland rivers (normally applied to rates of flow up to 3 d.w.f.); (2) partially treated sewage effluents discharged to rivers (normally applied to rates of flow in excess of 3 d.w.f.); (3) untreated sewage effluents from storm sewage overflows; (4) sewage effluents discharged to tidal waters; and (5) trade effluents.

324
POWER TO ACQUIRE LAND, CONSTRUCT AND EQUIP SEWERAGE SYSTEM,

Conn Gen Stat Ann sec 7-247 (1960).

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Descriptors: *Connecticut, *Sewage districts, *Condemnation, *Cities, Sewage, Sewage disposal, Sewage treatment, Sewers, Wastes, Environmental sanitation, Drainage systems, Storm drains, Regulation, Administrative agencies, Management, Storm runoff, Real property, Right of way, Eminent domain, Contracts, Control, Legislation, Local governments.

Any city may acquire, construct, and operate a sewerage system or systems. For that purpose, the city may enter upon and acquire property by purchase, condemnation, or other means. Cities may establish rules for the operation of the system, including regulation of discharge of sewer or any storm drain runoff into the system which they feel will adversely affect its operation. Cities may contract with any person or with any other city to provide or obtain sewerage system services for any sewage. The sewer authority shall: (1) establish rules for the transaction of its business; (2) keep records of its proceedings; and (3) designate an officer to be the custodian of its books.

325
HEALTH AND SAFETY,

Del Code Ann tit 16, secs 7907, 7929, 7930, 7931 (1953).

Descriptors: *Delaware, *Inspection, *Sewage, *Administrative agencies, Legislation, Evaluation, On-site investigations, On-site tests, Regulation, Water law, Legal aspects, Sewage disposal, Sewers, Cesspools, Waste disposal, Environmental sanitation, Potable water, Permits, Public health, Waste water (Pollution), Sanitary engineering, Social aspects, Water quality, Storm drains, Wells, Well permits, Water supply, Runoff, Plumbing.
Identifiers: Storm sewers, Storm sewage.

Agents of the State Board of Health inspect and supervise all water and sewer systems, building and house drainage systems, and their ventilation. Plumbing inspectors may enter any building or premises in the state when necessary for the performance of their duties and may inspect and order the removal of any plumbing fixture, pipe, or cesspool which they deem to be in an unsanitary condition. Storm waters must be drained into a storm water sewerage system or a combined sewerage system but not into a sanitary sewerage system intended for sewerage only. Privy vaults or cesspools are not permitted on premises accessible to a public sewer. Where a public water supply is available, dug wells or other sources of private water supply are unlawful unless approved in writing by the Board.

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WESTERN AND ATLANTIC RAILROAD V HASSLER (DAMAGES CAUSED BY INADEQUATE CULVERT),

92 Ga App 278, 88 SE 2d 559-565 (1955).

Descriptors: *Georgia, *Flood damage, *Precipitation excess, *Rainfall intensity, Judicial decisions, Damages, Rainfall, Precipitation, Railroads, Culverts, Rainfall Disposition, Runoff, Drainage, Surface runoff, Floods, Cloudbursts, Streams, Nonnavigable waters, Mills, Riparian land, Natural flow.
Identifiers: Negligence.

Plaintiff owned a mill adjacent to a non-navigable creek. The creek flowed through a culvert under defendant's tracks approximately two thousand feet from the mill. The culvert was adequate in area to take care of the normal flow of the creek. The defendant raised its tracks two and one-half feet, and reinforced the culvert by adding several inches of new masonry, thereby reducing the flow of water through the culvert by about fifteen percent. The raising of the tracks prevented the overflow of the water in time of heavy rains. During such rains, plaintiff's mill and cotton gin were damaged because of flooding. The question presented was whether damage resulted from an act of God or through the fault of the railroad. The court held that this was a question for the jury. If the flood that did occur was so extraordinary and unprecedented that it could not have been foreseen and the damage could not have been prevented by prudential means, the railroad could not be held liable.

327
CITY OF MACON V CANNON (SURFACE WATER RUNOFF),

89 Ga App 484, 79 SE 2d 816-826 (1954).

Descriptors: *Georgia, *Storm drains, *Flooding, *Drainage water, Subsurface drains, Drainage engineering, Highways, Roadbeds, Drainage systems, Overland flow, Natural flow, Precipitation excess, Rainfall, Storm runoff, Legal aspects, Judicial decisions, Local governments.

Plaintiff brought action to recover for damages resulting from defendant city's maintenance of a nuisance. The alleged nuisance consisted of a sewer beneath plaintiff's land which lacked the capacity to handle increased surface runoff. Judgment was entered for the plaintiff and city

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appealed. The reviewing court affirmed the lower court, holding that the evidence presented by the plaintiff was sufficient to establish: (1) that plaintiff's premises became flooded even during normal rain due to the inadequate capacity of the sewer, (2) that the paving of a nearby highway greatly increased the runoff into the sewer in question; and that (3) the city was guilty of maintaining a nuisance by failure to enlarge the sewer system after notification by plaintiff of the increased flowage into the sewer.

328
CHICAGO SANITARY DISTRICT,

Ill Ann Stat ch 42, secs 326, 326aa, 326bb, 329a. 330, 336, 337, 339, 341, 342, 344-349, 351, 352, 354-359 (Smith-Hurd 1956), as amended, (Supp 1969).

Descriptors: *Illinois, *Sewage treatment, *Drainage systems, *Water pollution, Legislation, Administration, Administrative agencies, Drainage, Municipal wastes, Sewage disposal, Cities, Pollution abatement, Treatment facilities, Channels, Channel improvement, Engineering structures, Sewage, Waste water (Pollution), Assessments, Water resources, Eminent domain, Flood control, Regulation, Permits, Water control.
Identifiers: *Sanitary districts.

The authority of sanitary districts includes jurisdiction over drainage, sewage, and treatment works within their respective territories. Districts are charged with prevention and abatement of pollution by establishing standards, requiring permits for construction of municipal sewage systems and for changed systems, and initiating court action against violators. Financing of projects may be through sale of bonds. Authority of districts includes building docks, highways, bridges, approaches, and other works related to drainage canals and channels, and existing waterways may be improved to facilitate drainage. Districts have the power of eminent domain in most instances and are held liable for all damage caused by improvements. Specifications are made for size and capacity of sewage and drainage watercourses, for restrictions on the type of sewage discharge allowed, and for connecting facilities between districts. Districts which violate the act are subject to court action initiated by the Attorney General. Municipalities are required to share water sources that have been saved from pollution with other cities. There is provision for inspection of new channels. The city of Chicago is organized as a drainage district, and the statutory powers are conferred on the corporate authorities.

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329
SANITARY DISTRICTS OUTSIDE OF MUNICIPALITIES,

Ill Ann Stat ch 42, secs 418, 421, 433, 437, 438, 439 (Smith-Hurd 1956), as amended, (Supp 1969).

Descriptors: *Illinois, *Administrative agencies, *Environmental sanitation, *Sewage disposal, Water purification, Sanitary engineering, Water law, Legislation, Legal aspects, Water policy, Administration, Financing, Taxation, Dams, Public health, Sewage treatment, Planning, Sewers, Sewage, Water utilization, Water pollution, Water pollution control, Water quality control.
Identifiers: *Sanitary districts.

The board of trustees of any sanitary district is responsible for the collection and disposal of sewage within their area and must protect the water supplied to their inhabitants from contamination. They may use such conduits, pipes and pumps as are necessary to construct an adequate sewage system for this purpose. They must also treat and purify all sewage before allowing same to flow into any lake, river or other water course. While real and personal property may be taken for the district's corporate purposes, whether by purchase or condemnation, adequate compensation must be paid therefore either by gross sum or annual rental. The district's sewers may pass along or under public roads or public ground and may have conduits and pipes laid under public waters, but in either case not in such a manner as to impede normal use thereof. A district has the power to keep its water courses free from pollution and may construct dams and remove debris from same in the interests of public health. The board may finance costs of such a system either through general taxation or special assessment.

330
DRAINAGE AND FLOOD CONTROL,

Ill Ann Stat ch 42, secs 472, 473, 481, 482 (Smith-Hurd Supp 1969).

Descriptors: *Illinois, *Flood control, *Administrative agencies, *Drainage, Legislation, Legal aspects. Water law, Water policy, Financing, Sewage disposal, Water utilization, Projects, Administration, Public health, Sewers, Drainage systems, Hydrographs, Drainage districts, Flood protection, Charts, Distribution patterns, Floods, Hydrograph analysis, Rainfall, Runoff, Mapping, Assessments.

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The Department of Public Works and Buildings is responsible for making a survey and preparation of a master plan for drainage and flood control of all watershed areas of this state so that hazards to persons and property may be reduced. Such a plan includes the full hydrography of each watershed area including rainfall, runoff, frequency and severity of floods. A drainage district may construct a sewage disposal system to eliminate sewage which is a menace to public health. Such a system may be financed through assessments on the lands benefitted. Revenue bonds may be used to pay the initial costs of such construction, to be repaid solely from the revenue from the operation of such system. The Department is responsible for general coordination and supervision of the efforts of the individual districts. It may also enter agreements with the federal and local governments for the formulation of plans, including funding, and for the construction, operation and maintenance of improvements for flood control, drainage and utilization of water and water resources.

331
DUNLAP LAKE PROPERTY OWNERS ASS'N INC V CITY OF EDWARDSVILLE (ABATEMENT OF POLLUTION),

22 Ill App 2d 95, 159 NE 2d 4-6 (1959).

Descriptors: *Illinois, *Bypasses, *Sewers, *Pollution abatement, Judicial decisions, Local governments, Sewage districts, State governments, Sanitary engineering, Disposal, Effluents, Public health, Sewage, Waste water (Pollution), Lakes, Storm drains, Sewerage, Damages, Water pollution, Water pollution sources, Administrative agencies.

Plaintiff, a non-profit corporation, sued to enjoin defendant from further using a sanitary sewer bypass which allegedly caused sewage to flow into a private lake. The lake was used by area residents for all household purposes. The by-pass is part of the city's combined storm sewer and sanitary sewer system. When the level in the sanitary sewer reaches a certain height at the point of a bypass because of a stoppage or an overloading caused by heavy rain, the sanitary sewer overflows into the storm sewer. At one particular by-pass, the storm sewer empties into a natural watercourse or ditch which, in turn, empties into plaintiff's lake. The injunction was denied, because plaintiff had not demonstrated actual and substantial injury. The court held that speculative or anticipated damage, as shown in the instant case by plaintiff, is not properly the subject of a permanent injunction proceeding brought by individuals. While plaintiff had shown that the defendant had created a condition whereby diluted sewage could, on infrequent occasions, flow into plaintiff's lake, there was no actual evidence of pollution. The court concluded that pollution control and abatement are best left to the appropriate specialized state agency, except in cases of flagrant and obvious polltuion.

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332
BROWN V CITY OF JOLIET,

247 NE2d 47-52 (Ill App Ct 1969).

Descriptors: *Illinois, *Surface drainage, *Storm drains, *Cities, Planning, Judicial decisions, Land use, Regulation, Drainage programs, Administrative agencies, Legal aspects, Project planning, Sewers, Surface runoff.
Identifiers: Joliet, Illinois.

Brown, a subdivision developer, sued to require the city of Joliet, Illinois to record her subdivision plat. Her plat had been down by the city planning commission and subsequently the city council because they felt she had failed to include adequate plans for surface runoff. The planning commission felt that development without adequate provision for storm drains would increase drainage problems in adjacent areas and would not drain her own development properly. Brown claimed that the requirement of more adequate provision for surface runoff was an illegal confiscation of her property. Judgment was entered for the city. The city had authority to make regulations for adequate water drainage before recording of a plat. There is a presumption of validity of these ordinances. There was sufficient evidence to show that Brown had not made adequate provision for surface drainage and that the city had acted properly under the ordinances. Brown was not deprived of property unconstitutionally as the problem required by the city to be remedied was a product of her own specific and unique activity. The problem was not one of the general community which the city is trying to force her to remedy at her own expense.

333
SEWERS AND DRAINS IN CITIES AND TOWNS,

Ind Ann Stat secs 48-3948 thru 48-3950 (Supp 1968).

Descriptors: *Indiana, *Local governments, *Drains, *Sewers, Administrative agencies, Construction, Benefits, Costs, Cost allocation, Cost-benefit theory, Cost-benefit analysis.

Whenever the Board of Public Works orders the construction of any local sewer or drain, it shall adopt a resolution to that effect. A hearing will be held, after which the Board shall decide if the benefits to be derived are worth the estimated cost.

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334
WATER AND SEWERS,

Md Ann Code art 23B, secs 78-92 (1966), as amended, (1968).

Descriptors: *Maryland, *Cities, *Water supply, *Drainage, Sewage, Municipal wastes, Sanitary engineering, Sewers, Sewage treatment, Cesspools, Sewage disposal, Pipelines, Conduits, Drainage systems, Storm drains, Leakage, Water pollution, Water rates, Water wells, Surveys, Condemnation, Public health, Boundaries (property), Plumbing, Maintenance, Sewerage.

Any city may construct and maintain water systems, sewerage systems and drainage systems, and do all things necessary for the efficient operation of such systems. Any company placing or changing any structure in the public way must receive authorization from the city. Any structure impeding the city water pipes may be ordered removed by the city, and they can use their condemnation power if necessary. The city may enter upon the county public way for the purposes of constructing or maintaining its water systems without obtaining a permit. The city shall provide connections with water and sewer mains for abutting property owners and may order existing cesspools and wells filled for the benefit of public health. A uniform charge may be levied for these connections. The city may require changes in plumbing to prevent waste or improper use of water. The city may prohibit the operation of private water systems and provide for the sanitary maintenance of other private sewage systems. The city may extend its systems beyond the town boundaries. City employees may enter private property to examine the water systems. No person shall pollute water used in the water supply. Service rates for water may be charged and special assessments levied to pay for the systems.

335
FULTON V TOWN OF BELMONT (DAMAGE FROM OVERFLOW OF STORM DRAINS),

127 NE 2d 569-572 (Mass Sup Ct 1955).

Descriptors: *Massachusetts, *Surface drainage, *Drains, *Cities, Damages, Flood damage, Ditches, Pipes, Drainage systems, Conduits, Seepage, Percolating water, Storm drains, Drainage water, Surface runoff, Sewers, Culverts, Judicial decisions, Legal aspects, Overflow.
Identifiers: Injunctions (mandatory).

Plaintiffs were landowners in defendant town. Along the street on which plaintiffs reside was an elevation called a berm, designed to carry sur-

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face water to two catch basins at a low point in front of plaintiff's property. One of the catch basins was drained by a pipe running under plaintiffs' property. The drain and pipe had been requested and installed by plaintiffs' predecessor in title in order to conduct the surface and percolating water from the catch basins to the rear of the property. The city furnished the pipes for the drain. Subsequent owners, including plaintiffs, allowed the drain to remain. Plaintiff sought a mandatory injunction requiring removal of the drains and a damage award for flood damage due to faulty drainage. The court held that defendant had a right to build the catch basins in order to keep the street in repair and safe for travel and that it would not be liable for any water therefrom which floods nearby land. Adjoining landowners may erect drains to prevent flooding of their land, but the city is not responsible for negligent construction thereof because the drain is in the control of the landowner.

336
MUNICIPALITIES - PARTICULAR POWERS,

Mich Comp Laws Ann secs 124.251-124.294 (1967), as amended, (Supp 1968).

Descriptors: *Michigan, *Cities, *Water supply, *Sewage disposal, Contracts, Financing, Condemnation, Sewers, Storm drains, Taxes, Engineering, Income, Interest, Cost analysis, Local governments, Legislation, Water distribution (applied), Sanitary engineering.
Identifiers: *Trust indentures.

Any two or more municipalities may incorporate an authority to acquire and operate plants used or useful in obtaining, treating, and distributing water. Articles of incorporation shall set forth powers to fulfill the corporate purpose. The authority may acquire and transfer property within or without its corporate limits, including by condemnation. The authority may enter into contracts of up to 50 years duration in order to sell or purchase water and may supply water to corporate or private consumers. Municipalities may also incorporate authorities to acquire and operate storm and sanitary sewers and sewage treatment plants used or useful in collecting and disposing of sewage or industrial wastes. Incorporation shall be as provided in this act. Contracts for sewage service shall not exceed 40 years and charges by either authority may be classified or varied from time to time. No change of jurisdiction over any territory by any municipality shall impair the contract obligation for either water or sewage services. The programs and contracts outlined shall be financed according to this act.

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337
JERUZAL V HERRICK (STATUTORY AUTHORITY OF DRAIN COMMISSIONER),

350 Mich 527,87 NW 2d 122-126 (1957).

Descriptors: *Michigan, *Drainage systems,*Sewers, *Legislation, Judicial decisions, Storm drains, Surface runoff, Surface waters, Jurisdiction, Administrative agencies, Public health, Remedies, Projects, Legal aspects, State governments, Local governments.
Identifiers: Mandamus.

A statute authorized the county drain commissioner to construct drains, and listed in its definition of 'drain' the term, "any sewer.' The commissioner proceeded with the planning and financing for a sanitary sewer for an area within the county. The commissioner stopped the proceedings until the legal question of whether he had authority to construct this sewer could be determined. The problem concerned the definition of 'drain' under the statute, and specifically, whether it included the system designed solely as a sanitary sewer, completely closed to surface or storm water drainage. Interested property owners filed application for a writ of mandamus to direct the commission to install the sewer. The court issued the writ, ruling that there was nothing in the language of the statute to preclude the commissioner from installing this particular sewer system.

338
WATER RESOURCES, CONSERVATION,

Minn Stat Ann secs 105.37 to 105.41 (1964), as amended (Supp 1968).

Descriptors: *Minnesota, *Legislation, *Administrative agencies, *Drains, Ditches, Runoff, Surface waters, Groundwater, Base flow, Tiles, Precipitation excess, Water resources development, Hydraulic structures, Adjudication procedure, Water conveyance, Water supply, Water conservation, Water utilization, Legal aspects, State governments, Permits, Regulation, Impounded wastes, Dams, Reservoirs, Condemnation, Eminent domain.

Subject to existing rights, all waters capable of substantial beneficial public use are declared to be public waters subject to state control. The Commissioner shall devise a water resources conservation program contemplating conservation, allocation, and development of all waters within the state, surface and underground. The Commissioner shall be guided by such a program in consideration of issuance of permits for construction of dams, reservoirs, and other control structures. The Commissioner is empowered to acquire property to implement this program by condemnation.

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The Water Division Director shall make such engineering surveys and reports as the Commissioner shall direct. A report on all future public ditches shall be filed with the Director. The Director is required to publish runoff data and information concerning the capacity of the drains within the state. The Director is empowered to conduct inspections of manufacturing plants. The Director is authorized to appear as an expert witness on behalf of the state in any matter affecting water within the state.

339
CLARK V CITY OF SPRINGFIELD (NUISANCE ABATEMENT SEWAGE AND SURFACE WATER),

241 SW 2d 100-109 (Ct App Mo 1951).

Descriptors: *Missouri, *Pipes, *Surface runoff, *Rainfall, Drainage water, Surface waters, Sewage disposal, Sewage sludge, Sewers, Drainage systems, Waste water, Local governments, Nuisance (water law), Operations, Judicial decisions, Legal aspects, Damages, Diversion structures, Ditches, Operation and maintenance.

Plaintiff brought this action for damages alleged to have been caused by the overflow of surface and sewage waters onto and across his premises. The evidence indicated that plaintiff's property was directly in the path of the natural flow of surface water in the area but that the city had installed a storm drain channeling the surface runoff into a ditch running toward plaintiff's property and directly above the city's sanitary sewer line. The result of maintenance of these tandem ditches was to increase the pressure in the sewer pipes by the infiltration of surface water from the ditch. Consequently, in periods of even light rain, the sewage contained in the pipes would boil up, flow through manhole covers, and mix with the surface water which was running across plaintiff's premises. The court recognized the common enemy doctrine which allows an upland owner to divert water from his premises by casting it upon the land of another. The city was found to have artificially impounded the surface water and to have cast it upon the plaintiff's servient estate in a destructive manner, thus violating a recognized qualification of the doctrine. Accordingly, damages were awarded in favor of the plaintiff.

340
SEWERAGE - WATER WORKS,

Mo Ann Stat secs 250.010 thru 250.250 (1959).

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Descriptors: *Missouri, *Public health, *Sewage districts, *Water pollution control, Legislation, Legal aspects, Cities, Construction, Maintenance, Treatment facilities, Waste disposal, Sewers, Water purification, Liquid wastes, Solid wastes, Industrial wastes, Domestic wastes, Administrative agencies, Costs, Assessments, Taxes, Financing, Rates, Planning, Leases, Pollution abatement, Water supply, Water quality.

Identifiers: *Bonds, *Sewer districts, Improvements, Storm sewers.

Cities and sewer districts are authorized to acquire, construct, improve, extent, maintain, and operate sewerage systems for the protection of the public health. 'Sewerage system' means storm water systems; sanitary systems; sewerage systems; sewerage treatment plants; and collection, purification, and disposal facilities. Two or more cities are authorized to operate combined water works and sewerage systems. Cities may delegate to their boards of public works the responsibility for and control of combined systems. The cost to any city or sewer district of acquiring, constructing, improving, or extending a sewerage system or combined system will be financed through tax levies, assessments, general revenue funds, or bond issuances. Cities and sewer districts are authorized to charge reasonable rates for the use of their sewerage systems. Cities may charge industrial establishments for the operation by the city of sewerage facilities to abate or reduce industrial water pollution. It is the purpose of this chapter to enable cities and sewer districts to protect the public health and welfare by preventing or abating water pollution and by supplying wholesome water. Cities and sewer districts are empowered to do all things necessary to carry out these purposes.

341
COOPERATION BY CITIES OF 100,000 INHABITANTS AND MORE WITH DRAINAGE DISTRICTS, ETC., FOR FLOOD PROTECTION,

Mo Ann Stat secs 70.330 thru 70.360 (1952).

Descriptors: *Missouri, *Cities, *Drainage districts, *Sewers, Legislation, Local governments, Watershed management, Flood control, Watersheds (basins), Public health, Environmental sanitation, Conveyance structures, Natural streams, Overflow, Flood damage, Eminent domain, Assessments, Cost-benefit theory, Costs, Cost repayment, Stream improvement, Cost allocation, Levees, Construction.
Identifiers: Storm sewers.

Cities with more than one hundred thousand inhabitants may contract with

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local drainage districts or other public corporations for cooperation or joint action in building sanitary and storm sewers in watersheds common to such cities and districts. These cities may also contract to construct levees or improve any natural watercourse to prevent overflow from injuring lands situated within their territorial limits. These cities may contract with the United States, private corporations, and any individuals owing lands subject to injury by overflow or in need of sewers. Where a watershed is located partially within an adjoining state, the preceeding activities may be carried on with the consent of the adjoining state if the public health and safety so require. These cities may acquire rights of way by purchase or eminent domain for any such sewers or watercourse improvements. The cities may pay for these works and rights of way out of their general funds or by imposition of special assessments upon benefited lands.

342
GOULD AND EBERHARDT, INC V CITY OF NEWARK (DISCHARGE OF SURFACE WATERS FROM STORM SEWER),

6 NJ 240, 78 A 2d 77-79 (1951).

Descriptors: *New Jersey, *Discharge (water), *Drainage water, *Drainage systems, Cities, Natural flow, Overflow, Alteration of flow, Storm drains, Surface waters, Storm runoff, Outlets, Remedies, Relative rights, Contracts, Construction, Projects.
Identifiers: *Equitable estoppel, Injunctions (prohibitory), Laches, Storm sewers.

Plaintiff brought this action against defendant city to enjoin the further discharge of storm and surface waters onto plaintiff's property from a storm sewer system constructed and maintained by defendant. Before undertaking the construction of the sewer system, the city consulted plaintiff and outlined its plans. After considering the project, plaintiff gave its consent. Over nineteen years passed before plaintiff expressed its dissatisfaction with the project. The city asserted that plaintiff should be estopped from claiming equitable relief because it had given its consent before the construction was undertaken. The court pointed out that a municipality's collection and discharge of surface waters upon private property in greater quantity than would occur from the natural flow is an active wrongdoing for which a court of equity can grant injunctive relief. However, while the court will not protect an active wrongdoer under the doctrine of equitable estoppel, in the present case, the city was not guilty of active wrongdoing since it was acting in reliance upon plaintiff's express consent. Therefore, the court held that plaintiff, having had knowledge of and having assented to the construction and having enjoyed the benefit of it for many years, was not entitled to the relief sought.

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343
PETER WENDEL AND SONS V CITY OF NEWARK (DAMAGE FROM ARTIFICIAL DRAINAGE SYSTEM),

46 A 2d 793-794 (NJ Ct Ch 1946).

Descriptors: *New Jersey, *Drainage systems, *Surface drainage, *Storm drains, Cities, Streams, Drainage water, Drainage, Ditches, Riparian rights, Outlets, Urbanization, Surface runoff, Culverts, Storm runoff, Navigable waters.

Plaintiff's land was located downstream from defendant's storm drain outlet. Prior to 1928, drainage water from the outlet traveled over undeveloped farm land and emptied into 2 natural brooks. By the time the water reached plaintiff's land, it was in a navigable state. In 1928, defendant constructed a surface drainage system causing the drainage water to flow in greater quantity and force, inundating portions of plaintiff's land. The court held that where a city deliberately enters upon a scheme of drainage and, by artifical means, casts drainage water on private property which would not otherwise receive such water, it commits a wrong which equity will restrain.

344
PROTECTION OF WATER SUPPLY FROM POLLUTION,

NJ Stat Ann aec 40:62-67 (1967).

Descriptors: *New Jersey, *Water pollution, *Public health, *Drains, Sewers, Sewage disposal, Legislation, Local governments, Cities, Drainage districts, Drainage systems, Construction, Water pollution control, Water quality control, Administrative agencies.

In municipalities having a public water supply obtained from a source beyond the municipal limits, the board or body having the control of such water supply may, when necessary to protect such water from pollution, construct, maintain, and operate, within this territory from which the water is derived or through which it flows, a system of drains and sewers for intercepting, taking off, and disposing of all sewage or other polluting matter. Every such system shall provide for the disposal of the sewage and other polluting matter taken up at a place and in a manner to render the same hamrless. The construction of such a system of drains and sewers shall not be commenced or entered upon unless and until the state department of health: shall approve the construction thereof as a sanitary measure; shall approve the plans therefore, which shall be submitted to it; and, shall define in a general way the limits of the district

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or territory within which or for which such system of drains of sewers shall be constructed.

345
STORMWATER SEWERS FOR COUNTY ROADS; MUNICIPAL COOPERATION,

N J Stat Ann sec 27:16-24 (1966).

Descriptors: *New Jersey, *Drainage systems, *Roads, Storm drains, Legislation, Local governments, Cities, Sewers, Legal aspects, Maintenance.

The board of chosen freeholders may direct the construction of a storm water drainage system in connection with the improvement or maintenance of a county road. The act provides the procedures to be followed in accomplishing such construction.

346
POWER OF CITIES,

N Y General City Law secs 20 (2), 20 (8), 20 (8a) (McKinney 1968).

Descriptors: *New York, *Cities, *Drainage, *Navigation, Legislation, State governments, Local governments, Sewers, Storm drains, Condemnation, Sewage disposal, Sewage, Water supply, Flood control, Right of way, Bridges, Beds, Navigable waters, Docks, Piers, Diversion, Public benefits.

Cities may obtain and hold real and personal property within or without the city limits. They may condemn real property for the construction, maintenance, and operation of sewage disposal plants, water supply systems, and drainage channels and structures for flood control, as well as all necessary rights-of-way for the above projects, and for any public or municipal purpose. Land so obtained may be sold or conveyed, but the rights of a city in and to its waterfront, ferries, bridges, wharves, submerged lands, streets, parks and all other public places are inalienable, except where specifically permitted in this section. Cities may control the waterfront and waterways of the city, and may establish, operate, and regulate docks, piers, wharves, warehouses, and all adjuncts and facilities for navigation and commerce, and for the utilization of the waterfront, waterways, and adjacent property. Cities may control filling and diversion of water-courses, except when authorized by a state or federal agency, by requiring that permits be obtained before such activities are commenced. Such permits may be denied if the city determines that the proposed filling or diversion is detrimental to the drainage or welfare of the city.

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347
PUBLIC HEALTH LAW (CLASSIFICATION OF WATERS AND PREVENTION OF POLLUTION),

N Y Public Health Law secs 1200, 1201, 1202 (b,c,d,e,f,i,l), 1205, 1220, 1221, 1225, 1250, 1251, 1252, 1260, 1261 (McKinney Supp 1968).

Descriptors: *New York, *Public health, *Water pollution control, *Sewage, Water resources development, Legislation, Water purification, Surface waters, Underground streams, Tidal waters, Organic wastes, Natural resources, Sewage disposal, Sewage treatment drainage, Conservation, Shellfish, Riparian rights, Industrial wastes.
Identifiers: Marine district.

The state of New York has passed extensive legislation dealing with the problem of water pollution and the protection of public health, fish, and wildlife. Their purpose is to safeguard the waters of the state from pollution. All waters of the state are included in the act. A water resources commission is set up to classify the waters and determine the standard of purity that should be maintained in each body of water. Water is classified according to its usage, i.e., drinking, bathing, fishing, and then assigned a standard of purity that must be maintained. Hearings by the commission to determine said standards are to be public. Pollution of water beyond the purity standard is made illegal as to both fresh and salt water. Permits must be obtained for the operation of a disposal system. Civil and criminal penalties are established for violation of these provisions and the use of injunctions are expressly authorized. No person other than the state acquires any actionable rights by virtue of the provision and it is in no way designed to create new or enlarge existing rights of riparian owners.

348
KUSHNER V PAZ CONSTR (STORM SEWER DRAINAGE),

171 NYS 2d 1007-1009 (S Ct 1958).

Descriptors: *New York, *Storm drains, *Obstructions to flow, Legal aspects, Judicial decisions, Manholes, Sewers, Drainage water, Flooding, Surface runoff, Natural flow, Relative rights.
Identifiers: Storm sewers.

Plaintiff sold the westerly portion of her parcel of land to the defendant. A storm sewer ran along the rear of both parcels and water in it naturally flowed in a westerly direction. The deed did not reserve an easement for the storm sewer in plaintiff's favor. To stop the flooding of his land due to a blockage of the sewer to the west of him, the defendant filled in a manhole located on his property.

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This caused a flooding of plaintiff's cellar. The court held that plaintiff was not entitled to a temporary injunction to compel the defendant to remove the obstruction and that an easement for sewer drainage over defendant's land would not be implied by law.

349
GIBSON V STATE (CONSTRUCTION AND MAINTENANCE OF SEWERS),

64 NYS 2d 632-644 (Ct Cl 1946).

Descriptors: *New York, *Storm runoff, *Sewers, *Highway effects, Overflow, Floods, Drainage, Drainage engineering, Storms, Surface runoff, Surface waters, Damages, Remedies, Judicial decisions, Legal aspects, Operation and maintenance, Rainfall-runoff relationships, Cities, Local governments, State governments, Highways.

Following a severe rain storm, water flowed from a nearby highway intersection onto plaintiff's property, damaging said property rather extensively. Plaintiff brought suit, alleging that the damage resulted from defendant's negligence in building and maintaining a highway sewerage system. The court granted defendant's motion for dismissal. It found that the state was under no duty to provide drainage for plaintiff's property. However, when a municipal corporation puts a sewerage plan into operation, it becomes liable for damages resulting from negligence in the construction and/or the maintenance thereof. In the case at bar, the evidence failed to establish any such negligence. The court also held that a municipality is not liable for an increase in flow of surface waters resulting solely from the paving of streets and the placement of other improvements. Liability may exist if the state diverts the surface runoff of a watershed from the course of its natural flow or collects such runoff in an artificial channel and discharges it in great volume upon the lands of another. But, in this case, the evidence disclosed no accumulation of water beyond that which would normally result from the construction of streets and roadbeds.

350
ACCURATE DIE CASTING CO V CITY OF CLEVELAND (FLOOD DAMAGE FROM SUBSURFACE DRAINAGE),

113 NE 2d 401-407 (Ohio Ct App 1953).

Descriptors: *Ohio, *Flood damage, *Cities, *Sewers, Drainage systems, Judicial decisions, Flood control, Flood protection, Overflow, Storm drains, Excessive precipitation, Natural flow, Subsurface drainage, Surface waters, Drainage water, Local governments, Outlets.
Identifiers: *Evidence.

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The plaintiff brought suit to recover for the flooding of his manufacturing plant, allegedly caused by the defendant's negligent sewer construction. The court found that the sewer outlets were not large enough to handle the accelerated water flow from a heavy rainfall. As a result of this condition, water was cast upon plaintiff's land in substantial quantities. The court found that the inadequacy of the drain to handle the accelerated waterflow was the proximate cause of the flooding and entered judgment for the plaintiff.

351
HOKE V CITY OF GREENSBURG (MUNICIPAL LIABILITY FOR DIVERSION OF SURFACE WATER THROUGH STORM SEWER).

42 Westmoreland County Law Journal, Vol 42, p 225-229 (Pa Ct C P 1959).

Descriptors: *Pennsylvania, *Surface drainage, *Diversion, *Storm drains, Sewers, Legal aspects, Judicial decisions, Channels, Damages, Drainage systems, Cities, Surface waters, Conveyance structures, Relative rights, Drainage effects, Water conveyance, Flooding, Artificial watercourses.
Identifiers: *Storm sewers.

The defendant City of Greensburg installed a 14 inch storm sewer that extended along the westerly edge of a city street in a southerly direction. The storm sewer was then extended in a westerly direction to a 48 inch storm sewer which passed in a general southerly direction to realestate owened by plaintiffs. Plaintiffs filed a suit to recover for damages resulting to their property when defendant diverted surface water through the system onto plaintiffs' land. The jury returned a verdict for the plaintiffs and the defendants moved for a new trial. On appeal, the court held that the determination of defendant's liability was properly left to the jury.

352
MASON V LAMP (ACTION TO RECOVER DAMAGES FROM SURFACE WATER RUNOFF ONTO PLAINTIFFS' PROPERTY),

189 Va 348,53 SE 2d 7-11 (1949).

Descriptors: *Surface waters, *Storm runoff, *Drainage, *Virginia, Relative rights, Watersheds, Drainage effects, Drainage practices, Ditches, Surface runoff, Flood control, Diversion, Surface drainage, Judicial decisions, Legal aspects, Flood damage.

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Plaintiffs brought this action seeking damage for injuries to their land and building caused by surface water which was diverted onto their land when defendant filled a low area on his property. The depression, which filled with water after heavy rains, had been located mainly on defendant's property, but had also extended to plaintiffs' property and to parts of other lots. Defendant took no special steps to provide a new drainage receptacle or avenue for collection or conveyance of surface water. During subsequent heavy rains, surface water drained from defendant's lot, among others, and from plaintiffs' own lot into plaintiffs' building, causing considerable damage. The court found that under the common law as adopted by Virginia, each landowner may protect his property from surface water damage as he sees fit, so long as he does not act wantonly or carelessly at the expense of other landowners. Plaintiffs failed to show negligence in defendant's filling and grading. The court held that defendant need not maintain a catch basin on his property for plaintiffs' benefit.

353
MUNICIPAL AND COUNTY GOV'T (SEWAGE SYSTEM),

Vt Stat Ann tit 24, secs 3501-3508 (1959).

Descriptors: *Vermont, *Sewage, *Sewage disposal, *Cities, Legislation, Regulation, Waste disposal, Wastes, Sewage treatment, Administrative agencies, Facilities, Local governments, Utilities, Public utilities, Taxes, Water rates, Storm runoff.
Identifiers: Domestic sewage, Storm sewage, Sanitary sewage, Sanitary treatment.

A municipal corporation may construct, maintain, and operate a sewage system and is authorized to purchase or acquire necessary real estate and easements. The municipal corporation may contract to make disposal of domestic or storm water sewage. The property owner using the sewage system shall be liable for rent, such rent being a lien on the real estate furnished with the service. The municipal corporation may purchase and hold realty and personalty and may levy and collect taxes necessary for the payment of the expenses and indebtedness of such sewage system. A board of sewage systems commissioners is created to supervise the municipal systems and to establish all needed rates for rent, with rules and regulations for its control and operation.

354
BRATONJA V CITY OF MILWAUKEE (ACTION TO RECOVER DAMAGES DUE TO FLOODING FROM HEAVY RAIN),

3 Wisc 2d 120,87 NW 2d 775-780 (1958).

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Descriptors: *Wisconsin, *Sewers, *Flood damage, Judicial decisions, Surface runoff, Surface waters, Storm runoff, Flood protection, Cloudbursts, Rain, Water law, Local governments, Cities, Legal aspects, Damages, Drainage systems.
Identifiers: Negligence, Storm sewers.

Plaintiffs owned buildings fronting on city streets. The area was within a natural saucer-like depression. A storm sewer in the area was laid in 1906. Improvements after that time mostly by the city, caused the level of the streets to be raised and soil by which rainfall would normally be absorbed to be covered. A relief sewer was later added. At least one plaintiff had suffered damages as a result of flooding due to a series of heavy rains. In 1949, another heavy rain fell, whereupon, several buildings in the area became flooded. Plaintiffs brought actions against the city, both on negligence and nuisance theories. The trial court found that there was no inadequacy or insufficiency in the original sewer plan, that the rainfall in 1949 was extraordinary, and that the city did not maintain the sewer system negligently. The appellate court affirmed, ruling that the city was under no obligation to collect the rainwater in the street; but if it actually took possession of such water and thereby assumed responsibility for it, it may have been liable for subsequently permitting it to escape on adjoining property. The plaintiffs failed to prove what part if any of their damage resulted from the backing up of the water in the sewer, contrasted with that from the flooding by surface water. The court held that attempting to label the condition a nuisance could not change the respective rights.

355
CREATION OF TOWN SANITARY DISTRICTS FOR POLLUTION CONTROL AND WASTE DISPOSAL,

Wis Stat Ann secs 60.30-60.304 (1957), as amended, (Supp 1969).

Descriptors: *Wisconsin, *Administrative agencies, *Drainage systems, *Waste disposal, Sewers, Sewage disposal, Sewage treatment, Drainage, Storm drains, Cities, Pumping, Construction, Jurisdiction, Real property, Public health, Legal aspects, Treatment facilities, Domestic wastes, Boundaries (property), Sewage districts.
Identifiers: *Sanitary districts.

Town sanitary districts may be created for the purpose of purchasing, establishing, or constructing surface or storm water sewers, drainage improvements, sanitary sewers, or a system of waterworks, sewerage, or garbage disposal. The districts may sue and be sued in furtherance of

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these purposes. 'Sewerage' includes all construction for collection, transportation, pumping, treatment, and final disposition of sewage. Procedure for creation of a town sanitary district is set forth. Town districts may be created within metropolitan sewerage districts since it is the intention of the legislature to permit auxiliary sewer construction in addition to the main and intercepting sewers constructed by metropolitan districts. Town boards are vested with jurisdiction to establish town sanitary districts. Petitions requesting such districts must be submitted by a fixed percentage of affected landowners to the town boards. Open hearings must be held by the town board before the creation of a district can be approved. Judicial review of the board's action is made available.

356
BOARD CONTROL OF REPAIR, CONSTRUCTION, AND IMPROVEMENT OF STREETS, SEWERS, SIDEWALKS, AND WATERCOURSES,

Wis Stat Ann sec 61.36 (1957), as amended, (Supp 1969).

Descriptors: *Wisconsin, *Local governments, *Sewers, Regulation, Watercourses (legal), Storm drains, Legislation, Administrative agencies, Drains, Structures, Canals, Legal aspects, Highways, Road construction, Construction, Drainage, Drainage practices.
Identifiers: Sanitary sewers, Storm sewers.

The village board may lay out, alter, extend, improve, repair, or discontinue any municipal roads, streets, alleys, sanitary and storm sewers, parks, and other public grounds. They may construct drains, canals, or sewers, and may alter, widen, or straighten watercourses. Their power extends to the building, alteration, repair, improvement, or discontinuance of any sidewalks and crosswalks as well as to the building and maintenance of roads and sidewalks required to connect the village with any transportation terminal or village property outside of its limits.

357
NEW AND PROPOSED LAWS,

Paul R. Bonderson
Paper presented at the Calif Water Pollution Control Assoc 42nd Annual Conference, Sacramento, Calif, Apr 29 to May 1, 1970.

Descriptors: *Legislation, *Water quality control, *Water pollution control, *Legal aspects, *California, *Water quality act.

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The Porter-Cologne Water Quality Control Act, a complete revision of the State's water quality laws, became effective January 1, 1970. The Act accomplishes the following objectives: (1) grants the State Board expanded powers to provide more leadership and greater influence over activities of regional boards; (2) requires regional boards to adopt more restrictive water quality control plans and discharge requirements so that better pollution control will be achieved; and, (3) makes major changes in enforcement procedures, including court assessment of $6,000 per day fines, which will give boards much more effective means for taking enforcement actions. Indications are that over 1,000 environmental quality control bills will be considered during the current legislative session. Consideration will be given to having a State sewage construction grant program. Major proposed water pollution control legislation will be summarized.

358
ANALYTICAL PROCEDURES FOR MEASURING CHEMICALS IN THE PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS, 1962,

Norman A. Clarke and John D. Weeks
J Amer Water Works Assoc, Vol 62, No 3, pp 172-176, Mar 1970.

Descriptors: *Standards, *Potable water, *Analytical techniques, *Measurement, *Chemical analysis.

The authors have compiled a list of chemical substances in the Drinking Water Standards and have defined recommended methods of analysis and sensitivity of techniques for measuring these chemicals. Also included are the methods of atomic absorption and spark emission spectroscopy, where applicable.

359
THE RESPONSIBILITY OF TREATMENT PLANT OPERATORS UNDER THE PORTER-COLOGNE WATER QUALITY CONTROL ACT,

Jerome B. Gilbert
Paper presented at the Calif Water Pollution Control Assoc 42nd Annual Conference, Sacramento, Calif, Apr 29 to May 1, 1970.

Descriptors: *Water quality act, *Water pollution control, *Water quality control, *Regulation, *Administrative agencies.

The State Water Resources Control Board and the nine California Regional Water Quality Control Boards are the state agencies responsible for control of water pollution and water quality. The Porter-Cologne Water Quality Control Act greatly strengthens and expands powers and duties of

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these agencies. Although there are many factors contributing to the degradation of water quality, discharges from municipal and industrial waste treatment plants are still the principal cause of water quality problems. Under the new law, requirements will be made further restrictive, resulting in highly sophisticated and more complicated treatment plants. Exacting performance by operators in charge of plants will be needed to prevent violation of requirements and to collect fines up to $6,000 per day. To help assure that qualified operators will be in charge, the State Board will classify all treatment plants and specify the level of competence necessary to operate them. The Board will also specify the training necessary to qualify an operator for each level of competence. All operators should take advantage of training opportunities in order to qualify themselves for new levels of operating competence.

360
COORDINATION THROUGH COOPERATION,

A. J. Hanis
Public Works, Vol 99, No 11, pp 68-69, Nov 1968.

Descriptors: *Construction, *City planning, Sites, Storm drains.
Identifiers: *Construction projects, *Sanitary sewers, *Storm sewers.

The Greater Tampa Utilities Group formed in 1960 recommends standards for planning and locating public and utility construction projects such as electric, telephone, gas, water, and sanitary and storm sewer lines. Street diagrams showing proposed utility locations are included with sanitary sewers placed along center lines and storm sewer lines at approximately the quarter point on one side. Municipal storm drains are placed beneath the curb and county/state drains beneath the pavement at the quarter point.

361
WATER QUALITY CONTROL IN CALIFORNIA,

Norman B. Hume
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA4, pp 873-874, Aug 1970.

Descriptors: *Legislation, *Water pollution control, *Water quality control, *Water resources, *Water rights, *Administration, *Pesticides, *Groundwater, *Water management (applied), *California.

A summary of the historical progression of water quality control legislation from 1949 through the present is given including: a description of the Dickey Water Pollution Act of 1949; reasons for combining the

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related functions of water rights determination, water pollution control, and water quality control; the responsibilities assigned to the State Water Resources Control Board; the regional approach to water resources control and management; the origin of pesticides; the methods for protection of groundwater; the water quality control study project and findings; and, the Porter-Cologne Water Quality Control Law of 1969.

362
ESTABLISHMENT OF WATER QUALITY STANDARDS IN THE CITY OF TAKAMATSU,

Takishi Ishibashi
Sangyo Kogai, Vol 6, No 6, pp 372-382, Jun 25, 1970.

Descriptors: *Standards, *Water quality, *Systems analysis, *Investigations, *Water pollution treatment.
Identifiers: Japan.

An urban river system was employed to establish water quality standards in the Takamatsu area. Normally the standard is established by an investigation of the individual source of pollutants. In large cities where numerous sources exist, an exhaustive investigation is impractical; consequently, an average water quality standard, based on a sampling investigation of primary sources of pollutants, together with considerations of the special properties of the water area are taken as a basis in establishing the individual standard. This new system was effective in expediting the formulation of the standard. The general situation of the water area in question, status of water utilization, water pollution, results of investigations on water quality, pollutants' source, planning of the public sewage system, and future prospects of water pollution are presented. Basic factors considered in establishing and finalizing the water quality standard are given. Discussions made at committee meetings for establishing the standard are also included.

363
BRITISH WATER POLLUTION CONTROL,

Samuel H. Jenkins
Environ Sci Technol, Vol 4, No 3, pp 204-209, Mar 1970.

Descriptors: *Discharge, *Pollution abatement, Legislation.
Identifiers: *Pollution control methods, Stormwater purification, Sewage purification.

Water pollution abatement is being realized in Great Britain due to the construction of varying types of purification plants which produce effluents fit for discharge to public sewers or rivers. Past and pre-

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sent legislation and national policy in the area is described along with techniques used in water pollution abatement. Major improvements have been made possible by granting complete power to municipal authorities to control industrial discharges, thus, insuring that mixtures of sewage and industrial effluents are treated in accordance with required standards. Pollution control procedures covered include: industrial water reuse, metal finishing waste treatment, sewage treatment plants, plastic filter media, and slude disposal. In Britain, maximum amounts of storm water are purified. Trunk sewers convey 6 d.w.f., but sewage treatment plants complete purification to only 3 d.w.f. The remainder spills into tanks of 6 hour d.w.f. capacity, and it is later pumped back for treatment.

364
THE SEWERAGE (SCOTLAND) ACT 1968,

Dugald McDonald
Surveyor, Vol 84, No 4036, pp 46-48, and 51-53, Oct 17, 1969. 3 fig.

Descriptors: *Legislation, *Sewerage, *Sewage disposal, *Sewers, *Prior appropriation, Jurisdiction, Local governments.
Identifiers: *Trade effluents, *Scotland.

This paper describes the Sewerage Scotland Act, a modern, comprehensive code governing sewerage, sewage disposal, and trade effluents. The act is divided into three parts: sewerage, trade effluents, and a supplemental part. The following subjects included in the act are discussed in the first part: local authority to provide sewerage, sewer maintenance, sewers vested in local authority, new sewer construction, sewer connections, joint sewerage and sewage disposal, highway drainage, septic tanks, adoption of private sewage works, defective drainage, abolition of special drainage districts, and prohibition on buildings erected on sewers. The part on trade effluents includes: the right to discharge to sewer, and existing and new discharges. The supplemental section reviews: the rights to sewage, powers of entry, sampling sewage, prohibition on harmful substances, application to the Crown, and settlement of appeals and disputes.

365
PORTER-COLOGNE ACT REVISITED,

Ronald B. Robie
Paper presented at the Calif Water Pollution Control Assoc 42nd Annual Conference, Sacramento, Calif, Apr 29 to May 1, 1970.

Descriptors: *Legislation, *California, *Water quality control, *Water quality act, *Legal aspects.

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The Porter-Cologne Water Quality Control Act, effective January 1 this year, provides the State Water Resources Control Board and the nine California Regional Water Quality Control Boards with the "tools" to implement and carry out an effective water quality control program. The new law is geared to enhance the water environment as well as to prevent water pollution. This is evidenced by the inclusion of esthetic enjoyment and the preservation of fish, wildlife and other aquatic preserves among the water uses to be protected. Other major provisions of the new law include: civil fines up to $6,000 per day for violation of cease and desist orders relative to a waste discharge; payment of a filing fee not exceeding $1,000 to accompany a report of a proposed or material change in a waste discharge; mandatory cleanup of pollution by a violator with full liability for cleanup costs; and integration of water quality into consideration of water rights, including appropriation of water by storage to be released in order to protect or enhance water quality.

366
UTILIZATION OF STREAM FOR STORM DRAINAGE,

D. A. Schneider
Public Works, Vol 98, No 4, p 87, Apr 1967.

Descriptors: *Legislation, Drainage districts.
Identifiers: *North Carolina.

As the Court stated in a North Carolina case, municipalities can be held liable for damages caused by their failure to maintain proper sewer conditions including good drainage and freedom from obstruction. Thus, when a locality utilizes a natural waterway for sewerage and drainage, it is obligated to keep this water in proper condition, and it is liable under the law for damages resulting from neglect to perform this duty.

367
PHOSPHATES IN SURFACE WATER AND DETERGENTS,

P. J. Weaver
J Water Pollution Control Fed, Vol 41, No 9, pp 1647-1653, Sep 1967.

Descriptors: *Phosphates, *Surface runoff, Water pollution sources, Detergents.
Identifiers: Urban runoff, Stormwater.

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The presence of phosphates in surface waters may be caused by municipal, industrial, and/or agricultural sources. Millions of pounds of phosphate enter lakes and streams each year. An estimated 120,000 to 200,000 lb (54,500 to 90,800 kg) of phosphorus (as P) were measured daily in the Maumee River Basin in Ohio. Agricultural sources, animal wastes, and lake bottom muds are important sources of the phosphate nutrients in addition to wastes encountered at wastewater treatment plants from domestic disposal systems, urban runoff and drainage, and stormwater overflow. The removal of P from treatment plants may be accomplished by chemical, chemical biological, and other methods. Phosphates are important ingredients of detergents because they soften water, sequester, emulsify, provide alkalinity and many other advantages.

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368
WASTE DISPOSAL -WATER TREATMENT PLANTS (JOINT DISCUSSION).

J Am Water Works Assoc. Vol 58, No 9, pp 1102-1116, Sep 1966.

Descriptors: *Water treatment, *Waste disposal, *Sludge disposal, *Application methods.
Identifiers: *Detroit, Michigan, Back-wash water.

In a joint discussion at the annual conference of the AWWA in May 1966 several speakers discussed various aspects of the problem of disposing of wastes from water treatment plants without causing pollution. Local factors were taken into account when deciding whether or not such wastes were likely to have an adverse effect on the receiving water. The effects of Pennsylvania state water quality standards and of federal pollution-control legislation on the disposal of wastes from water works were considered, and the methods of disposal at Detroit, Michigan, were described by G.J. Remus. One of the Detroit works is situated on the banks of the Detroit river and the filter wash-water from this plant is discharged directly to the river; since the flow is rapid, the wash-water is dispersed rapidly and there is no evidence of sludge deposits. The wash-water is chlorinated before discharge and is bacteriologically of better quality than the river water. The other three water works are situated away from the river; at the largest of these the filter back-wash water is recirculated for reuse, while at the other two it is discharged to a sanitary sewer, and settled before discharge to a storm sewer, respectively. The sludges from the sedimentation tanks at all the plants are discharged to the sanitary sewers.

369
THE LARGEST BIOLOGICAL SEWAGE-TREATMENT PLANT ON THE CONTINENT.

Ber Abwassertech Ver (BABVAD), Vol 18, No 2, V, 1967.

Descriptors: *Biological treatment, *Sewage treatment, *Sludge treatment, Channels, Investigations.
Identifiers: Germany.

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An account is given of plans for a large biological treatment plant to be built in Essen, Germany, to deal with the increasing quantities of sewage to relieve the existing Emscher plant. The new plant will be able to treat a load of 20 m^3 per second, and during rainfall this amount can be increased to 30 m^3 per second. Provisions have also been made to construct the influent and effluent channels of the mechanical stage in such a way that a loading of up to 45 m^3 per second would be possible. The section where the preliminary treatment is carried out is to be built below ground to that incoming sewage can enter without pumping; the biological stage will then be built above ground and the sewage will be pumped into individual tanks accomodated in 3 buildings. The plan for separate units applies to the whole plant for convenience of necessary repairs. Special provision is made for the separation of oil. Oxygen is supplied mechanically to the aeration tanks, which will have a total volume of 180,000 m; the final sedimentation tanks will also have a volume of 180,000 m^3. Primary sludge, amounting to about 60% of the total sludge, is to be transported to the sludge-drying plant in Essen-Karnap via a pressure pipeline. Experiments are at present being carried out on methods for disposal of excess activated sludge.

370
10,000 FT LONG SEA OUTFALL AT HASTINGS IN SUSSEX,

Civil Eng Public Works Rev, Vol 63, No 746, p 1003, Sep 1968.

Descriptors: *Outlets, *Pumping plants, Pollution abatement, Pretreatment (water), Construction, Sewage disposal.
Identifiers: *Great Britain, Stormwater sump.

A new sewage disposal scheme is under construction to eliminate seashore pollution caused by direct discharges to the ocean through two conventional outfalls. The plan involves pretreatment of sewage after which it is pumped through a long outfall pipe to a point two miles offshore. The pumping station will handle sewage flows up to 6 dwf or 7.5 mgd, and a combination storm weir and automatic penstock will pass excesses to the stormwater sump. A culvert will connect the stormwater sump to the foreshore, and for sea-levels below mid-tide the stormwater will discharge to the sea by gravity. At other times when the culvert is tide-locked, a stormwater pump will operate. Descriptions of physical characteristics, workings, and methods of construction of the long sea outfall and the pumping station are included along with a diagram of the new severage scheme.

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371
RE-USING STORM RUN-OFF.

Environ Sci Technol, Vol 2, pp 1001-1005, 1968.

Descriptors: *Design, *Cost analysis, Lakes, Potable water, Runoff.
Identifiers: Columbia, Maryland.

A design and cost study of the 1100-acre Wilde lake watershed in Columbia, Md., which considers the treatment of runoff and its re-use as potable water, is described. The scheme includes the collection and storage of runoff in 10 small lakes and preliminary treatment there by sedimentation, chemical coagulation, and chlorination.

372
TRANSMISSION PLANT TREATS 100,000 GPD.

Modern Power Eng, Vol 64, No 6, pp 64-66, Jun 1970. 2 tab, 1 diag.

Descriptors: *Waste treatment, *Sewers, *Sewage treatment, *Industrial wastes, Separation techniques, Water distribution (applied), Storm runoff.
Identifiers: Interceptor sewer.

Prior to installing General Motors' automatic transmission treatment plant, plans were made for the separation of industrial wastes from other liquid wastes. Separation of sewage and sanitary wastes was accomplished by laying interceptor sewers from washrooms to connect to municipal sewers. Stormwater was separated through the construction of an overhead collection system connected to rainwater leaders from the roof. Clean cooling water from production operations was also pumped into this overhead collector and the contents fed to municipal storm systems. Industrial waste purification was accomplished through the installation of the complex waste treatment plant, which is described in detail and which, since September 1968, has passed only treated industrial wastes to municipal sewers.

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373
PHASE 1 EXTENSION WILL CATER FOR EXTRA 1.7 M.G.D. FLOW,

Munic Eng (London), Vol 146, p 756, 1969.

Descriptors: *Sewage treatment, Humus, Sedimentation, Filtration.
Identifiers: * Great Britain, Storm tank.

An illustrated description is given of extensions in progress to the Tixall sewage works of the Stafford Borough Council, including humus, sedimentation, digestion, and storm sewage tanks, additional percolating filters, and a building to house filter presses. The extended works, which also treats sewage from an area administered by Stafford R.D.C., will have a treatment capacity of 3.7 m.g.d.

374
COMBINED SEWAGE WORKS OPERATING AT FARINGDON,

Munic Eng (London), Vol 146, p 1221, 1969.

Descriptors: *Sewage treatment, *Storm runoff, *Biocontrol.
Identifiers: *Combined sewers, *Effluent discharge, *Biological filtration, Great Britain.

An illustrated description is given of the new sewage works served by a combined severage system and provided by Faringdon R.D.C., Berks. Treatment is by biological filtration. The final effluent flows into a stream after discharge to a small irrigation area, and excess stormwater is distributed over a 5-acre seepage site from where it drains to the stream through a clinker bed. Crude sludge is dewatered in drying beds.

375
FULL TREATMENT CAPACITY INCREASED TO 3.36 M.G.D. by 29,000-POUND EXTENSION,

Munic Eng (London), Vol 145, p 2090, 1968.

Descriptors: *Sewage treatment, Sludge disposal.
Identifiers: *Great Britain, Capacity, Storm sewage.

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Recent extensions to the sewage works of Fleet, Hants., which have increased capacity to a dry-weather flow of 1.12 m.g.d., are described. Additional facilities include sludge-drying beds with mechanized removal of sludge, and modifications have been made to humus tanks and percolating filters to provide more working volume. The humus-tank effluent passes through microstrainers before discharge and storm sewage overflows are treated on the land before discharge to a stream.

376
LOWESTOFT CHOOSES TUNNEL FOR SEWAGE OUTFALL,

Surveyor, Vol 84, No 4030, p 18, Aug 29, 1969. 2 fig.

Descriptors: *Outlets, *Sewerage, *Construction, *Currents (water), *Costs, *Tunnel design, Discharge (water), Sewage treatment, Tunnel construction, Tunneling machines.

The sewage outfall project at Lowestoft is controversial in concept as well as in mode of construction. Problems of such outfalls include their frequent damage by heavy seas and their questionable ability to adequately disperse effluents. Sea currents at discharge points were investigated and found to be conducive to properly carrying effluent out to sea. The slightest beach pollution, however, will promote intense public distrust of the plan. Discharge shafts of the tunnel beneath the sea-bed will be raised through the use of massive hydraulic jacks, an unusual technique. Both the tunnel work and the shaft raising will be done employing compressed air. Dimensions of the tunnel and other construction techniques and problems are related. The scheme adopted is inexpensive with regard to capital and service costs. A complete sewage treatment works for the town would cost at least twice as much.

377
TIVERTON SEWAGE WORKS RECOGNIZES FLOOD HAZARD

Surveyor, Vol 84, No 4028, pp 30-32, Aug 15, 1969. 7 fig.

Descriptors: *Drainage systems, *Sewage disposal, *Sewers, Flood control, *Multiple-purpose projects, *Treatment facilities, Design criteria, Sludge treatment, Sewage treatment.
Identifiers: *Great Britain.

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Extensive main drainage and sewage disposal schemes were completed at Tiverton, Devon. Plans involved relaying of the town's sewers, the provision and renovation of pumping stations, and the reconstruction of sewage disposal works. All three aspects of the work are fully described. Previous town sewers consisted of old brick culverts which were badly silted, and infiltration water entered in places. A complicating factor at Tiverton is that the works are susceptible to flooding from the nearby River Exe. This complication was considered in the design of the works, particularly with regard to sludge treatment. To overcome problems of drying sludge, a method of mechanical drying, called sludge pressing, was installed. A mixture of primary, humus, and stormwater sludges is passed to a chemical conditioning tank where lime and ferrous sulphate solutions are added and mixed with the sludge. The pressing, which takes about seven hours, is performed automatically. The entire procedure is outlined.

378
DUAL PURPOSE SETTLEMENT TANKS AT ANDOVER,

Surveyor, Vol 83, No 4013, pp 29 and 44, May 3, 1969. 1 fig

Descriptors: *Sewage treatment, *Treatment facilities, Design, Sediment control, Pumping plants, Weirs, City planning.
Identifiers: *Storm tank, *Storm overflows, *Great Britain.

Andover's new sewage treatment works embodies four unusual design features, namely, dual purpose primary sedimentation and stormwater tanks, double filtration, elutriation, and filter pressing. As a temporary extension, three sedimentation tanks were constructed to deal with an excess dry weather flow. The original pumping station was converted to a stormwater pumping station, and preliminary treatment units were replaced by an inlet works composed of coarse screens, a bypass channel, flow controlling weirs, and a storm overflow chamber. Flows up to 3 d.w.f. pass to the new main pumping station. Flows between 3 and 6 d.w.f. surcharge and pass to the old station converted for stormwater pumping. Flows exceeding 6 d.w.f. discharge into existing stormwater tanks. The rectangular sedimentation and stormwater tanks were combined into one unit of eight tanks, four back-to-back with a gallery between. Advantages of this system are cited. Descriptions are given of the previous facilities, effluent requirements, temporary extensions, the new main pumping station, the pumping main, the treatment works, primary and secondary treatment, final settlement, sludge digestion, elutriation and conditioning, filter pressing, and landscaping architecture.

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379
ASHFORD (KENT) SEWAGE WORKS AFTER FOUR YEARS,

Surveyor, Vol 83, No 4000, pp 38-41, Jan 31, 1969. 3 fig, 1 tab.

Descriptors: *Construction, *Design, *Operations, *Sewage disposal, *Treatment facilities, *Sewage treatment, *Controlled drainage, *Sludge treatment, *Effluents, Storm runoff.
Identifiers: *Great Britain.

Major items are presented from a longer paper that described in detail the design, operation, and problems involved in construction of the Bybrook Sewage Disposal Works at Ashford in Kent. In one town served by the old Bybrook works, flows exceeding 6 d.w.f. discharged directly to the old River Stour. Old stormwater storage tanks, previously serving Bybrook only, were improved and a short weir constructed so that all flows pass through both tanks before discharge to the river. Two auto sludge scraping mechanisms aid removal of sludge which is returned along with the tank contents by a stormwater pump to the works for full treatment. The following topics relating to the new disposal works are discussed: trade wastes, the standard of effluent, inlet works, settlement tanks and filters, humus tanks, the irrigation area, stormwater, sludge treatment, commissioning techniques, percolating filters, the digestion plant, mechanical plant problems, the pumps' insides and filter arms grounding. The paper concentrates on early operational problems, but notes that the disposal works' effluent has proven to be excellent.

380
FARINGDON RDC NEW SEWAGE WORKS,

Surveyor, Vol 82, No 3980, pp 54-56, Sep 13, 1968. 5 fig.

Descriptors: *Treatment facilities, *Sewerage, *Sewers, *Overflow, *Controlled drainage, Storm runoff.
Identifiers: *Combined sewers, *Storm sewers, *Great Britain, Capacity.

A conventional treatment plant of modern design and large capacity, plus a new and extensive sewerage system replaced a formerly overloaded system at Faringdon in the Berkshires. Additional sewers were provided to relieve the existing system from surcharge and from extremely heavy flows from a new relief road constructed to overcome flooding. Faringdon has a combined sewerage system which must be of a size and capacity sufficient to handle the heaviest storm. The sewage disposal

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works and sewers leading to the works were designed to handle 3 x dwf. Provision was made for flows over 3 x dwf by constructing large diameter sewers which operate immediately when combined sewers run over. The stormwater sewers do not flow to the disposal works, but discharge onto a stormwater irrigation area. Advantages of this system over the previous one are reported. The new treatment works is described in general, in addition to the procedure used to treat storm flows over 3 x dwf.

381
LAUNCHING A TWO MILE SEWAGE OUTFALL,

Surveyor, Vol 82, No 3978, pp 16-17, Aug 30, 1968. 4 fig.

Descriptors: *Drainage systems, *Treatment facilities, Outlets, Water pollution sources, Construction, Pumping plants, Weirs, Storm runoff, Flow control, Costs, Design data.
Identifiers: *Great Britain

The Hastings western area main drainage scheme includes a severage outfall, two new pumping stations, a partial treatment works, and a pumping main. The scheme was designed to replace two conventional outfalls which caused pollution of the foreshore and shallow water because of insufficient length. The new outfall was built up into seven strings in a special assembly area, and these sections were joined successively before the entire pipe was launched into its final position on the sea bed. Further construction procedures are explained along with the means used to determine the proper length of the outfall. The new pumping station pumps sea sewage flows up to 6 d.w.f., and a discharge to a stormwater sump. The sump connects to the foreshore by a culvert and for sea levels below mid-tide, stormwater discharges to sea by gravity. At times when the culvert is tide-locked, a stormwater pump operates. Costs, dimensions, and other details of the entire scheme are included in the article.

382
NEW SEWAGE DISPOSAL WORKS FOR OAKENGATES U.D.C.,

Surveyor Munic City Engrs, Vol 129, No 3920, pp 31-32, 1967.

Descriptors: *Sludge treatment, *Sewage treatment.
Identifiers: *Great Britain, *Storm tank, *Biological filtration.

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An illustrated description is given of a new sewage works at Oakengates, Salop., which provides complete treatment by biological filtration for up to 3 times the dry-weather-flow of 0.8 m g.d. Primary sludge and sludge from stormwater tanks are discharged to thickening tanks, and secondary sludge is returned for treatment or pumped to the thickening tanks if required. After thickening, sludge is dewatered on beds.

383
AWARD WINNING INDUSTRIAL WASTE TREATMENT PLANT,

Water Pollution Control, Vol 107, No 7, p 18, Jul 1969.

Descriptors: *Waste treatment, Ponds, Storm runoff
Identifiers: *Stormwater pond.

Chrysler's industrial waste treatment plant handles combined storm and industrial wastewater. The plant is designed to remove and dispose of free and emulsified oils, detergents, caustic strippers, and acid rinses. A stormwater holding pond of three million gallons stores excess flow from the industrial plant under storm conditions. Exceptionally long and heavy rainfalls could cause the pond to overflow; however, a sufficient detention time would still allow suspended solids to settle out. Stored stormwater is treated later when the plant sewage load has decreased

384
WILMINGTON GOES ON LINE WITH MODERN NEW SECONDARY TREATMENT PLANT,

Water Sewage Works, Vol 116, No 12, pp 471-473, Dec 1969.

Descriptors: *Sewage treatment, *Sewerage, Sewers, Water pollution.
Identifiers: *Sewer hydraulics, Combined sewers, Wilmington, Delaware.

Wilmington Delaware's recently-built secondary sewage treatment plant will allow the city to meet federal regulations regarding water pollution. Although the city has a combined sanitary, industrial wastes, and stormwater sewerage system, entire flows are given primary treatment before passing to the river. During periods of rainfall, sewage pumping stations discharge approximately 120 mgd with three pumps in operation. The structure of the new sewage treatment plant is described along with the advantages it provides.

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385
OXFORD SEWAGE TREATMENT PLANT,

Water Waste Treat, Vol 12, No 9, pp 280-281, Sep/Oct 1969.

Descriptors: *Treatment facilities, *Overflow, Sewage treatment, Regulation.
Identifiers: Great Britain.

Extensions of the Oxford Sewage Treatment Plant were required when overloads reached 2 million gallons per day. Now all flows, after preliminary treatment, are pumped to the inlet channel where two-thirds are sent to the old works and one-third to the new works with peak flow/storm balancing tanks acting progressively above 7,000 g.p.m. The dimensions and workings of new units are described. Additions to the plant include: three peak flow/storm balancing tanks, an aeration plant unit, side wall unit extensions to the original flat bottom tanks, infinitely variable speed pumps serving the return activated sludge plant, two hopper bottom tanks, a secondary sludge digestion unit, and three tanker vehicles for conveying consolidated activated sludge.

386
NEW PUMPING STATION FOR LIVERPOOL,

Water Waste Treat, Vol 12, No 9, p 297, Sep/Oct 1969.

Descriptors: *Pumping plants, *Treatment facilities, *Pumps.
Identifiers: *Great Britain, *Storm tank.

The new pumping station for Liverpool is part of a major extension program which provides further sedimentation tanks, stormwater tanks, and increased biological filtration capacity. The station is designed to accomodate seven vertical sewage pumps, four of which (dryweather pumps) are arranged so as to deliver sewage through one rising main to the primary sedimentation tanks. The three remaining pumps (stormwater pumps) deliver sewage through a second rising main to the stormwater tanks. The operation and output of the pumps are described. Ultraviolet lamps are used to suppress odor and retard any fungoid growth which may occur in the pump house basement.

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387
INSTRUMENTATION AND CONTROL AT DALMARNOCK SEWAGE DISPOSAL WORKS,

Water Waste Treat, Vol 12, No 1, pp 19-20, May/Jun 1968.

Descriptors: *Sewage treatment, *Flow measurement, Sludge treatment, Effluents.
Identifiers: *Scotland.

The instrumentation and control provided by the Lea Recorder Co. for the new activated-sludge plant at Dalmarnock, Glasgow, are described in detail. Provision has been made for automatic sampling at various stages of treatment, as well as for the control and recording of the flows of sewage, stormwater, and effluent. The final effluent is discharged to the River Clyde.

388
SALISBURY SEWAGE WORKS,

Water Pollution Control, Vol 97, No 5, pp 536-538, Sep 1968.

Descriptors: *Design, *Severage, Storm runoff, Sewage treatment.
Identifiers: *Storm tank, Sewage system.

The workings of the Salisbury Sewage system are described. In the case of heavy rainfall (flows in excess of 3 d.w.f) storm sewage passes to 4 storm tanks with a combined capacity of 700,000 gal., serving a design population of 46,000. After the storm, the contents are returned for full treatment and the tanks are cleaned by high-pressure hose jets.

389
SHREWSBURY SEWAGE WORKS,

Water Pollution Control, Vol 67, No 4, p 400, 1968.

Descriptors: *Design, *Severage, Storm runoff, Sewage treatment.
Identifiers: *Storm tank, Sewage system.

The new Shrewsbury sewage works opened in 1964 is described. Flows exceeding 6 x d.w.f. are discharged over a double-sided weir and pass directly into a nearby river. Flows in excess of 3 x d.w.f. pass to the storm tanks which have a combined capacity equivalent to 6 h d.w.f.

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390
WATER RE-USE,

Chem Eng Program, Symposium Series, Vol 63, No 78, 1967. 284 p.

Descriptors: *Water reuse, *Water pollution control, *Waste water treatment, *Application methods, *Analytical techniques, Design, Sewers, Sewage treatment.

This publication contains the papers presented at the 59th annual meeting of the American Institute of Chemical Engineers in Detroit, Michigan, during an international conference on the conservation of waste water by reuse, and additional papers from other meetings of the Institute are also included to give broad coverage of the subject. Information on the reuse of waste water for industrial or municipal supplies is presented for 9 countries and consideration is also given to the role of water reuse in the prevention of pollution, management of water resources, and design of sewerage systems; medical, legal, and economic aspects; internal reuse of water in factories; treatment for reuse, including the use of chemicals, ionizing radiation, activated carbon, and biological processes; removal of viruses, phosphates, and nitrogen compounds; reuse in spaceships; recovery of chemicals; analytical techniques; disposal of sludges; and complete reuse of all waste waters including storm sewage.

391
MERSEY AND WEAVER RIVER AUTHORITY. FIRST ANNUAL REPORT 1965-1966,

Descriptors: *Water resources, *Fisheries, *Sewage treatment, Quality control, Activated sludge, Effluents, Investigations.
Identifiers: Storm sewers, Suspended solids.

This report contains information on water resources, including the preparation of a hydrometric scheme and a survey of water demand in connection with the investigation of the Morecambe Bay Barrage Scheme: fisheries and causes of fish mortalities: and pollution prevention, including the results of chemical surveys of the major rivers. The policy of closing the smaller sewage works and treating all the sewage at larger, improved, works, which also treat trade wastewaters, is proving successful. The policy of recommending separate sewerage systems wherever circumstances permit has been vindicated by results of investigations on the characteristics of discharges from the stormwater sewers, which are relatively free from organic matter although they contain inert suspended solids. Laboratory studies have shown that most effluents from textile and paper mills can be treated

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by the activated-sludge process, producing an effluent of high quality, providing nitrogenous and phosphate nutrients are added as necessary. A new plant used for the treatment of textile wastewaters by chemical precipitation and sedimentation operates on a "fill-and-draw" system using a series of 3 tanks. While one tank is filling, liquid in a second tank is being mixed, neutralized, and coagulated and settled liquor is being decanted from a third tank. A well-clarified effluent is produced.

392
PROBLEMS OF WATER TREATMENT IN DEVELOPING COUNTRIES,

D. Anderson
Effluent Water Treat, Vol 8, No 10, pp 513-516, Oct 1968

Descriptors: *Water treatment, Waste water (pollution), Sewage.
Identifiers: Developing countries.

There will be an increase in the volume of wastewater and in the concentration of pollutants due to the increase in the total use of water for municipal, agricultural, and industrial purposes. The problems created by this increase include: development of water resources investigating river morphology and irrigation: sewage waste stressing the reduction of the oxygen consumable in sewage: trade wastewater caused by a rapid program of industrialization; equipment and processes wherein design standards used in industrial countries were also applied to developing countries, citing the installation of a treatment plant and an inadequate stormwater system: water and wastewater management; and water-borne disease. Research information is needed for combatting the water treatment problems.

393
EXTRACTS FROM THE ANNALS OF A SEWAGE-WORKS MANAGER, 1950-1966,

T.A. Austin
Paper presented at a meeting of the Institute of Water Pollution Control, Birmingham, November 1967.

Descriptors: *Sewage treatment, Effluents, Water pollution, Water reuse, Investigations, Biochemical oxygen demand.
Identifiers: *Great Britain, Storm sewage, Suspended solids.

An historical account is given of the development of sewage works at Leamington Spa with special reference to the problems encountered. Aspects considered include: the system adopted for charging, conveying,

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and treating trade wastewaters; raising of weirs on storm sewage overflows to overcome pollution of the River Leam; and experiments on the treatment of effluent to permit reuse for industrial purposes. The works now serve a population of 58,000 and treat an average flow of 4.5 m.g.d., with an efficiency of 93.7 per cent (based on BOD). In view of continually increasing loads, a scheme is being developed for a new works, together with a new Avon valley sewer. Trials were carried out using spray-irrigation of screened sewage on grass plots with underdrains which removed 89 per cent of the BOD and 95 per cent of the suspended solids.

394
SEPARATION OF SEWAGE FROM STORMWATER,

V.W. Bacon, R. Leland, and B. Sosewitz
In: Symposium on Storm Sewage Overflow, Inst of Civil Engrs, pp 143-152, 1967.

Descriptors: *Sewers, *Water pollution sources, Storage, Design, Investigations.
Identifiers: *Storm sewage, *Chicago.

In the U.S., since the conversion from existing combined sewage systems to separate systems would not be economical, various alternate methods of preventing pollution by storm sewage have been investigated. The Chicago underground storage plan followed by back-pumping to surface reservoirs for sedimentation and chlorination is discussed.

395
STORAGE AND TREATMENT OF COMBINED SEWAGE AS AN ALTERNATE TO SEPARATION,

A.W. Banister
In: Combined Sewer Overflow Seminar Papers, Edison, N.J., Nov 4-5,1969, Water Pollution Control Research Series, DAST-37, pp 19-36, Mar 1970. 4 fig.

Descriptors: *Separation techniques, *Storm runoff, *Treatment facilities, *Project planning.
Identifiers: *Chippewa Falls, Wisconsin.

The city of Chippewa Falls, Wisconsin needed to complete a program of separating stormwater from its sanitary sewage and waste collection and treatment facilities, or to provide a method of treating the combined sewage and wastes. The project selected consisted of certain combined trunk sewers, certain minor separate storm sewers, a combined sewage pumping station, and a combined sewage storage pond. A detailed description of the project operations and results is given.

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396
HYDROGEOLOGIC STUDIES ARE KEY TO SAFETY IN WASTE MANAGEMENT PROGRAMS,

Robert E. Bergstrom
Water Sewage Works, Vol 116, No 4 pp 149-155, Apr 1969. 7 fig, 7 ref.

Descriptors: *Groundwater, *Waste disposal, *Water pollution, *Illinois, *Treatment facilities, *Tunnels, Flow control, Aquifers, Data collections, Investigations, *Hydrogeology.
Identifiers: *Disposal operations, *Storm tunnels, *Waste management, Deep tunnel plan, Chicago.

Waste disposal is explored as a possible factor in groundwater contamination. State-reviewed disposal operations in Illinois that are specifically discussed include: landfills and dumps, radioactive waste burial grounds, sewage treatment and waste storage ponds, disposal wells, and sewage-stormwater tunnels. The Chicago Sanitary District's tunnel plan for the prevention of stormwater and raw sewage bypassing treatment plants and polluting streams is described. Initial reports concluded that stormwater and sewage would not pollute the groundwater reservoir because the rock in which the tunnel was bored is tight, and head relations provide that water only moves into and not out of the tunnel. Possible problems created by this project are mentioned. The following suggestions are proposed to aid groundwater practitioners in waste management; (1) the selection of sites for waste disposal based on hydrogeologic conditions which indicate natural safeguards and the protection of health and resources; (2) procurement of data needed to develop criteria for determining geologic conditions and beneficial engineering practices; and (3) the study of investigations relating to waste management topics such as saturation and water movement in typical geologic terrains that might be used for waste disposal.

397
THE DESIGN AND CONSTRUCTION OF REGIONAL SEWERAGE AND SEWAGE TREATMENT WORKS FOR LIVINGSTON NEW TOWN INCLUDING ITS ENVIRONS AND FOR THE NEWBRIDGE AREA,

T.A.C. Brownlie and W. Ferguson
J Inst Public Health Engrs, Vol 68, Part 3, pp 160-188, Jul 1969.

Descriptors: *Sewerage, Sewage treatment, Design, Overflow.
Identifiers: *Storm sewers, *Combined sewers, Treatment methods, Storm tank, Great Britain.

Described in detail are plans for Livingston New Town and its environs and Newbridge. Separate sewers were adopted for the New Town while existing combined systems were re-sewered for separation only when redevelopment took place. Overflows were suggested where

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major existing sewers were to be connected to newer sewers, and at least 6 d.w.f. will be passed to the new sewer. Primary tanks of the existing sewage treatment works will be converted to storm water tanks and pumps installed to convey stored sewage back to the new sewer. No flows below 15 d.w.f. should reach rivers without treatment. Surface water storm sewers will be built according to the size necessary to drain the "once a year storm," even though rain of this intensity and duration is not likely to occur more than once in three or five years. Descriptions are given of the size, capacity, and mode of treatment and operation for the numerous parts of the sewage treatment plants proposed. No storm water settling tank is envisaged for the first development, and future expansion and increase in population will determine whether a storm settling tank is required. Partial treatment of 6 x d.w.f. or more will be possible. Capital and operating costs for both treatment plants are tabled as are data concerning capacities and dimensions of each treatment mechanism.

398
OPERATING EXPERIENCES AT SWINDON, 1962-1967,

W.F. Carmichael
Water Pollution Control, Vol 68, No 4, pp 458-464, Jul 1969.

Descriptors: *Sewerage, *Sewage treatment, Sludge treatment, Overflow.
Identifiers: *Storm sewage, Combined sewers, Great Britain.

The sewerage system of Swindon is constructed as a combined system from pre-war days, and as a separate sewerage system for expansion areas. The report stresses sludge treatment and disposal, power generation, and sewage treatment which emphasizes biological filters, screens, primary settling tanks, and storm sewage treatment. The operation of the storm sewage treatment as well as analysis data concerning overflows onto underdrained land are given.

399
COMPLETE WATER RE-USE,

L.K. Cecil
Chem Eng Program, Symposium Series, Vol 63, No 78, pp 258-261, 1967.

Descriptors: *Water reuse, Water pollution control, Activated sludge, Phosphates, Chemical precipitation.

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Identifiers: *Treatment methods.

The author outlines a system of water pollution control in which all wastewaters from the area are treated for reuse as municipal or industrial water supplies. No wastewaters are discharged to public watercourses, and water is drawn from natural sources only to replenish losses by evaporation and other processes. The choice between combined and separate sewerage systems in such an area and the selection of a treatment system for the wastewaters are considered, and a practical system of treatment is described comprising removal of grit and sand. Simultaneous removal of carbonaceous and nitrogenous compounds and reduction of phosphate by activated sludge with incineration of excess sludge to ensure removal of phosphate from the system is examined; as well as chemical precipitation to reduce carbonate hardness, COD, phosphates, silica, boron, fluorides, and viruses, followed by filtration through diatomaceous earth. The removal of dissolved solids in a series of five units consisting of hydrogen cation-exchange column, three activated-carbon columns, and an anion-exchange column is explored. The system recovers about 95 per cent of the initial water. Water can be removed from the system at several stages for selected purposes.

400
OVERVIEW OF CONTROL METHODS,

Francis J. Condon
In: Combined Sewer Overflow Seminar Papers, Edison, N.J., Nov 4-5, 1969. Water Pollution Control Research Series, DAST-37, pp 9-17, Mar 1970.

Descriptors: *Water pollution sources, *Sewers, *Infiltration, *Control systems, Treatment facilities, Control structures.
Identifiers: *Overview.

Pollution problems caused by combined sewers and separate sewers that act as combined ones because of widespread infiltration and malfunctioning regulators are examined. Methods of control which are presently being investigated are discussed herein.

401
CITY OF NORWICH SEWAGE WORKS,

P. Cotton
Water Pollution Control, Vol 67, No 4, pp 454-457, 1968.

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Descriptors: *Sewage treatment, *Biocontrol, *Sludge treatment.
Identifiers: *Great Britain, *Biological filtration, Storm tank.

An illustrated description is given of the sewage works of Norwich, which are designed to treat a dry-weather flow of 7.5 m.g.d. by biological filtration with recirculation of effluent. Flows in excess of three times design flow are settled in storm tanks. Sludge is thickened by sedimentation before digestion and digested sludge is passed to a storage lagoon before being dried on beds, disposed of on land in liquid form, or distributed by tanker to surrounding farms.

402
SEWERAGE PLANNING IN GREATER STOCKHOLM AREA,

Anders Cronstrom
Water Sewage Works, Vol 116, No 9, pp 356-358, Sep 1969.

Descriptors: *Severage, *Sewage treatment, *Biological treatment, *Planning, *Design, *Treatment facilities, *Tunnel design, *Tunnels.
Identifiers: *Sweden.

An intensive redistribution within and to the Greater-Stockholm area is expected by the year 2000, and consequently large and difficult severage problems are created. The problems caused by severage and sewage discharge in the surrounding area of Stockholm are discussed in relation to treatment facilities now in use. Two courses of problem solving are described as: 1) tunnel systems for sewage collecting from catchment areas which would carry the sewage for the whole region to a common sewage treatment plant with ocean discharge; and, 2) a tunnel system constructed as an outlet conduit to better receiving waters for the biologically treated sewage from various existing sewage treatment plants. No decision has been made as to which method will be employed

403
ASSESSMENT OF ALTERNATIVE METHODS FOR CONTROL/TREATMENT OF COMBINED SEWER OVERFLOWS FOR WASHINGTON, D.C.,

John A. DeFilippi
In: Combined Sewer Overflow Seminar Papers, Edison, N.J., Nov 4-5, 1969. Water Pollution Control Research Series, Report DAST-37, pp 123-138, Mar 1970. 1 tab.

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Descriptors: *Overflow, *Control systems, *Laboratory tests, Hydraulic models.
Identifiers: *Treatment methods, *Combined sewers, *Comparative analysis, *High-rate filtration, *Washington, D. C.

An investigation, which deals with the assessment of alternate methods for control/treatment of combined sewer overflows for the District of Columbia, is presented herein and has the following three components: 1) problem definition, 2) the study of the feasibility of high-rate filtration for treatment of combined sewer flows, and 3) the study of alternative methods of solution. Problem definition dealt with attempting to define hydraulic properties and water quality characteristics of combined and separated storm sewer flows. The second major area of study, high-rate filtration, was investigated by bench-scale laboratory experiments. The third part of the investigation was accomplished by analyzing various approaches used in other parts of the country relative to their applicability to the Washington, D.C. system. This paper presents a discussion of the three major portions of the investigation. The approaches are described and appropriate conclusions presented.

404
MICROSTRAINING OF SEWAGE EFFLUENTS IN THE USA,

E.W.J. Diaper and M.R. Lowndes
Effluent Water Treat, Vol 10, No 6, pp 323-325, 327,328. Jun 1970.

Descriptors: *Filtration, *Waste water treatment, *Pollution abatement, *Investigations, Pollutant identification, Economic justification, Standards, Legislation, Suspended load, Chlorination, Ozone.
Identifiers: *Microstraining, Storm overflows, Chicago, Lebanon, Ohio.

Emphasis has recently been placed on up-grading effluent standards to maintain, or improve, river quality in lieu of increasing contamination from municipal and industrial discharges. Each state must formulate standards for waste water treatment as a result of legislation introduced by the Federal Government. Increased attention has been paid to the compounds of phosphorus and nitrogen in effluents since these chemicals provide nutrients for plant life in the receiving stream. The basic operating principles of a typical microstraining installation are reviewed. The article outlines the results from three investigations in which microstraining has been assessed as an economic aid in preventing pollution in: 1) Lebanon, Ohio -where methods of removing suspended matter that tend to overload advanced waste treatment processes were explored: 2) Chicago - where the necessary tertiary treatment stage at three plants is being determined in order to meet

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state standards; and, 3) the Cochrane Division of the Crane Co. - where the removal of suspended solids in stormwater overflows by microstraining and the reduction of bacteria in these effluents by chlorination and ozonation are being evaluated.

405
NEW APPROACHES TO WASTEWATER TREATMENT,

Discussions by E.W.J. Diaper and Russell L. Culp
J Sanit Eng Div, Am Soc Civil Engr, Vol 95, No SA 5, pp 978-980,

Descriptors: *Sewage treatment, Storm runoff.
Identifiers: Combined sewers, Philadelphia.

In his comments, E.W.J. Diaper mentions the fact that the combination of microstraining and ozonation for the treatment of combined sewer stormwater overflows is being evaluated in Philadelphia, Pennsylvania.

406
NEW ACTIVATED SLUDGE PLANT TO SERVE THREE WARWICKSHIRE VILLAGES,

Brian M. Dumbleton
Surveyor, Vol 82, No 3972, pp 31-33, Jul 19, 1968. 5 fig.

Descriptors: *Sewage treatment, *Treatment facilities, *Separation techniques, Sewers, Drainage programs, Design, Overflow.
Identifiers: *Great Britain, Trunk sewer, Storm tank.

The Atherston Rural District Council constructed a new sewage treatment works and installed several miles of trunk sewers to supercede three existing, overloaded works and to provide for mains drainage in two towns not previously sewered. An activated sludge plant was also proposed for construction. The partially separate sewers in most of the villages were adequate for even anticipated future flows, but in a few instances where surcharging occurred, new sewers were laid. In one area, storm overflows on the sewers were considered to reduce flow to the new works, but separation at the site of the works was found to be preferable. A complete description of the design of the new works is given. Storm tanks can hold the equivalent of 12 hours d.w.f. At times of very heavy rainfall, tanks overflow to Penmire Brook. After a storm, contents of the tanks are returned to the pumping station to be lifted to the works for treatment. The treatment process and sludge handling are described.

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SUBMARINE PIPELINE TO DISCHARGE TREATED EFFLUENT AT SPILSBY RDC.

Nigel East
Surveyor, Vol 85. No 4053, pp 38-40, Feb 13, 1970. 10 fig.

Descriptors: *Sewage treatment, *Treatment facilities, *Separation techniques, *Steel pipes, Construction, Outlets, Storm runoff, Sewers, Sewerage, Effluents
Identifiers: *Great Britain, Storm tank.

Spilsby RDC's sewerage scheme involves two sewage treatment works and construction of a 1.5 mile outfall sewer to dispose of effluent from both works. In one works, storm flows exceeding 3 d.w.f. are separated and passed to storm tanks and additional flows screened only before passing to the final effluent sump. The previous raw sewage, storm-water, and effluent pumping plant was augmented and the filter distributer arms replaced with others of greater capacity. The outlet sewer system was revised to take the effluent to the submarine outfall. Modifications of the second works provided a degree of treatment similar to that at the first works. The bitumen enamel-coated steel submarine pipeline is described in addition to methods used for trench excavation and launching.

408
TREATMENT OF URBAN STORMWATER RUNOFF.

F.L. Evans, E.E. Geldreich, S.R. Weibel, and G.G. Roebeck
J Water Pollution Control Fed, Vol 40, No 5, Res Suppl, R162-170, 1968.

Descriptors: *Sedimentation, *Chlorination, *Laboratory tests, Microorganisms.
Identifiers: *Cincinnati, Ohio, Runoff treatment.

Tabulated and graphical results are given of laboratory studies on treatment by sedimentation and chlorination of runoff from an urban area of Cincinnati which is sewered on the separate system. Plain sedimentation for less than one hour was not effective in reducing COD, BOD, concentrations of nitrogen, phosphate and solids, or the total counts of three bacterial indicators, but improved removals were obtained with sedimentation for four hours. A dose of 2-6 mg of chlorine per litre applied for 20 min was neccessary to effect a 99.99 per cent kill of total coliform organisms, faecal coliform organisms, and faecal streptococci. Even with such high doses of

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chlorine and the presence of free residual chlorine after treatment, aftergrowth of total coliform organisms occurred in 24-72 hours; however, there was no significant aftergrowth of faecal organisms. From these results it is suggested that the count of faecal coliform organisms rather than total coliform organisms is more realistic indicator of the downstream effects of chlorinated discharges.

409
WATER REUSE IN INDUSTRY.

E.F. Gloyna, D.L. Ford, and J.M. Eller
J Water Pollution Control Fed, Vol 42, No 2, pp 237-242, Feb 1970
3 diag, 3 graphs, 2 tab.

Descriptors: *Liquid wastes, *Pollutants, *Storm runoff, *Water reuse, *Industrial wastes, Waste treatment, Separation techniques.
Identifiers: *Cresylic acid, *Sodium sulfide solutions, *Collection system.

A system designed to treat liquid wastes from oil refineries and produce a salable product is described. The waste material is shipped to the treatment plant. Pollutants in the waste material include phenols, cresols, cresylic acid, mercaptans, sulfides, thiophenols, caustic soda, and heavy metals. The finished products are cresylic acid and sodium sulfide solutions. Stormwater runoff is utilized after separation into contaminated and uncontaminated portions. The wastewater collection system consists of a comprehensive network of drip pans, collection troughs, dikes, and tanks. The network is interconnected to the process system and cooling towers.

410
KAPPALA UNDERGROUND SEWAGE WORKS, STOCKHOLM.

E. Isgard and A. Rosander
Civil Eng Public Works Rev, Vol 65, No 766, pp 517-520,
May 1970. 4 diag, 1 map, 1 tab.

Descriptors: *Sewage disposal, *Tunnels, *Treatment facilities, Construction, Planning, Cost analysis, Infiltration, Storm runoff.
Identifiers: *Gravity sewer, Sweden.

Ten suburban communities north of Stockholm formed the Kappala Union to deal with their sewage problems. They planned to convey sewage to a sewage treatment plant on Lidingö Island, enabling effluent to

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Descriptors: *Rainfall-runoff relationships, *Routing, *Runoff forecasting, *Mathematical models, *Computer programs, Hydrographs, Hyetographs, Hydrograph analysis, Synthetic hydrology, Time lag
Identifiers: *Australia.

An investigation was made of the values of lag time for natural catchment areas, as measured from center of mass of excess-rainfall to center of mass of resulting runoff. Any variation in this value for an individual catchment is an indication of a nonlinear response. Values of lag were measured for a range of floods on 5 catchment areas. The difference in value between catchments was found to be a function of the catchments' characteristics, while variation in the values for an individual catchment was strongly related to the magnitude of the floods. As the degree of this variation was fairly constant for the areas studied, the degree of nonlinearity was also considered to differ little between the catchments. The development of 3 general formulae required a detailed analysis to be made of a large volume of hydrologic data by an objective systematic procedure. For this purpose lag was measured to the center of mass of direct runoff and a weighted mean discharge measure of flood magnitude was devised. Numerous hyetograph characteristics were measured and studied, but none appeared to have any significant influence on the value of lag time. Computer program listings for computing lag-discharge relationships and for regression analysis of lag-discharge relationships are included.

460
MAN'S INFLUENCE ON HYDROLOGICAL PHENOMENA,

J. Balogh and I. Matrai
2nd Int Postgrad Course on Hydrol Methods for Develop Water Resources Mange, Budapest, Hungary, Manual No 14, 1968.

Descriptors: *Water management (applied), *Flood control, *River training, Irrigation, Drainage systems, Land management, Reservoir operation, Water demand, Watershed management, Water utilization, Water quality, Forest management, Runoff, Streamflow, Ice, Navigation, Water pollution, Urbanization, Industries, Agriculture.
Identifiers: *Technical manuals.

The effects on the hydrologic cycle of human water-controlling activities, which include urbanization, agriculture, forestry, industry, and commerce, are examined in this technical manual. Agricultural and forestry activities modify the water budgets of entire drainage basins, which change runoff precipitation, and other quantitative factors, but they have relatively little effect on quality. Commercial, industrial, and urbanization activities have much less effect on quantity than on water quality. Much of man's water demand must be met by use of groundwater. The effects of flood control and river training works on stream hydrology and the effect of human uses of catchment areas are discussed in detail. Water management efficiency and various management techniques are evaluated.

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461
ESTIMATING DESIGN FLOODS FROM EXTREME RAINFALL,

Frederick C. Bell
Colorado State Univ, Hydrol Paper No 29, Jul 1968. 21 p, 20 fig, 5 tab. [illegible] ref.

Descriptors: *Design flood, *Rainfall, *Precipitation (atmospheric), *Forecasting, *Storm runoff, Watersheds (basins), Drainage basins, Bibliographies, Hydrology, Floods, Small watersheds, Hydrologic data, Time lag, Flood forecasting, Flood hydrographs, Flood peaks, Design storm, Rainfall-runoff relationships, Rational formula.
Identifiers: Flood hydrology.

Distinct differences exist between estimating specific floods from data on specific rainfall events and estimating design or representative floods from rainfall statistics. The latter should be regarded as a more generalized procedure in which high accuracy cannot be expected. Many physical details of specific events are irrelevant for estimating representative events. A single parameter is sufficient to express the time-distributing characteristics of a watershed for design purposes. The suggested parameter is the representative lag, closely related to the volume/peak ratio. For small watersheds in the western U. S., the same return period may be assigned to the design flood and the corresponding extreme rainfall. This finding is not expected to apply to all climatic situations, but may be a reasonable assumption in the absence of any other information. The rational-loss rate method is suggested for estimating extreme floods from extreme rainfall because of its simplicity, flexibility, and consistency with the requirements and limitations of the problem. This method does not give satisfactory reproductions of the 10-yr floods on the test watersheds and cannot be strongly supported by this performance.

462
USING ANALYTICAL METHODS TO DEVELOP A SURFACE-RUNOFF MODEL,

Roger P. Betson, Russell L. Tucker, and Faye M. Haller
Water Resources Res, Vol 5, No 1, pp 103-111, Feb 1969. 9 p, 5 fig, 2 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Analytical techniques, Rainfall intensity, Antecedent precipitation, Meteorology, Mathematical models, Computer models, Digital computers, Surface runoff, Graphical analysis.
Identifiers: Analytical models.

By using analytical methods, successive restrictions were imposed on a mathematical version of the U. S. Weather Bureau's graphical surface-runoff model to develop an analytical model that expresses the API (Antecedent precipitation index)-runoff relations with 2 equations and

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5 coefficients. The analytical model is similar in concept to the graphical model in that both relate rainfall, week number, and the API measure to surface runoff. The concise relations of the analytical model, however, can be rapidly derived from a historical storm list by computer. When tested, runoff relations, derived with the analytical model over selected watersheds, predicted surface runoff from those watersheds somewhat better than the regional, graphical relations developed for the Tennessee Valley.

463
ANALYTICALLY DERIVED UNIT GRAPH AND RUNOFF,

Roger P. Betson and Ralph F. Green
J Hydraul Div, Am Soc Civil Engrs, Vol 94, No HY6, pp 1489-1505, Nov 1968.

Descriptors: *Runoff, Hydrologic aspects.
Identifiers: Parametrics.

A technique has been programmed to solve analytically for measures of precipitation excess and unit graph shape parameters. The optimization procedures achieved a very high degree of adjustment of the model to data, but the results were inconsistent. The development of an objective fitting technique is described. A two-step fitting procedure was devised which substantially increased the objectivity of the fitting technique. The two shape parameters were first individually corrected by a univariate technique to near-optimum values. This reduced the effect of the higher-order partial derivatives with respect to the shape parameters. The simultaneous differential correction technique was then used to obtain corrections for both the shape parameters and the runoff parameters. While this two-step solution technique does not yield exact results, they are close enough to the desired values and can be obtained consistently from different starting points.

464
EFFECTS OF URBANIZATION ON PEAK FLOWS,

E. F. Brater and Suresh Sangal
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, University of Texas Press, Austin and London, pp 201-214, 1969. 14 p, 8 fig, 36 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Storm runoff, *Routing, Hydrograph analysis, Model studies, Mathematical models, Simulation analysis, Infiltration, Runoff, Overland flow, Peak discharge, Floods.
Identifiers: Urban hydrology.

Study of the effect of urbanization on peak flows requires the best possible knowledge of the runoff process. The volume of surface runoff is the rainfall minus infiltration and permanent retention. Some of the impermeable portions of basins result from urbanization and their magni-

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tude must be considered in computing the infiltration capacity. Hydrologically significant impermeable area is probably smaller than the actual impermeable area, and there is evidence that it is related to population density. For basins near Detroit the significant value varies from 1% to 10%, for population densities varying from about 500 to 7,000 per square mile. Many routing techniques may provide the basis for a mathematical model of the hydraulics of storm runoff. One method of evaluating the influence of urbanization on the runoff hydrograph is to study relationships between unit hydrograph shape parameters and some measures of drainage basin characteristics. Much work has been and is being done to help find better ways of predicting peak flows from rainfall, and more emphasis is being placed on the determination of the effect of urbanization.

465

RAINFALL-RUNOFF RELATIONS FOR SOUTHEASTERN LOUISIANA AND SOUTHWESTERN MISSISSIPPI,

Anthony J. Calandro
Louisiana State Dep Public Works Tech Rep No 2a, 1967. 61 p, 2 fig, 3 tab, 11 ref, append.

Descriptors: *Rainfall-runoff relationships, *Louisiana, *Mississippi, Hydrographs, Hydrograph analysis, Data collections, Rainfall, Runoff, Statistical models, Regression analysis, Antecedent precipitation, Duration curves, Runoff forecasting, Rain gages, Storm runoff
Identifiers: Thiessen methods.

A method for estimating storm runoff from rainfall records is presented for southeastern Louisiana and southwestern Mississippi. A rainfall-runoff relationship generally useful in the study area relates storm runoff to storm rainfall and the week of its occurrence. Values of weekly coefficients and exponents are tabulated. The standard error of estimate of this relationship for all storm is about 40%; for storm rainfalls greater than 4 inches, the standard error decreases to about 25%. With these limitations, the rainfall-runoff relations can also be used to distribute incremental rainfall excess with time. Records for 20 stream-gaging stations and 34 rainfall stations in the area studied were used to compute antecedent rainfall parameters, rainfall duration, total storm rainfall, and total runoff for 959 storm hydrographs. Graphical analysis indicates that regressions of rainfall versus runoff for each week of the year are as good as or better than regressions involving parameters of antecedent conditions and rainfall duration for estimating storm runoff. Apparently, the week-of-year factor accounts for seasonal variations in duration and antecedent conditions, and use of the seasonal factor alone will provide useful estimates of storm runoff in the area studied.

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466
EXTENSION OF ROLE OF LINEAR SYSTEMS ANALYSIS IN HYDROGRAPH THEORY,

A. B. Carrasquilla and F. E. Perkins
M.I.T., Dept Civil Eng, Hydrodynamics Laboratory Report 106, Sept 1967.

Descriptors: Optimization, Mathematical studies, Systems analysis, Analytical techniques.

The extension of techniques developed for the identification of response characteristics from past rainfall-runoff records to the most general case within the framework of a single input-single output linear system theory--time variant system with nonzero initial conditions is discussed. The identification process is formulated as the optimization problem for minimization of the mean square error between predicted and observed outputs. It is shown that the representation of a kernel in linear parametric form reduces the optimization problem to a solution of a set of optimization formulation were developed.

467
HANDBOOK OF APPLIED HYDROLOGY,

Ven Te Chow, editor
McGraw-Hill Book Company, New York, 1964. 1491 p.

Descriptors: *Hydrology, *Water resources development, Oceanography, Hydrogeology, Geomorphology, Soil physics, Statistics, Water quality, Planning, Legislation.

This handbook contains a vast range of information on hydrology and water-resources technology with interdisciplinary coverage of information to date. Sections of the book, each authored separately, can be divided into four groups: (1) closely-related sciences upon which hydrology depends including oceanography, hydrogeology, geomorphology, soil physics, plant ecology, silviculture, fluid mechanics, statistics, probability, operations research, and electronic computers; (2) phases of the hydrologic cycle such as rainfall, snow, evapotranspiration, infiltration, groundwater, runoff, ice and glaciers, reservoir and river sedimentation, droughts and low streamflow, and water quality; (3) practice and application of hydrology including flow determination, flood routing, streamflow measurement, reservoir regulation, river forecasting, urban hydrology, agricultural lands, forests and rangelands, lakes and swamps, and arid and semiarid regions; and (4) socio-economic aspects of hydrology such as water resources planning and development, flood-plain adjustment and regulation, and water law and policy.

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468
HANDBOOK OF APPLIED HYDROLOGY, SECTION 14, RUNOFF,

Ven Te Chow
McGraw-Hill Book Company, New York, pp 14:1 to 14:54, 1964. 15 graphs, 9 tab, 7 diag, 147 ref.

Descriptors: *Runoff, Surface runoff, Overland flow, Storm runoff.

The introduction to this section briefly defines terms such as surface runoff, overland flow, storm flow, groundwater runoff, storm runoff, etc. The rest of the section deals with the basic aspects of runoff including terminology, runoff phenomena, time and space distributions, variability, and other aspects not discussed elsewhere in the handbook. (See abstract number 467).

469
THE SPATIAL DISTRIBUTION OF STORM RAINFALL,

V. K. Collinge and D. G. Jamieson
J Hydrology, Vol 6, No 1, pp 45-47, 1968.

Descriptors: *Rain gages, *Storms, Topography, Hydrograph analysis.
Identifiers: *Storm rainfall, Rainfall-surface wind relationship, Great Britain.

This investigation employed a network of rain-gages to ascertain the average areal precipitation on major zones of the Tyne catchment in Northern England. The actual rainfall for each storm was compared to the predicted rainfall which was obtained by using past rainfall figures and surface-wind speed and direction for each storm. Errors between actual and predicted rainfall are tabulated, the mean percentage of error being 4.6%. In spite of the sparsity of rain-gage equipment and the small number of storms studied, this investigation demonstrated the direct relationship between spatial rainfall distribution and surface wind and topography. Using such parameters, estimations can be made of the average areal storm rainfall over subcatchments. This process could be extended to predict flood hydrographs at particular parts of a drainage system.

470
EFFECT OF URBANIZATION ON STORM WATER PEAK FLOWS,

Pedro C. C. Da Costa
J Sanit Eng Div, Am Soc Civil Engrs, Vol 96, No SA2, pp 187-193, Apr 1970.

Descriptors: *Rational formula, *Storm runoff, *Hydrology, Urbanization, Rainfall intensity.
Identifiers: *Storm sewers, Rainfall-runoff relationships, Sewer hydraulics.

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The rational formula, Q = c i A, may be considered a rough expression of the influence of urbanization on stormwater sewer flows. The unique runoff coefficient, c, is the product of three factors, each one having some correlation with the degree of urbanization given to the watershed. The presented general rational formula is related to the other rainfall - runoff relationships derived by Snyder and Horner - Flynt. Results from the formula are compared with those obtainable by the Chicago method. Modifications by urbanization are graphed. Variability of rainfall frequency is attributed to topographic and urban conditions.

471
POTENTIALLY BIGGEST RUNOFF FROM TORRENTIAL RAINFALLS,

Kazimierz Debski

Rozpr Hydrotech, Polska Akad Nauk, Part 23, pp 51-64, 1969. 14 p, 4 fig, 4 tab, 9 ref.

Descriptors: *Rainfall, *Runoff, *Streamflow, Watersheds (basins), Topography, Forecasting, Storm runoff, Synoptic analysis, Mathematical studies.
Identifiers: *Poland.

Stream runoff, as a result of torrential rainfalls, was analyzed on the basis of the data recorded by Polish hydrological gaging stations. The maximum runoff, as a result of a torrential rain is very different from a runoff formed by spreading rains. These 2 types of rain runoff cannot be expressed by a single formula common to these 2 phenomena. The peak rate of storm runoff increases with the growth of water basin and can be well represented by a definite monotonic function, whereas the peak runoff from a spreading rain increases with an increase in the water basin area, according to a definite parabolic function. The study also shows that under the same physiographic conditions the peak rate of a storm runoff in small basins is greater than that from spreading rains. In evaluating the runoffs from their corresponding rainfalls the Pagliari formula was adapted as the most suitable for the hydrogeological conditions prevailing in the Polish areas.

472
EVALUATION OF SEGMENTED IUH FROM DERIVATIVES,

M. H. Diskin

J Hydraul Div, Am Soc Civil Engrs, Vol 95, No HY1, pp 329-346, Jan 1969.

Descriptors: *Analytical techniques, Hyetographs, Hydrographs, Surface runoff, Precipitation excess.

A new method for analysis of rainfall excess hyetographs and direct surface runoff hydrographs, and for the derivation of instantaneous unit hydrographs is explained. The method is based on a theorem for the convolution of derivatives of functions and shows how derivatives of an assumed instantaneous unit hydrograph can be obtained from analysis of the shapes of an available rainfall excess hyetograph and a direct sur-

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face runoff hydrograph. Numerical examples accompany the development of the method and an example illustrating the application of the method is included.

473

RAIN-GAUGING PROGRAM TO PROVIDE GUIDE TO STORM SEWER DESIGN,

Harvey W. Duff, Russ L. Tobey, and George C. C. Hsieh
Water Sewage Works, Vol 116, No 11, pp 420-424, Nov 1969.

Descriptors: *Rain gages, *Data collections, *Storm drains, *Design criteria, *Electronic equipment, Computers.
Identifiers: *Rain data, *Storm sewers, *Seattle, Washington.

The Sewage and Drainage Section, Design Division of the Seattle, Washington, Engineering Department, is conducting a rain gaging program to provide sufficient precipitation data and storm data for urban-water studies for the purpose of determining a more realistic basis for the design of storm drain systems. Data for the program are obtained from electronic instruments and handled by a computer. It is estimated that only 0.2 percent of the possible data covering a four-year period is missing.

474

URBAN EFFECTS ON THE UNIT HYDROGRAPH,

William H. Espey, Jr., David E. Winslow, and Carl W. Morgan
In: Effects of Watershed Changes on Streamflow, Water Resource Symposium No 2, Austin, Texas, October 1968, University of Texas Press, Austin and London, pp 215-228, 1969. 14 p, 10 fig, 4 tab, 15 ref. OWRR Project C-1098.

Descriptors: *Urbanization, *Storm runoff, *Hydrograph analysis, *Frequency analysis, Hydrology, Rainfall-runoff relationships, Peak discharge, Floods, Unit hydrograph, Flow.
Identifiers: Urban hydrology, Houston, Texas.

Summaries are presented of work concerning peak floods for urban areas and of a recent study concerning watersheds in Houston, Texas. Increased urbanization results in increased peak flows and accentuated high and low flows. Equations presented show that peak flows may be expected to increase from two to four times that of the flow from the undeveloped watersheds, depending upon the type of channel improvement, amount of vegetation in the channel, and the type of secondary drainage system. The capacity of the secondary drainage facilities may have a limiting effect on the peak discharge.

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475
EFFECTS OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,

M. M. Fogel
Trans Am Soc Agricultural Engrs, Vol 12, No 6, pp 808-812, Nov/Dec 1969.

Descriptors: *Frequency analysis, *Rainfall-runoff relationships, Data collections, Storms.
Identifiers: Storm analysis, Convective storms.

The relation between rainfall frequency and runoff frequency is examined and a rainfall-runoff relationship for convective storms is presented. The analysis of 13 years of rainfall and runoff data collected on the Atterbury experimental watershed formed the basis for study. A linear multiple-regression model was used to determine the relative effects of the storm depth of rainfall and the positioning of the storm on the watershed.

476
STATISTICAL TREATMENT OF RAIN GAUGE CALIBRATION DATA,

A. E. Freeny
Bell System Tech J, Vol 48, No 6, pp 1757-1766, Jul-Aug 1969.

Descriptors: *Calibrations, *Statistical models, Parametric hydrology, Gages, Measurement.
Identifiers: *Holmdel, New Jersey, *Capacitance gages.

Statistical treatment of calibration data of capacitance gages used for the measurement of rain rates in a rain gage network set up in a 160 sq km area surrounding Crawford Hill, Holmdel, N. J., is described. The distribution of parameters and residuals is discussed and the refinement, which corrects for fitting bias, is given.

477
RAINFALL-RUNOFF RELATIONSHIPS EXPRESSED BY DISTRIBUTION PARAMETERS,

Emil O. Frind
J Hydrology, Vol 9, No 4, pp 405-426, Dec 1969. 11 graphs, 1 tab, 15 ref.

Descriptors: *Rainfall-runoff relationships, *Parametric hydrology, *Input-output analysis, Computer models.
Identifiers: *Statistical parameters.

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This study is concerned with statistical parameters of precipitation and runoff and the interrelations between corresponding parameters. Three processes are considered: the input process (mean annual effective precipitation), the transformation process (basin storage), and the output process (mean annual runoff). The input is assumed to be a pure-random series with known statistical parameters. The transformation is characterized by an exponential recession curve with one parameter. With these assumptions, equations are developed expressing statistical parameters of the output for any simulated series, which are analyzed for their moments. The type of distribution of the output is also established.

478
THE YEARLY DISTRIBUTION OF RAINFALL INTENSITIES,

A. L. H. Gameson and R. D. Quaife
Meteorol Mag, Vol 94, No 1115, pp 173-180, 1965.

Descriptors: *Rain gages, *Rainfall-runoff relationships, *Hydrologic data.
Identifiers: *Storm sewage, *Great Britain.

Autographic rain-gages were installed at Bradford and Brighouse, Yorks., and Northampton during investigations of the flow and composition of storm sewage. The Northampton data were studied in detail in an attempt to compare the observed runoff distribution from an impermeable area of 115 acres with that calculated from the rainfall pattern. An equation used in the calculation of the probable yearly duration of rainfall intensities exceeding any particular value in inches per hour at a station with a given annual rainfall is presented.

479
AVERAGE INTENSITY OF RAINFALL FOR USE IN THE RATIONAL FORMULA,

H. M. Gifft and George E. Symons
Water Wastes Eng, Vol 5, No 12, pp 44-45, Dec 1968.

Descriptors: *Hydraulics, *Storm runoff, *Rational formula, *Rainfall intensity.
Identifiers: *Nomograms.

For convenience in design problems concerned with storm flow runoff where climatological data are not available, the attached nomogram and the map of iso intensities are applicable to the following formula, $R = 5.5 \times H^{5} F^{.2} T^{.5}$ where:

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R = rainfall intensity (in./hr.)
R_5 = rainfall intensity (in./hr., 5-year frequency)
F = frequency of storms (years)
T = time of concentration (min.).

480
HANDBOOK OF APPLIED HYDROLOGY, SECTION 9, RAINFALL,

Charles S. Gilman
McGraw-Hill Book Company, New York, pp 9:1 to 9:68, 1964. 34 diag, 24 graphs, 79 ref.

Descriptors: *Meteorology, *Rainfall, Simulated rainfall.
Identifiers: *Rainfall data applications.

This section seeks to aid the hydrologist in understanding the meteorology of rainfall, to enable him to appreciate the overlap between the two fields, and to inform him of the sources of further knowledge. The first subsection deals with rainfall measurement, the basis for all hydrologic and hydrometeorological work. The second treats the physics and hydrodynamics of rain, including the artificial inducement of precipitation. The third subsection, on the synoptic meteorology of rain, includes tropical rainfall, local convective thunderstorms, and quantitative precipitation forecasting. The next subsection details space-time relationships of rainfall. The last subsection, on design applications of rainfall data, includes frequency analysis, which is utilized in designing urban storm sewers; storm transposition; predicted maximum precipitation; and specifications of standard project storms. (See abatract number 467).

481
A MODEL FOR GENERATING SYNTHETIC SEQUENCES OF SHORT-TIME-INTERVAL RAINFALL DEPTHS,

R. A. Grace and P. S. Eagleson
Proceedings of International Hydrology Symposium, Sept 6-8, 1967, Colorado State Univ, Fort Collins, Vol 1, Paper 35, pp 268-276, 1967. 9 p, 4 fig, 1 tab, 5 ref.

Descriptors: *Rainfall, *Forecasting, *Synthetic hydrology, *Simulated rainfall, *Mathematical models, Simulation analysis, Digital computers, Computer programs, Computer models.
Identifiers: Rainfall data.

An analytical model is developed for the synthesis of short-time-interval sequences of rainfall data. The model uses the probability distribution of the time between storms and the storm duration as well as an equiva-

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lent joint distribution of storm rainfall depth and duration to generate sequences of lumped storms which retain the stochastic features of the historical storm data. The prescribed total storm depths are then distributed over their respective durations by using a special type of urn model in such a way that the short-time-increment rainfall sequences within synthetic storms possess, on the average, the same serial correlation and percentage mass characteristics as their historical counterparts. Probability distributions and storm characteristics are obtained from 10-min summer rainfall data for a period of 5 years at St. Johnsbury, Vermont. These sequences are extended synthetically, and the characteristics of the synthetic storm are shown to agree adequately with the historical attributes. Not only does the model give valid results, but it does so quickly, since it is possible to compile the necessary computer programs and then generate 15 summers of lumped storms or 5 summers of 10-min data in 3 minutes.

482
RUNOFF VOLUME PREDICTION FROM DAILY CLIMATIC DATA,

Monroe A. Hartman, Walter G. Knisel, Jr., and Ralph W. Baird
Water Resources Res, Vol 5, No 2, pp 84-94, Feb 1969. 11 p, 8 fig, 9 ref.

Descriptors: *Rainfall-runoff relationships, *Soil moisture, *Runoff forecasting, Model studies, Mathematical models, Digital computers, Discharge (water), Infiltration, Inflow, Streamflow, Water balance, Evaporation, Duration curves, Hydrograph analysis, Hydrographs.

A two-soil-moisture-reservoir model is developed to improve the estimate accuracy of a runoff-volume-prediction model. Soil moisture accounting in the two reservoirs is an intermediate step to runoff prediction. A decay-type function describes the moisture depletion between days of rainfall. The moisture depletion constant in the function varies by season with soil moisture, pan evaporation, and mean daily temperature. The runoff-prediction equation relates runoff to rainfall and soil moisture at the beginning of the storm. Computed runoff volumes are compared with values observed on a 3-acre native grass-meadow watershed for an 11-year period. Accumulated computed amounts for the period agree within 1% of the accumulated observed amounts.

483
A NOTE ON AREAL RAINFALL DEFINITION,

David M. Hershfield
Water Resources Bul, Vol 5, No 4, pp 49-55, Dec 1969. 7 p, 4 fig, 1 tab, 2 ref.

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Descriptors: *Rainfall, *Distribution patterns, Sampling, Mathematical studies, Instrumentation, Networks, Data collections, Rainfall disposition, Hydrology, Correlation analysis, Rain gages.

Sources of error in defining areal rainfall on a storm basis include the instrumental error, sampling fluctuations over the area, and network density. Analysis of dense rain gage data show the magnitude of the errors resulting from the natural variability of rainfall. Except for one watershed in Arizona, the coefficient of variation, based on a sample of storm totals from the individual gages in various size areas, remains relatively constant with increasing area for a particular storm. The error due to rainfall variability over the area is probably the most important and must be considered in experiments which attempt to resolve small-area hydrologic problems.

484
JOINT PROBABILITIES IN RAINFALL-RUNOFF RELATION,

L. A. V. Hiemstra
Nat Acad Sciences--Nat Research Council--Highway Research Rec, No 261, pp 1-17, 1969.

Descriptors: *Rainfall-runoff relationships, *Surface drainage, Runoff, Rainfall intensity, Runoff forecasting.

A study of the problem in surface drainage of highways deals with peak rates and total volumes of runoff predicted from rainfall with known probability of occurrence. A deterministic water budget approach makes it possible to translate the rainfall input into a runoff hydrograph. It was possible to describe a time pattern of rainfall intensity by means of an incomplete beta-function. A two-parameter, log-normal, distribution function was a suitable descriptor for all necessary probability distributions.

485
RUNOFF HYDROGRAPH AS A FUNCTION OF RAINFALL EXCESS,

I. K. Hill
Water Resources Res, Vol 5, No 1, pp 95-102, Feb 1969. 8 p, 5 fig, 6 ref.

Descriptors: *Rainfall-runoff relationships, *Mathematical models, *Runoff forecasting, *Streamflow forecasting, *Hydrographs, Duration curves, Rainfall intensity, Hyetographs, Precipitation excess, Surface runoff, Overland flow, Storm runoff.
Identifiers: Kinematic wave theory.

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A set of differential equations has been obtained for the overland runoff from an arbitrary catchment when the rainfall excess over the catchment is known as a function of space and time. An analytical solution is given for a steady rain of finite duration. The differential equations obtained are also solved analytically for a moving top-hat storm over a plane catchment, and the maximum depth is obtained explicitly as a function of the storm duration and catchment length. The results for all plane catchments with a given resistance formula are reduced to a single curve. It is found that the depth is increased if the storm moves downstream and decreased if the storm moves upstream the slower the storm the greater being the change. Finally, it is shown that all the results apply qualitatively to open channel flow where the kinematic wave approach is suitable. If the lateral inflow replaces the rainfall excess, it is found that the form of the curve describing the variation of depth with time is a function of the cross-section geometry but is qualitatively similar to the overland flow curve described above.

486
AVERAGE ANTECEDENT TEMPERATURES AS A FACTOR IN PREDICTING RUNOFF FROM STORM RAINFALL,

Charles D. Hopkins, Jr. and Dale O. Hackett
J Geophys Res, Vol 66, No 10, pp 3313-3318, Oct 1961.

Descriptors: *Rainfall-runoff relationships, *New York, *New England, *Basins, *Storms, Rainfall, Storm runoff, Runoff forecasting.
Identifiers: *Elevation-temperature relationships.

Rainfall-runoff relations in New England and New York have been shown to vary widely from basin to basin in a manner related to average basin latitudes and elevations. Station elevations and latitudes have been shown to be related to average temperatures. Average monthly and annual temperatures were computed for each basin sampled and average weekly basin temperatures estimated. These weekly temperatures were used to derive an index of average antecedent basin temperature based on a logarithmic recession. Two rainfall-runoff relationships were derived in which the index of antecedent basin precipitation, the index of average antecedent basin temperatures corresponding to the season of the storm, the average annual basin temperature, storm rainfall, and storm runoff were used. One of these relations applied to the spring and summer, the other to the fall and winter. Testing showed that a large part of the variation in the raiufall-runoff relationship had been removed. It was concluded that average basin temperatures can be used with profit in computing runoff in New England and New York.

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487
TIME DISTRIBUTION CHARACTERISTICS OF RAINFALL RATES,

F. A. Huff
Water Resources Res, Vol 6, No 2, pp 447-454, Apr 1970. 2 tab, 6 graphs, 6 ref.

Descriptors: *Illinois, *Rainfall intensity, *Mathematical studies, *Time series analysis.
Identifiers: *Warm-season storms, *Variability analysis.

Data from a 50-storm sample on two dense networks in Illinois were used to investigate the time distribution of 1-minute rainfall rates in warm-season storms. Absolute and relative variability were analyzed for point and mean rates on areas from 25 to 100 square miles. Several variability measures were employed including sequential variability that uses both the magnitude and the sequence of rates in characterizing the time distribution. Since the variability parameters were found to fit closely a log normal distribution, probability distributions were constructed to define interstorm variability relations. Both absolute and relative variability showed a wide range within and between storms, and between areas of different size. Little difference in variability properties was noted between rain and synoptic weather types associated most frequently with warm-season storms. No evidence of regular oscillations in the time distribution of rainfall rates in convective storms was shown by lag correlation analyses.

488
SPATIAL DISTRIBUTION OF RAINFALL RATES,

F. A. Huff
Water Resources Res, Vol 6, No 1, pp 254-260, Feb 1970. 2 diag, 3 tab, 2 graphs, 6 ref.

Descriptors: *Illinois, *Rain gages, *Rainfall intensity, *Instrumentation, *Radar, *Measurement, *Spatial distribution.
Identifiers: *Warm-season storms.

A 29-storm sample of 1-minute rainfall rates was obtained with an Illinois network of 50 recording gages in 100 square miles during the warm seasons of 1952 and 1953. These gages were equipped with enlarged orifices and 6-hour charts to provide nearly instantaneous spatial patterns of rainfall intensity on the network. The data were used to determine quantitative estimates of rainfall rate gradients, sampling errors in the measurement of mean areal rates, and spatial correlation patterns. The derived relations are considered first approximations for midwestern warm-season storms. It was concluded that the spatial variability of rainfall

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rates is frequently so great within and between convective storms that the rain gaging equipment and operational requirements for accurate rate measurements may be prohibitive for most users when sampling areas are 100 square miles or greater. Consequently, it is recommended that the use of radar in combination with recording gages be investigated as a possible solution to the measurement problem.

489
SPATIAL CORRELATIONS OF STORM, MONTHLY AND SEASONAL PRECIPITATION,

F. A. Huff and W. L. Shipp
J Appl Meteorol, Vol 8, No 4, pp 542-550, Aug 1969. 7 diag, 6 tab, 1 graph, 7 ref.

Descriptors: *Precipitation, *Measurement, *Statistical models, *Rainfall disposition, *Spatial distribution, *Correlation analysis, *Storms, *Rainfall intensity, *Illinois.

One approach to defining sampling requirements for precipitation measurement networks is through statistical correlation methods. Data from three dense rain gage networks in Illinois were used with this method on rainfall measurements ranging from 1-minute rates to total storm, monthly and seasonal amounts. Effects of rain type, synoptic storm type, and other factors on spatial correlations were studied. Correlation decay with distance used to indicate sampling requirements was greatest in thunderstorms, rain showers and air mass storms. Conversely, minimum decay occurred with steady rain and the passage of low pressure centers. Seasonally, the decay rate is much greater in May-September storms than in cold season precipitation. Sampling requirements are extreme in measuring rainfall rates; thus, assuming a minimum acceptance of 75% explained variance between sampling points, a gage spacing of 0.3 minutes is needed for 1-minute rain rates compared with 7.5 minutes for total storm rainfall in summer storms.

490
MESOSCALE SPATIAL VARIABILITY IN MIDWESTERN PRECIPITATION,

F. A. Huff and W. L. Shipp
J Appl Meteorol, Vol 7, No 5, pp 886-891, Oct 1968.

Descriptors: *Rain gages, *Precipitation (atmospheric), Illinois.
Identifiers: *Variability analysis.

Data from four dense rain gage networks operated for periods of 7 to 12 years on areas of 10 to 550 sq mi in Illinois were used to determine

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spatial relative variability of monthly and extended period precipitation of storms in continental climate typical of midwestern United States. The relation of storm variability to areal mean precipitation, storm duration, precipitation type, synoptic weather type, season, and size of sampling area was investigated.

491
SOME APPLICATIONS OF CROSS-SPECTRAL ANALYSES IN HYDROLOGY: RAINFALL AND RUNOFF,

I. R. Iturbe and C. F. Nordin
Water Resources Res, Vol 5, No 3, pp 608-621, 1969.

Descriptors: *Water circulation, Rainfall, Runoff.
Identifiers: *Rainfall cycle, *Runoff cycle.

Correlations between yearly cycles of rainfall and also runoff, for stations in the Pacific coast region of U.S.A. were obtained from cross-analysis of the monthly records. It was found that for stations within 1000 km of each other the precipitation cycle was virtually the same, and that there was a similar although less coherent relation for the runoff cycle. It was also found that the yearly temperature cycle was highly correlated with the yearly rainfall cycle but that the yearly cycle in atmospheric pressure appeared related to the rainfall cycle only through the temperature cycle.

492
HANDBOOK OF APPLIED HYDROLOGY, SECTION 20, HYDROLOGY OF URBAN AREAS,

Stifel W. Jens and M. B. McPherson
McGraw-Hill Company, New York, pp 20:1 to 20:45, 1964. 19 graphs, 9 tab , 2 diag, 58 ref.

Descriptors: *Hydrologic data, *Storm runoff, *Design storm, *Methodology, *Surface drainage, Rational formula, Waste water (pollution), Water supply, Drainage engineering.
Identifiers: *Urban hydrology.

This section outlines current uses of hydrologic data and methods of solution of urban water problems and needs. Stormwater drainage is emphasized, and the utilization of urban hydrology in the areas of flooding, water supply, pollution, airports, and expressways is mentioned. The first subsection, involving qualitative descriptions of urban stormwater runoff, explains the hydrologic cycle in terms of runoff-producing

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storms in order to aid engineers in designing collection and disposal facilities for stormwater. The next subsection on the quantitative determination of urban stormwater runoff includes empirical formulas for determining design storm drain discharges, the rational method, correlation studies of rainfall and runoff, the hydrograph method, the inlet method, and the hydraulics of inlets and gutter flow. The next three shorter subsections deal with urban flooding, water supply, and pollution from inadequately treated wastes. Subsection VII explores the objectives, hydrologic data, subsurface and surface drainage of airports, and Subsection VIII concerns the hydrology of urban expressways. (See abstract number 467).

493
URBAN HYDROLOGY OF THE HOUSTON, TEXAS METROPOLITAN AREA-COMPILATION OF BASIC DATA-1966,

S. L. Johnson
Geol Surv Duplicated Basic-Data Rep, 1968. 275 p, 13 fig, 12 tab, Charts, Hydrographs.

Descriptors: *Data collections, *Urbanization, *Hydrologic data, *Texas, Rainfall, Runoff, Stream gages, Hydrographs, Streamflow.
Identifiers: Houston, Texas.

Basic data of the urban hydrology of Houston, Texas, 1965-66, are compiled. Surface-water records are from gaging stations, crest-stage partial-record stations; rain gages, and miscellaneous sites. Each gaging-station record includes location, drainage area, gage type and history, average discharge, extremes, remarks; daily discharge, total discharge, mean discharge, annual maximum, minimum, and mean discharges, and peak discharges. Runoff and rainfall are computed for each drainage basin and hydrographs and mass curves are drawn. A map of each basin shows locations of all gages.

494
LOSS RATES ON SELECTED CATCHMENTS IN VICTORIA,

A. Karoly
Water Res Found of Australia Bull No 13, 1965. 48 p, 22 fig, 10 tab, 8 ref.

Descriptors: *Rainfall-runoff relationships, *Surface-groundwater relationships, *Rainfall disposition, Base flow, Infiltration, Runoff coefficient, Small watersheds.
Identifiers: *Australia.

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Storm rainfalls on 9 catchments in Victoria, Australia were analyzed for rainfall-runoff relationships and 137 loss rates were derived. Loss rate is defined as the average rate of potential infiltration loss to surface runoff during the supply period of a storm. Relationships between loss rates and some hydraulic factors of the drainage basins were calculated. Frequency distributions and seasonal variations of loss rate were calculated and compared with U.S. and other Australian rates.

495
A NONLINEAR APPROACH TO RUNOFF STUDIES,

V. C. Kulandaiswamy and C. V. Subramanian
Proceedings of International Hydrology Symposium, Sep 6-8, 1967, Vol 1, Paper 10, p 72-79, 1967. 8 p, 5 fig, 1 tab, 4 ref.

Descriptors: *Rainfall-runoff relationships, *Mathematical models, *Runoff forecasting, Computer models, Streamflow forecasting, Simulation analysis, Rainfall disposition, Unit hydrograph, Hydrograph analysis.
Identifiers: Watershed models.

The process of conversion of rainfall excess into surface runoff is studied by treating drainage basins as lumped systems. The rainfall excess is considered as inflow and the surface runoff as outflow. Making use of the equation of continuity, a differential equation used with field data indicates that the system behavior is nonlinear but can, however be treated as linear by approximation in the case of major floods. The proposed equation is verified by applying it to observed storms, and the results are found to be very encouraging. This method of approach provides considerable scope for an analytical treatment of rainfall excess-surface runoff relationship.

496
THE ESTIMATION OF RUNOFF FROM RAINFALL FOR NEW BRUNSWICK WATERSHEDS,

J. Lee and D. I. Bray
J Hydrology, Vol 9, No 4, pp 427-437, Dec 1969. 4 tab, 11 ref.

Descriptors: *Runoff forecasting, *Watersheds (basins), *Storm runoff, *Storms, *Estimating equations, Analysis.
Identifiers: *Canada.

Prediction equations have been derived for forecasting runoff volume for regions within the Province of New Brunswick. Five basins were selected so as to provide a regionally representative distribution

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over the province. The prediction equations are based on the storm rainfall, antecedent precipitation index, base flow, and week number in which the storm occurred. Statistical methods were used to obtain the least-squares multiple linear regression equation, correlation coefficient, and the standard error for each of the techniques used for the watersheds. The number of storms varied from 8 to 23 for the basins studied. The standard error of the optimum prediction equations for runoff ranged from 0.065 inches to 0.212 inches and the multiple correlation coefficient (R) varied from 0.556 to 0.963. Results of the regression equations developed for one basin were extended to a neighboring basin of similar hydrological characteristics, but with only recent streamflow records.

497
HYDROLOGY FOR URBAN LAND PLANNING—A GUIDEBOOK ON THE HYDROLOGIC EFFECTS OF URBAN LAND USE,

Luna B. Leopold
Geol Surv Circ 554, 1968. 18 p, 8 fig, 1 tab, 28 ref.

Descriptors: *Urbanization, *Hydrologic aspects, Hydrographs, Hydrograph analysis, Storage, Sediment yield, Water temperature, Water pollution.
Identifiers: Urban hydrology.

The effects of urbanization on hydrologic factors are discussed and rainfall-runoff relations of urbanized and unurbanized watersheds are compared. Urbanization increases the amount of impervious area in a watershed so that the intensity and amount of runoff increase and peak discharges occur sooner. Sediment yields are 10-100 times larger in urbanized watersheds, water quality decreases, water values usually decrease. Hydrographs, frequency curves, and sediment yield-discharge curves, are used to show typical effects of urbanization on streams.

498
RAINFALL-RUNOFF MODEL FOR SMALL BASIN FLOOD HYDROGRAPH SIMULATION,

R. W. Lichty, D. R. Dawdy, and J. M. Bergmann
Symp on Use of Analog and Digital Computers in Hydrol, Tucson, Ariz, Dec 1968, Vol 2, Int Ass Sci Hydrol Publ No 81, pp 356-367, 1968. 12 p, 6 fig, 2 tab, 10 ref.

Descriptors: *Rainfall-runoff relationships, *Flood forecasting, *Mathematical models, Digital computers, Computer programs, Streamflow forecasting, Parametric hydrology, Infiltration, Surface-groundwater relationships, Simulation analysis, Optimization, Runoff forecasting.
Identifiers: Philips equation.

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A simplified, mathematical model of the surface runoff component of streamflow response to storm rainfall was developed and programmed for digital computer solution. The model uses an infiltration component based on an equation by Philip to determine rainfall excess, which is transformed by a linear basin-response function to simulate the flood hydrograph. An objective-fitting procedure that emphasizes the simulation of peak-discharge rate was used to identify optimum model parameters in a pilot study of a 5-sq mi drainage basin in North Carolina. Split-sample fitting and testing showed that predictive capability varied for 3 samples of flood events. Results of simulation for 2 test samples of pre-1948 flood events showed reasonable correspondence between simulated and observed flood peaks. The post-1948 test sample showed wide scattering between simulated and observed flood peaks. Sensitivity analysis of objective-function response to parameter incrementation showed that antecedent moisture accounting grossly controlled the results of optimization.

499
URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,

Ray K. Linsley (discussion)
J Hydraul Div, Am Soc Civil Engrs, Vol 96, No HY4, pp 1100-1102, Apr 1970. 5 ref.

Descriptors: *Hydrographs, *Runoff forecasting, Flood routing, Computers, Methodology.
Identifiers: *Rainfall characteristics, *RRL.

The author compares various methods of deriving hydrographs for urban drainage studies, and explains why the lag and route method is superior to the unit hydrograph. Computer use is suggested to aid in estimating runoff from pervious areas and to help integrate characteristics of rainfall into calculated flows and simplify the problem of determining frequency of computed peak flows. This method would aid testing of the RRL procedure described in the original paper.

500
COMMITTEE ON STATUS AND NEEDS IN HYDROLOGY - MEETING OF AGU COMMITTEE ON STATUS AND NEEDS IN HYDROLOGY,

Ray K. Linsley
Trans Am Geophys Union, Vol 45, No 3, pp 693-698, Sep 1964.

Descriptors: *Hydrology, *Water quality, Base flow, Investigations.
Identifiers: *Hydrologic research.

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The Committee on Status and Needs in Hydrology investigated research needs in hydrology and their report is summarized in this article. They conclude that within hydrology, water quality requires increasing attention. Also, the position of biological rather than physical processes of the hydrologic cycle needs to be studied, and efforts should be made to research chemical, physical, and biological phenomena associated with flow in permeable media in and near the ground surface. A list of sixty-three research topics, compiled by the Committee, encompass these points. The order of the list conveys the relative importance of needed research in the overall field of hydrology, rather than a judgement of intrinsic scientific merit. Rainfall-runoff relations, areal distribution of storm precipitation, hydrologic systems analysis, unit-hydrograph simulation, and processing of hydrologic data are examples of topics listed.

501
ANALYSIS OF FORMING AND DETERMINATION OF RAINFALL-RUNOFF LOSSES IN EASTERN CARPATHIANS,

P. M. Lyutik
Sb Rab Gidrol (SGGGAI), No 7, pp 60-75, 1967. 16 p, 7 fig, 2 tab, 15 ref.

Descriptors: *Rain, *Runoff, *Water loss, *Rainfall-runoff relationships, Floods, River basins, Precipitation (atmospheric), Discharge (water), Hydrologic properties, Drainage districts, Infiltration, Evaporation, Hydrograph analysis, Climatic zones, Storm runoff, Frequency.
Identifiers: *USSR, Carpathian Rivers.

On the basis of discharge and precipitation data recorded at several gaging stations of the Carpathian Rivers, the rainfall-runoff losses were analyzed by using the standard technique of subdividing a river discharge into the total and basic parts. Flood frequencies, runoff coefficients, precipitation, and water loss volumes were calculated and expressed by charts and tables. The analysis of runoff coefficients indicates an initial loss of water equal to a layer of 40-50 mm in thickness for summer floods and 10-15 mm for spring and fall floods. The hydrologic data record at the Transcarpathian gaging station shows the greatest losses (as much as 90%) after isolated rainfalls in river basins of small areal extent. The smallest losses occur after long intensive rainfall or after a long rainfall period. The majority of rainfalls characterized by maximum discharges have high rainfall-coefficient values (0.60 - 0.90) and occur during the spring and fall months.

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502
AN ANALYSIS OF NATIONAL BASIC INFORMATION NEEDS IN URBAN HYDROLOGY,

M. B. McPherson, D. C. Taylor, and L. S. Tucker
Am Soc Civil Eng Basic Inform Rep, Apr 1969. 112 p, 14 fig, 4 tab, 73 ref.

Descriptors: *Rainfall-runoff relationships, *Urbanization, Drainage systems, Instrumentation, Hydrologic data, Measurement, Networks, Meteorological data, Surveys, Data processing, Water quality.
Identifiers: *Urban hydrology, Storm sewers.

The article focuses on data needs, data devices and data networks. Primarily aimed at improvement in design of storm drainage, an intensive study was made of the data requirements for analyzing rainfall-runoff-quality relationships and of suitable data collection instrumentation, with consideration of the types of networks required for the collection of adequate data. Suitable data collected with properly coordinated instrumentation in networks representing a variety of climatic, topographic, and land use conditions, are virtually non-existent. There are very meager amounts of performance data with which existing or proposed storm drainage facilities can be checked or designed. Transfer of data findings between metropolitan regions is a central and primary objective. Recommendations centered on hydrologic information needs are related to storm sewers. The replacement value of existing storm sewerage systems in the United States is at least $22 billion, and it is estimated that an average of about $3.5 billion per year will be spent on construction of new storm sewerage systems over the next several years. The plan recommended for a minimum national program of urban storm drainage research would cost on the order of 1/3% of this average annual construction cost.

503
SOME NOTES ON THE RATIONAL METHOD OF STORM DRAIN DESIGN,

M. B. McPherson
ASCE Urban Water Resources Res Prog Tech Mem No 6, Jan 22, 1969. 84 p, 9 fig, 3 tab, 42 ref, 2 append. USGS Contract No. 14-08-0001-11257.

Descriptors: *Urbanization, *Storm drains, *Rainfall-runoff relationships, *Rational formula, *Storm runoff, *Design, Drainage systems, Surface runoff, Routing, Hydrographs, Runoff, Hydraulic design, Design flood, Systems analysis, Stream gages, Gaging stations.

Because the 'rational method' of designing urban storm drainage facilities has substantial liabilities, new design procedures are discussed and the urgent need for more field stream gaging data is stressed. The limitations of the rational method consist mainly of the weaknesses of

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projecting standard values of the rainfall-runoff relationship over wide geographical areas, the use of too many standardized assumptions, and using the same runoff routing methods in too many dissimilar situations. Suggested improved design methods would use on-site gaged rainfall-runoff relations to determine flow probabilities in mathematical models so that the optimum drainage system for each particular case may be designed. Presently there are no gaging programs of sufficient scope in operation. Other suggestions include the use of surface detention to flatten runoff peaks, storage of urban runoff for water supply use, or use of urban runoff as a source of recreational water.

504
THE NATURE OF CHANGES IN URBAN WATERSHEDS AND THEIR IMPORTANCE IN THE DECADES AHEAD,

M. B. McPherson
ASCE Tech Mem No 5, Urban Water Resources Res Program, Dec 1968. 18 p, 3 tab, 23 ref. OWRR Contract No. 14-01-0001-1585, USGS Contract No. 14-08-0001-11257.

Descriptors: *Urbanization, *Urban sociology, *Water resources development, Social aspects, Drainage systems, Land use, Sewers, Utilities, Water utilization, Water supply, Water reuse, Water quality.
Identifiers: Urban hydrology.

Urban changes, largely social and economic, that affect urban hydrology are discussed in a survey and bibliography of urban sociology and recent urban history largely consisting of quotations and reviews of non-engineering and non-hydrological literature. Urban expansion is considered largely a function of development of new forms and trends of use of high-speed urban transport. The urban areas of the country are growing rapidly with trends of increasing urbanization added to increasing growth of suburbs. Urban problems of crowding, water supply, waste disposal, and general environmental quality are growing even faster than the cities. The need for comprehensive planning rather than solving single problems such as waste disposal or water supply is stressed. The environment of cities is a function of all social and physical factors. Hydrological problems can be solved only as part of the total environmental problem.

505
URBAN WATER RESOURCES RESEARCH,

M. B. McPherson
Am Soc Civil Eng Annual Prog Rep, 1968. 43 p, 4 fig, 3 tab, 38 ref, 11 append. L. S. Tucker, Director. Work supported by OWRR, Dept of Interior. OWRR Contract No. 14-01-0001-1585.

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Activities in urban water resources research by ASCE in 1967-1968 are reported. The objective of the research is to provide guidelines for initiating and expanding a program of long-range studies in urban water problems. Considerable attention was given to storm drainage to arrive at mathematical descriptions of the rainfall-runoff relationship, to predict pollution loads, and to develop methods of planning water quantity, quality, and drainage development. Data collection system design and data requirements are discussed. Systems analysis, statistical studies, and model studies are being initiated. Considerable attention was given to research needs in political, economic, social, legal, and related aspects of urban hydrology. Appendices contain technical and feasibility studies of modeling, flood damages, non-hydrological aspects, research needs, systems engineering, and economics.

506
GENERALIZED CHARTS OF HYDROLOGIC FACTORS USEFUL IN URBAN PLANNING,

John F. Miller
Paper presented at the Am Geophys Union - 1969 National Fall Meeting.

Descriptors: *Urban renewal, *Hydrologic data, *Planning.
Identifiers: *Urban hydrology, *Tables.

The Environmental Science Services Administration prepares maps and tables of average and extreme values for various climatic and hydrologic factors. Many of these products are useful to the urban planner. A brief description is given of the meteorological or climatological basis for some of these products and examples are shown of possible applications to urban hydrology.

507
EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,

Walter L. Moore and Carl W. Morgan
Water Resources Symposium No 2, Austin, Texas, October 1968. Published by Univ of Texas Press, Austin and London, 1969. 289 p.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Hydrograph analysis, *Water quality, Flood control, Reservoirs, Water yield, Planning, Water management (applied), Hydrology, Floods, Peak discharge, Model studies, Hydraulic models, Mathematical models, Computer models, Analog models.
Identifiers: Urban hydrology.

This special lecture series was arranged to present the most advanced approaches to evaluating the effects of watershed changes on streamflow. To an increasing degree man's activities are altering the hydrologic

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characteristics of watersheds, both rural and urban, and it is urgent to know the character and extent of the changes and how they affect plans for development. Numerous field studies designed to evaluate the effect of specific watershed changes by comparisons between watersheds have been in operation for sufficient time to build up a significant length of record. New methods of computer simulation of watersheds have reached a stage of development to offer an attractive tool for attacking the problem in new ways. The effects of the changes can best be evaluated when the entire performance of the watershed is understood in detail. Then all of the physical processes can be followed and the performance of the watershed can be simulated by numerical or analog techniques which correspond to the physical processes. Watershed changes produce effects on both the amount and the quality of streamflow. The topics discussed include model studies, land treatment in rural watersheds, flood control structures, rural pollution, the effects of urbanization on peak flow, the effects of urbanization on water yield, and urban water quality changes.

508

SOME EFFECTS OF URBANIZATION ON RUNOFF AS EVALUATED BY THORNTHWAITE WATER BALANCE MODELS,

Robert A. Muller

Proc 3rd Annual Amer Water Resources Conf, Nov 8-10, 1967, San Francisco, Calif, pp 127-136, 1967. 10 p, 4 fig, 5 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Water balance, *Urbanization, New Jersey, Evaporation, Rainfall, Runoff, Infiltration, Flood control.
Identifiers: Thornthwaite method, Raritan River basin, New Jersey.

Water balance methodology (including the Thornthwaite potential evapotranspiration) and water balance models are applied to the Raritan River basin in New Jersey. In order to gain some understanding of hydroclimatological processes and interrelationships associated with urbanization of drainage basin. The precise objectives are: to compare and contrast selected Thornthwaite water balance components as calculated by several more or less 'standard' techniques; to demonstrate that potential evapotranspiration and water balance models can be utilized as hydroclimatological controls to obtain first approximations of the consequences of land cover type change, or urbanization within a river basin; and, to explore generated water balance data based on the assumption of the transformation of a watershed from rural to urban. Calculated runoff takes into account the monthly and seasonal variation of precipitation and soil moisture storage as well as energy availability for evapotranspiration loss. Measured runoff not only includes the climatic

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variation but in addition the effects of land use change. Hence, the differences between calculated and measured runoff overtime should be a measure of the effects of land use change on runoff.

509
HANDBOOK OF APPLIED HYDROLOGY, SECTION 12, INFILTRATION,

G. W. Musgrave and H. N. Holtan
McGraw-Hill Book Company, New York, pp 12:1 to 12:30, 1964. 18 graphs, 7 tab, 4 diag, 19 ref.

Descriptors: *Infiltration, *Flow, Hydrograph analysis, Rainfall-runoff relationships, Runoff.
Identifiers: *Infiltration index, Infiltration research.

The first two subsections of this part concern early concepts and factors affecting water flow through the soil surface or infiltration. The subsection on infiltration measurement includes descriptions of rainfall simulators and flooding type infiltrometers, plus three methods of runoff hydrograph analyses to estimate infiltration. The role of infiltration in the rainfall-runoff relationship is explored generally, based on data from small agricultural watersheds. Infiltration in computations of runoff is discussed in the next subsection in relation to small-area projects such as urban drainage, airports, etc. and also in relation to larger watersheds. Infiltration indexes, which express infiltration as an average rate throughout a storm, are explained in another subsection, and lastly, some forecasts are made regarding future research in infiltration. (See abstract number 467).

510
HANDBOOK OF APPLIED HYDROLOGY, SECTION 25-IV, HYDROLOGY OF FLOW CONTROL, PART IV, RIVER FORECASTING,

T. J. Nordenson and M. M. Richards
McGraw-Hill Book Company, New York, pp 25:98 to 25:111, 1964. 5 graphs, 5 tab, 2 diag, 13 ref.

Descriptors: *River forecasting, *Flood control, Operations, Rainfall-runoff relationships, Hydrographs, Forecasting.

Basic river forecasting procedures utilized by the U.S. Weather Bureau are described along with discussions of common operational problems. Day-to-day river forecasts of inflow to reservoirs and discharges are needed for those studying flood control, navigation, water supply, stream pollution, etc. Tools of the river forecaster include rainfall-runoff relations, unit hydrographs, routing methods, recession curves, and

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stage-discharge relations. In one subsection, a specific river forecasting example of a hypothetical river basin is studied for runoff computations and forecasts of headwater and downstream points. The final subsection involves special forecasts such as flash flood warnings, and water supply and low flow predictions. (See abstract number 467).

511
ANALYSIS OF TWO MAJOR RUNOFF-PRODUCING SOUTHWEST THUNDERSTORMS,

H. B. Osborn and K. G. Renard
J Hydrology, Vol 8, No 3, pp 282-302, Jul 1969. 21 p, 20 fig, 1 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Thunderstorms, *Storm structure, Arizona, Hyetographs, Hydrographs, Storm runoff, Runoff forecasting, Meteorology, Demonstration watersheds, Small watersheds.
Identifiers: Walnut Gulch Experimental Watershed.

The two largest runoff-producing storms for 10 yr of records, the first in 1964 and the second in 1967, recorded on the Walnut Gulch Experimental Watershed in southeastern Arizona are analyzed and compared. Both storms were non-frontal thunderstorms which produced peak discharges on the order of 1500 cfs per sq mi; in 1964 from a 2000-acre subwatershed, and in 1967 from an 84-acre subwatershed. During the 1967 storm rainfall of 3.35 inches in 45 min was recorded at one point on the watershed. Approximately 18 acre-ft of runoff was produced on the 84-acre subwatershed in the 1967 storm. Runoff-producing rainfall lasted for less than 60 minutes for both storms. For both storms, runoff per unit area decreased with increasing subwatershed size because of the large transmission losses in the ephemeral channels and because of the limited areal extent of the runoff-producing rainfall.

512
URBAN HYDROLOGY, STORM DRAINAGE, AND FLOOD PLAIN MANAGEMENT IN METROPOLITAN AREAS OF THE UNITED STATES,

Herbert G. Poertner
Georgia Institute of Technology Water Resources Center Report, Aug 1968. 28 p. OWRR Project X-102.

Descriptors: *Water management (applied), *Planning, *Government, *Urbanization, Storm runoff, Water supply, Legislation, Regulation, Reviews.
Identifiers: *Urban hydrology.

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Current practices in urban hydrology, storm drainage, and flood plain management are reviewed. These practices have characteristics which not only limit solutions to present problems but contribute to future problems. An illustration is the opposition by land owners and tax authorities to flood plain zoning. One alternative to the present unsatisfactory state of management is to establish a program responsive to all segments of the population. Major limitations of present practices in engineering and design are deficiencies in knowledge of urban hydrology, lack of analyses of accumulated data, and ineffective use of data for producing optimum designs of integrated drainage systems. Problems of urban drainage are primarily institutional. Enabling legislation is needed for management of water in entire metropolitan areas by a single authority. Programs on federal, state, and local levels for correction of deficiencies within present flood plains and drainage systems need development to serve existing communities as well as those that may emerge in the surrounding area.

513
A NONLINEAR HYDROLOGIC SYSTEM RESPONSE MODEL,

Ramanand Prasad
J Hydraul Div, Am Soc Civil Eng, Vol 93, No HY4, pp 201-221, Jul 1967. 21 p, 9 fig, 2 tab, 15 ref, 2 append.

Descriptors: *Simulation analysis *Analog computers, *River basins, Mathematical models, Numerical analysis, Rainfall-runoff relationship, Reservoirs, Storm runoff, Illinois.

The effects of the physical factors responsible for the transformation of rainfall excess into direct runoff were simulated by the action of a conceptual nonlinear reservoir. A nonlinear differential equation of the basin response was derived. Because no analytical solution for the system response equation existed, solutions were found by means of an electronic analog computer and a numerical method. Model parameters were found to be correlated with basin, main channel, and rainfall characteristics for seven east central Illinois basins. The consistency of the results obtained from an analysis of storms over those basins indicated that the proposed model could be adopted for nonlinear simulation of the hydrologic system response.

514
AN EXPERIMENTAL INVESTIGATION OF PARTIAL AREA CONTRIBUTIONS,

Robert M. Ragan
Intern Assoc Sci Hydrol Pub No 76, pp 241-251, 1968. Symp on Hydrol Aspects of Util of Water, Bern, Sept 25-Oct 7, 1967. 11 p, 5 fig, 8 ref.

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Descriptors: *Routing, *Runoff, *Rainfall-runoff relationships, Subsurface runoff, Flood routing, Surface-groundwater relationships, Hydrographs, Discharge (water), Infiltration, Rainfall intensity, Storm runoff, Interception, Vermont.

The paper describes a detailed experimental-numerical investigation of the concept of partial area contributions to storm hydrographs. A computer solution of a numerical flood routing technique was used to isolate the time-spatial distribution of local runoff entering the main channel of a small watershed. Extensive experimental information collected in the vicinity of the 619 ft length of second order stream provided a means of interpreting these land-phase hydrographs. Analysis of a series of storms showed that only a small portion of the watershed ever contributed flow to the storm hydrograph. The contributing area was found to be a function of the storm duration and intensity and, rather than being uniformly distributed along the length of the channel, it existed in the form of localized zones of intense contribution. In a given storm, the contributing area was found to fluctuate with changes in the rainfall intensity. During periods of low intensity, most of the flow came from channel precipitation and rain falling on the wet areas surrounding a series of seeps. If a period of high intensity occurred, flow developed through the forest litter on the hillsides and thereby created a larger contributing area. No interflow in the soil mass above the water table was encountered. A rapid response of the groundwater at some points along the channel, however might have been interpreted as interflow if extensive measurements had not been taken. The behavior of the watershed was quite logical when the fundamentals of the individual processes were considered. The results of the study illustrate that there is a need for a reevaluation of some of the traditional methods used for runoff computations. Further, any parametric model developed for the synthesis of hydrologic events should be able to reflect partial area contributions.

515
FREQUENCY ANALYSIS OF RAINFALL INTENSITIES FOR CALCUTTA,

V. Raman and M. Bandyopadhya
J Sanit Eng Div, Am Soc Civil Engrs, Vol 95, No SA6, pp 1013-1030, Dec 1969. 18 p, 10 fig, 9 tab, 7 ref, append.

Descriptors: *Rainfall disposition, *Frequency analysis, *Duration curves, *Depth-area-duration analysis, Rainfall intensity, Statistical methods, Runoff, Rational formula, Rainfall-runoff relationships, Storm runoff, Storm drains, Drainage engineering.
Identifiers: *India, Storm sewers.

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Analysis of the point rainfall data in Calcutta, India for 23 yr yields a procedure for arriving at the relationship between the average intensity of excessive rainfall, the corresponding duration the rain continued to fall at the average rate, and the frequency with which these combinations of intensity and duration of such storms occur. Probability methods based on annual maximum events and partial duration series, and mathematical and graphical curve fitting, based on frequency analysis, are employed for developing the relationships. Intensity duration frequency relations are expressed in tabular and graphical forms and as mathematical equations. The various methods do not give exactly identical results, and discretion must be used to choose between them for application in the design of a storm sewer system. No particular method can be considered as the best for rainfall frequency determination.

516
URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,

S. E. Rantz
Geol Surv Circular No. 601-B, Washington, 1970. 11 p, 1 fig, 1 map, 5 photo, 3 tab.

Descriptors: *Urbanization, *Flooding, *Flood control, Storm runoff, Land use, Landslide.
Identifiers: *Urban sprawl.

The floods of January 1969 in south-coastal California provide a timely example of the effect of urban sprawl on flood damage. Despite record breaking, or near record breaking, stream discharges, damage was minimal in the older developed areas that are protected against inundation and debris damage by carefully planned flood-control facilities, including debris basins and flood-conveyance channels. By contrast, heavy damage occurred in areas of more recent urban sprawl where the hazards of inundation and debris or landslide damage have not been taken into consideration, and where the improvement and development of drainage or flood control facilities have not kept pace with expanding urbanization.

517
SYNTHESIS OF URBAN RAINFALL,

A. J. Raudkivi and N. Lawgun
Water Resources Res, Vol 6, No 2, pp 455-464, Apr 1970. 8 tab, 6 graphs, 3 ref.

Descriptors: *Computer models, *Depth-area-duration analysis, *Markov processes, *Parametric hydrology.
Identifiers: *Urban hydrology, *New Zealand.

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A statistical analysis of rainfall records is used to develop a computer model for generation of a sequence of short period rainfalls. Time intervals between rainfalls are generated by sampling from a frequency distribution fitted to historical data. The model also uses a first order Markov process in addition to random sampling from a frequency distribution in order to obtain the rainfall durations. Rainfall depths are obtained by sampling from the joint distribution of rainfall depths and durations. Model parameters are based on meterologic conditions of the Auckland area, and all statistical tests were performed at a 5% level of significance. The model produces comparable time intervals between storms and a linear correlation between rainfall depths and durations, but extreme values of rainfall depths and durations are absent from the generated data.

518
EFFECT OF A COMMERCIAL CLEARCUTTING IN WEST VIRGINIA ON OVERLAND FLOW AND STORM RUNOFF,

Kenneth G. Reinhart
J Forest, Vol 62, No 3, pp 167-171, 1964.

Descriptors: *Rainfall-runoff relationships, *Watershed management, Watersheds (basins), Overland flow, Storm runoff, West Virginia, Infiltration, Hydrologic aspects.
Identifiers: Experimental watersheds.

A commercial clearcutting was made on a 74-acre gaged watershed on the Fernow Experimental Forest; skidroads were loggers' choice--without limitations as to grade or provisions for drainage. After-logging infiltration rates in the watershed remained well above maximum rainfall intensities except on portions of the skidroads. Overland flow occurred only from the skidroads; it resulted from the combination of rain directly on the skidroads and interception of subsurface flow by the road cuts. Increased storm runoff in the growing seasons--up to a maximum of about 1/2 area-inch in any one storm--was largely the result of decreases in field-moisture deficiency rather than changes in the proportions of surface and subsurface flow. This study indicates that, in judging hydrologic condition of logged areas, perhaps as much emphasis should be placed upon road conditions and forest-floor disturbance as upon the amount of timber cut and condition of the stand.

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519
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,

J. Paul Riley and V. V. Dhruva Narayana
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, pp 183-200, October 1968, University of Texas Press, Austin and London, 1969. 18 p, 14 fig, 3 tab, 7 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Computer models, *Analog models, Analog computers, Simulation analysis, Hydrograph analysis, Storm runoff, Peak discharge.
Identifiers: Urban hydrology, Austin, Texas.

In the synthesis of hydrograph characteristics of small urban watersheds, the distribution of the water among the various phases of the runoff process is attempted by the concept of 'equivalent rural watershed.' For a given input into both the models, the outputs must be identical. The hydrograph of outflow from an urban watershed is obtained by chronologically deducting the losses due to interception, infiltration, and depression storage from precipitation on the equivalent rural watershed and then routing it through the surface and channel storages. This is being approached by computer simulation. Testing and verification of the basic mathematical model is being done by using observed rainfall and runoff data from well-instrumented runoff areas. Coefficients representing interception, depression storage, and infiltration are determined by the trial and error process on the analog computer in such a way that the outflow hydrograph predicted by the model is nearly identical to the measured prototype hydrograph. Relationships between these coefficients and various urbanization characteristics or parameters are established. Sensitivity studies which investigate the significance of each of the watershed coefficients on the outflow characteristics are also undertaken.

520
CORRESPONDENCE: "The analysis of urban rainfall runoff and discharge,"

E. J. Sarginson, D. E. Bourne, and L. H. Watkins
J Inst Munic Engrs, Vol 96, No 6, p 181, Jun 1969.

Descriptors: *Hydrographs, *Analytical techniques.

L. H. Watkins: The author contends that there are two misconceptions about the RRL hydrograph method: 1) the method does not currently assume uniform proportional depth in the whole sewer system; and, 2) the routine technique as applied to an areal/time calculated hydrograph is not illogical. The use of computer service is advocated.
E. J. Sarginson and D. E. Bourne: In reply to Watkins' comments, the authors insist that their analysis can be modified to allow for variations

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in proportional depth from pipe to pipe. They further contend that the method they have proposed separates the effects of ground and pipe storage, and the resulting hydrograph simultaneously gives the attenuation in the peak discharge and the delay in the time of its occurrence resulting from the combined effects of overland flow and flow in the sewer.

521
ANALYSIS OF URBAN RAINFALL-RUN-OFF AND DISCHARGE,

E. J. Sarginson and D. E. Bourne
J Inst Munic Engrs, Vol 96, No 3, pp 81-85, Mar 1969.

Descriptors: *Hydrographs, *Rainfall, *Analytical techniques, *Design standards, *Discharge measurement.

This paper considers phenomena which modify a rainfall hydrograph for an urban catchment, and it examines the extent to which these modifications are satisfied by existing design methods. The theory presented accounts for phenomena concerned. A method for analysis of existing urban rainfall and discharge records is given. This design method was developed with the hydrograph based on a standard storm which is successively routed over the ground and through a sewer, assuming a linear storage-flow relation for each.

522
CORRESPONDENCE: "The Analysis of Urban Rainfall Run-off and Discharge,"

E. J. Sarginson, D. E. Bourne, and M. V. King
J Inst Munic Engrs, Vol 96, No 5, pp 155-156, May 1969.

Descriptors: *Storm runoff, *Hydrographs, Rainfall, Discharge measurement.
Identifiers: Sewer hydraulics.

M. V. King: The author disputes certain parts of the paper by D. E. Bourne and E. J. Sarginson. He corrects the misconception that the equation $i=e^{-3/4}/4$ is the Meteorological Office equation, and he argues that storm runoff should be considered with regard to time of flow through the sewer. He holds that the authors' rainfall hydrographs are valid only if the drainage area had zero time of concentration. He exposes the weakness of the authors' hydrograph method, and he explains and defends his proposed method.
E. J. Sarginson and D. E. Bourne: Replying to King's criticisms, they dispute his assertion that their rainfall hydrographs hold only if the drainage area had zero time of concentration. They also do not consider

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velocities of flow necessary to their analyses; instead, they cite the important factors as being volumetric rates of runoff and discharge. They discuss King's method, but continue to support their original statements.

523
A PROGRAM IN URBAN HYDROLOGY. PART II: AN EVALUATION OF RAINFALL-RUNOFF MODELS FOR SMALL WATERSHEDS AND THE EFFECTS OF URBANIZATION ON RUNOFF,

P. B. S. Sarma, J. W. Delleur, and A. R. Rao
Purdue University Water Resources Research Center Technical Report No 9, Oct 1969. 240 p, 58 fig, 30 tab, 105 ref, 3 append. OWRR Project B-002-IND.

Descriptors: *Urbanization, *Storm runoff, *Watersheds (basins), *Rainfall-runoff relationships, *Time lag, *Model studies, Water yield, Runoff, Hydrographs, Rainfall, Runoff coefficient, Indiana, Routing.
Identifiers: Nash model, West Lafayette Watershed.

The data for this study were taken from four watersheds with varying degrees of urbanization located in West Lafayette, Indiana. The analytical approach adopted was the linear (time variant, lumped) system analysis. The conceptual linear systems considered in the analysis of the data were the single linear reservoir model, the double routing method, the Nash model, and the single linear-reservoir with linear-channel model. The single linear reservoir model was selected to simulate the rainfall-runoff process on small urban watersheds (less than 5 square miles) based on the larger watersheds (between 5 and 20 square miles). The relationship of the degree of urbanization and the time lag, the magnitude of the peak discharge, and the frequency of peak discharge were studied. Studies will be continued with linear models and, in addition, nonlinear models will be considered in the hydrologic simulation of the larger watersheds in order to develop design methods and criteria for predicting runoff from areas with varying degrees of urbanization.

524
APPLICATION OF THE LINEAR CONVOLUTION MODEL IN DESCRIBING THE RAINFALL - RUNOFF RELATIONSHIP OF AN URBAN DRAINAGE BASIN,

Fred A. Schmer, Robert A. Clark, and Edward A. Hiler
Paper presented at the Am Geophys Union - 1969 National Fall Meeting.

Descriptors: *Rainfall-runoff relationships, *Watersheds (basins), *Systems analysis, *Hydrologic aspects, *Input-output analysis, *Testing.
Identifiers: *Urban hydrology, *Convolution relationship.

This investigation is concerned with the applicability of the linear convolution relationship for approximating the rainfall-runoff phenomenon

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for an urban drainage basin. A solution for the transfer function of the convolution relationship is obtained by employing discrete mathematics similar to the Wiener-Hopf equation. The solution is obtained, based on the restraints of the physical system by linear programming. In this investigation, the hydrologic system is analyzed as a truly linear system. Recorded rainfall intensity is the *input* of the system, and recorded runoff the *output*. A major concern of the study involves the effects of antecedent moisture conditions on the transfer function. Results are presented which substantiate the use of the proposed linear model as an approximation to the hydrologic system. Generalized transfer functions are developed for each basin and tested with independent events. Antecedent moisture conditions are shown to have a definite predictable effect on the transfer function, and rainfall events are classified with an antecedent moisture condition criteria in order to select the proper transfer function for the event. Comparisons are made with more conventional hydrologic analysis.

525
THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,

William J. Schneider
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium, No 2, p 165-168, October 1968, University of Texas Press, 1969.

Descriptors: *Planning, *Urbanization, *Data collections, *Water management (applied), Research and development, Water resources development, Water supply, Waste disposal, Storm runoff.
Identifiers: Urban hydrology.

The Water Resources Division of the U.S. Geological Survey is currently expanding its role in urban hydrology as rapidly as possible to meet new demands. Almost since the first stream gaging stations were established, more than 80 years ago, water resources data have been collected in urban areas. Today, some data are available for every one of the 222 standard metropolitan areas in the United States. In addition to the collection of basic data, the Water Resources Division has conducted studies either within or including urban areas. These have resulted in numerous reports published in the Survey publication series and in outside technical journals. In recent years, the emphasis of these studies has been on the assessment of changes in the water resources caused by urbanization. Storm drainage today is still largely designed on the basis of the empirical rational formula using rainfall intensity modified by a coefficient of runoff. The inefficiency of this method is well recognized. Greater knowledge of the part of the hydrologic cycle involving rainfall-runoff relations in urban environments is needed. A study, currently under way, will consider the data needs for urban runoff studies, appraise available and needed instrumentation for collection of these data, and advise on types of networks for collection of these data. The study is for design of pilot areas.

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526
EFFECTS OF URBAN DEVELOPMENT ON DIRECT RUNOFF TO EAST MEADOW BROOK, NASSAU COUNTY, LONG ISLAND, NEW YORK,

G. E. Seaburn
Geological Survey Professional Paper 627-B, p B1-B14, 1970. 14 p, 5 fig, 1 plate, 8 tab, 18 ref.

Descriptors: *Rainfall-runoff relationships, *New York, *Urbanization, *Storm runoff, Storm drains, Unit hydrograph, Duration curves, Hydrographs, Hydrology.
Identifiers: Nassau County, New York, Long Island, New York, Urban hydrology.

The effects of intensive urban development on direct runoff to East Meadow Brook, a southwardflowing stream in central Nassau County, N.Y., during the period 1937-66, are described. The special objectives of the study were to relate indices of urban development to increases in the volume of annual direct runoff to the stream; to compare hydrograph features at different periods during the transition of the drainage basin from rural to urban conditions; and to compare the rainfall-runoff relations for periods before and after urban development. Periods of housing and street construction in the drainage basin correspond to 3 distinct periods of increased direct runoff. During each period, the average annual direct runoff increased because of an increase in the area served by storm sewers that discharged into East Meadow Brook. The amount of land served by sewers increased from about 570 acres in 1943 to about 3,600 acres in 1962, or about 530 percent. During this same period, the average annual direct runoff increased from about 920 acre-feet per year to about 3,400 acre-feet per year, or about 270 percent.

527
SUMMARY REPORT STORMS OF 1969,

Larry D. Simpson
Los Angeles County Flood Control District Summary Report, Jun 1969. 55 p, 30 photo, 1 plate, 3 tab.

Descriptors: *Floods, *California, *Flood control, *Reservoirs, Peak discharge, Storm runoff, Urbanization, Flood protection, Channel improvement, Flood damage, Streamflow, Rainfall-runoff relationships, Stage-discharge relations.
Identifiers: Los Angeles County, California.

Data on flood-producing storms of 1969 in Los Angeles County, California, are tabulated. During the months of January and February of 1969, storms occurred over the southern California area which were of such a magnitude

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as to tax the capacities of a number of the facilities of the district and to cause significant damage to public and private property in those areas where complete flood protection had not yet been attained. These storms began with a two-phase storm which occurred between January 18 and 26, 1969. The effects of these storms on the Los Angeles County Flood Control District and the communities within Los Angeles County are discussed.

528
EFFECT OF URBAN DEVELOPMENT ON FLOOD DISCHARGES-CURRENT KNOWLEDGE AND FUTURE NEEDS,

H. F. Smith
J Hydraulics Div, Am Soc Civil Engrs, Vol 95, No HY1, pp 287-309, Jan 1969. 23 p, 2 append.

Descriptors: *Bibliographies, *Urbanization, *Hydrology, Information retrieval, Discharge (water), Floods, Hydraulics, Runoff, Surface runoff, Streamflow.

This Progress Report by the Task Force on Effect of Urban Development on Flood Discharges, Committee on Flood Control, Hydraulics Division, ASCE attempts to provide, as a guide for engineers, planners, governmental officials, and all others interested in the problems of urban runoff, an annotated up-to-date bibliography of reports, papers, and other material pertaining to the effect of urban development on flood discharges. The report includes a brief discussion of the impact on flood runoff which can be expected by urban development and the factors directly affecting the runoff regimen of a drainage area, as suburbs and cities replace the rural landscape. Included is a listing of pertinent research projects which are underway with identification of areas where, in the opinion of the Task Force, additional research is required.

529
THE ROLE OF SOLID AND LIQUID PRECIPITATIONS IN RUNOFF FORMATION,

I. S. Sosedov
Tr Inst Gidrogeol Gidrofiziki (TIGDB), Vol. 2, p 101-109, 1969.

Descriptors: *Precipitation (atmospheric), *Rain, *Snow, *Runoff, Surface runoff, Erosion, Water supply, Water balance, Mathematical studies, Soil water, Rain gages, Snow cover, Snowmelt.
Identifiers: *USSR.

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Sources of surface runoff were investigated on the basis of a water balance equation in the Transilian Ala Tau region. Evaluation of the effects of altitude, snow cover, geographical location, vegetation, and slope orientation yields coefficients of runoff formed by solid (snow) and liquid (rain) precipitation.

530
SYNTHETIC HYDROGRAPHS: EFFECTS OF NETWORK GEOMETRY,

A. J. Surkan
Water Resources Res, Vol 5, No 1, pp 112-128, Feb 1969.

Descriptors: *Mathematical models, *Unit hydrograph, Simulation analysis, Storms.
Identifiers: *Storm analysis.

A mathematical model for channel networks (represented by directed graphs on a rectangular grid) is used to generate synthetic hydrographs. This makes possible the simulation of effects of changes in geometric factors specified by shape and connectivity, while keeping a fixed prescribed temporal and spatial precipitation pattern. Alternatively, this model may be used with fixed networks of interest to study the effects of different types and motions of storms. The model provides for a discrete approximation of the distributed network, and transformation relating a runoff hydrograph to input precipitation.

531
HIGH WATER RESPONSE PLAN FOR FLOOD CONTROL,

John Teipel
Public Works, Vol 100, No 7, pp 82-83, Jul 1969.

Descriptors: *Runoff, *Rainfall, *Planning, *Forecasting, *Operations, *Overflow.
Identifiers: *Storm sewers.

Dallas, Texas has instituted a high water response plan in order to cope with runoff from overloaded storm sewers and flash flooding from small creeks which cause problems during heavy rainfalls. Planned operations begin with initial forecasts of severe weather followed by mobilization of forces to serve areas called Phase Locations which are classified according to their particular difficulties. Phase I forces handle local downpour locations; Phase II forces handle major creek locations; and Phase III forces handle locations affected by river flooding, including

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operation of six flood control pump stations. Other actions taken to alleviate problems before, during, and after the storm are explained.

532
URBAN RUNOFF BY ROAD RESEARCH LABORATORY METHOD,

Michael L. Terstriep and John B. Stall
J Hydraulics Div, Am Soc Civil Engrs, Vol 95 No HY6, p 1809-1834, Nov 1969.

Descriptors: *Storm runoff, *Urbanization, *Mathematical models, Rainfall-runoff relationships, Roads, Model studies, Storm drains, Hydraulics, Hydrology, Sewers, Streamflow, Planning.
Identifiers: Urban hydrology.

A simple mathematical model of an urban basin presented in 1962 by the British Road Research Laboratory is tested on three urban watersheds in the United States. The basins are located in Baltimore, Md. and Chicago, and Campaign, Ill. They contain 0.395, 12.5, and 2290 acres respectively. The model produces a runoff hydrograph by applying rainfall to only the directly connected impervious area of the basin. The basin is described by a time-area diagram and a discharge-storage relationship. The peak discharges of actual and predicted hydrographs are shown for 8 of these. To apply the model to a basin, the pattern of impervious areas must be known in detail, as well as the slopes and sizes of all surface and subsurface drains.

533
AVAILABILITY OF RAINFALL-RUNOFF DATA FOR PARTLY SEWERED URBAN DRAINAGE CATCHMENTS,

L. S. Tucker
ASCE Technical Memorandum No 13, Urban Water Resources Research Program, Mar 1970. 156 p, 24 fig, 15 tab, 49 ref. append. OWRR Project C-1536 (No 1992) (3).

Descriptors: *Data collections, *Rainfall-runoff relationships, *Cities, *Storm runoff, *Stream gages, Sewers, Open channels, Urbanization, Hydrologic data, Runoff, Drainage systems, Storm drains.
Identifiers: Japan, Urban runoff.

Available rainfall-runoff data for partially sewered urban drainage catchments are identified to facilitate model development by researchers. Information on the availability of rainfall-runoff data from 64 developed partially sewered urban drainage catchments in U.S. and 8 in Japan is summarized. The 64 catchments in the U.S. are concentrated in 8 states,

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and the locations of these instrumented catchments are shown by a map. Rainfall-runoff data for most of the catchments are available from the agencies collecting the data. A summary of information on the 64 instrumented, highly-developed, partially sewered urban drainage catchments in the U.S. is presented. Additional details such as availability of data, how to obtain further information about catchments and data, gage locations, and maps of catchments are presented.

534
SEWERED DRAINAGE CATCHMENTS IN MAJOR CITIES,

L. S. Tucker
ASCE Urban Water Resources Res Program Tech Mem No 10, Mar 31, 1969.
71 p, 34 fig, 4 tab, 13 ref. USGS Contract No. 14-08-0001-11257.

Descriptors: *Cities, *Rainfall-runoff relationships, *Storm drains, *Sewers, Storm runoff, Drainage systems, Water quality control, Water pollution control.
Identifiers: Combined sewers.

The size distribution and number of sewered drainage catchments in San Francisco, Washington, D.C., Milwaukee, Houston, and Philadelphia are summarized to provide data for urban rainfall-runoff-water quality studies. The 4 cities are in 4 distinctly different regions of the US, and are different topographically. The sizes of all sewered drainage catchments are tabulated, maps show catchment boundaries, and supporting discussions are presented. Only the drainage catchments served entirely by storm or combined sewers are discussed, and partially sewered urban drainage catchments are omitted. The distribution of sewered drainage catchment size is unique for each city. The number of catchments varies from 42 in San Francisco to 1,283 in Houston. The largest catchment varies from 1,820 acres in Milwaukee to 6,180 acres in Washington, D.C. The average catchment size varies from 65 acres in Houston to 560 acres in San Francisco. The median catchment size varies from 6 acres in Houston, to 190 acres in San Francisco. In Washington, D.C., drainage catchments varying in size from 1 to 50 acres account for 46% of the total number of catchments varying in size from 1 to 50 acres account for 46% of the total number of catchments, but their cumulative area served by sewers. On the other hand, over 50% of the total District area served by sewers is accounted for by the 5 largest drainage catchments, which are only 5% of the total of 93 catchments.

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535
AVAILABILITY OF RAINFALL-RUNOFF DATA FOR SEWERED DRAINAGE CATCHMENTS,

L. S. Tucker
ASCE Urban Water Resources Res Program Tech Mem No 8, Mar 3, 1969. 43 p, 14 fig, 5 tab, 18 ref. USGS Contract No 14-08-0001-11257. OWRR Contract No 14-01-0001-1585.

Descriptors: *Data collections, *Gaging stations, *Cities, *Rainfall-runoff relationships, *Urbanization, Drainage systems, Runoff, Storm drains, Sewers, Storm runoff, Flow rates, United States.

Data on the availability of rainfall-runoff data from gaged, sewered urban catchments are compiled. Only 13 completely sewered catchments in the U. S. are gaged. Runoff is measured by flume in Northwood, Gray Haven, and Swansea, all in Baltimore, Md. Reduced data from 29 Gray Haven Storms are tabulated. The 13 catchments are summarized in a table giving name, size, data collected, type of flowmeter, type of storm sewer, data available, operator of the installation, location, and period of operation. Each installation and catchment is described in detail. Baltimore has 3 gaged catchments, Cincinnatti, Ohio has 1, St. Louis, Mo. has 3, Chicago, Ill. has 1, Philadelphia, Pa. has 1, New York City has 4, and Washington D.C. has 1.

536
OAKDALE GAGING INSTALLATION, CHICAGO-INSTRUMENTATION AND DATA,

L. S. Tucker
ASCE Tech Mem No 2, Urban Water Resources Res Program, Aug 15, 1968. 14 p, 8 fig, 2 tab, 2 append. OWRR: 14-01-0001-1585, USGS: 14-08-0001-11257.

Descriptors: *Data collections, *Storm runoff, *Rainfall, *Rainfall-runoff relationships, *Urbanization, Watersheds (basins), Stream gages, Flumes, Rain gages, Land use, Drainage, Discharge (water), Runoff, Hydrographs, Hyetographs, Sewers.
Identifiers: *Urban hydrology, Chicago, Illinois.

An instrumented 12.9 acre urban drainage area in Chicago, Illinois is described. Rainfall and runoff data for storms for which data are reliable are tabulated and presented. The area is 2 1/2 blocks by 1 block wide and consists entirely of detached family dwellings. The drainage system is a 30-in. combined sewer draining into a 10.5 ft square concrete trunk sewer. Runoff is measured by a parabolic flume in an underground vault. A tipping bucket rain gage is located about 1 block north of the drainage area. The rain and flume gages are

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connected to recorders by telephone lines. Rainfall and runoff records from storms are shown in tables, hyetographs, and hydrographs. Copies of some of the original recorder charts are included.

537
NORTHWOOD GAGING INSTALLATION, BALTIMORE-INSTRUMENTATION AND DATA,

L. S. Tucker
ASCE Tech Mem No 1, Urban Water Resources Res Program, Aug 1, 1968. 16 p, 11 fig, 2 tab, 3 append. OWRR: 14-01-0001-1585 and USGS-14-08-0001-11257.

Descriptors: *Rainfall-runoff relationships, *Data collections, *Storm runoff, *Urbanization, Watersheds (basins), Stream gages, Flumes, Rain gages, Land use, Discharge (water), Runoff, Hydrographs, Hyetographs, Evaporation, Rainfall.
Identifiers: *Urban hydrology, Baltimore, Maryland.

Detailed data of the hydrology of Northwood, a small urban drainage area in Baltimore, Maryland, are presented. Northwood is one of the few sewered catchments in the U.S. that is gaged with flumes. The 47.4 acre drainage area is about 4 mi north of downtown Baltimore in a residential suburban area. It contains a 17.4 acre shopping center and 30 acres of residential development. Buildings in the residential area are very uniformly grouped houses with 3-4 houses per group. The average imperviousness of the drainage area is 68%. Ground slopes average 3%. A weighing bucket rain gage and a Parshall flume were installed in 1959, and the rain gage was replaced with a tipping bucket gage in 1963. Both in the rain gage and stream gage have recorders. Runoff is estimated to be within 5% of actual flow 95% of the time for flume depths over 4 in. Reduced rainfall and runoff data for 14 storms, hourly precipitation, and daily pan evaporation data are tabulated. Hyetographs and hydrographs illustrate the rapid response of the drainage area.

538
BASIC DATA FOR URBAN HYDROLOGY STUDY, DALLAS, TEXAS - 1966,

Trigg Twitchell
Geol Surv Open-file Rep, 1966. 203 p, 3 fig, 1 tab.

Descriptors: *Rainfall-runoff relationships, *Urbanization, *Data collections, *Texas, Streamflow, Runoff, Hydrographs, Rainfall, Surface waters, Hydrologic data, Depth-area-duration analysis.
Identifiers: Dallas, Texas, Urban hydrology.

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Basic hydrologic data compiled for the study of urban hydrology in Dallas, Texas include data from raingages, stream gages, and flood-profile partial-record stations. Hydrographs and mass curves are given for major storms at each station.

539
USING RUNOFF EVENTS TO CALIBRATE SMALL FORESTED CATCHMENTS,

S. J. Ursic and T. W. Popham
In: 14th Congr Proc, Int Union Forest Res Organ, Vol 1, pp 319-324, 1967.

Descriptors: *Calibrations, *Rainfall-runoff relationships, *Storm runoff, Water measurement, Mathematical models, Watershed management, Hydrologic aspects, Mississippi.
Identifiers: *Experimental watersheds.

Calibration and analysis based on individual runoff events appear efficient for evaluating changes in the hydrologic performance of small paired catchments. The approach is particularly useful where effects of watershed treatment on changes in ephemeral flow phenomena are of primary concern.

540
EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,

Donald VanSickle
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium

No 2, p 229-254, October 1968. University of Texas Press, Austin and London, 1969. 26 p, 17 fig, 4 tab, 17 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Unit hydrograph, *Synthetic hydrology, Rational formula, Storm runoff, Peak discharge, Floods, Hydrograph analysis, Routing.
Identifiers: Houston, Texas, Urban hydrology.

An example is given of the adaptation of preliminary research data to the development of new drainage design criteria for a major metropolitan area. The new criteria should be closer to the actual needs than the old rational method criteria. The Houston metropolitan area, one of the most rapidly urbanizing areas in the United States, was used to establish and test new urban runoff criteria. In order to apply urbanization factor data to design, the following procedures are followed: (1) develop the mean basin length and mean basin slope values from topographic maps; (2) estimate the degree of development anticipated in the watershed for

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the period of design; (3) estimate drainage density for each of the areas of use; (4) multiply the drainage density by the area for each type of land use to get total channel length; (5) determine the basin factor; (6) from the curves, determine the time to peak and the unit hydrograph peak for the degree of development involved; and (7) develop the unit hydrograph. A simpler way to use the criteria is to develop them as empirical curves of drainage area versus discharge, of specific use only in the urban area and for the storm frequencies for which they are designed. Synthetic unit hydrographs were prepared and tested for about 50 drainage areas in the Houston areas.

541
URBAN STORM RUNOFF RELATIONS,

Warren Viessman, Jr., Walter R. Keating, and Kalkunte N. Srinivasa
Water Resources Res, Vol 6, No 1, pp 275-279, Feb 1970. 1 diag, 2 graphs, 1 tab, 7 ref.

Descriptors: *Storm runoff, *Model studies, *Data collections, Rainfall-runoff relationships.
Identifiers: *Urban hydrology, *Comparative analysis, *Baltimore, Maryland.

A model incorporating the hydrologic and hydraulic phases of stormwater flows to estimate the runoff from a 23-acre residential area has prediction errors that are generally less than 10% when the peak flow is used as the criterion for comparison. The data for this study were derived from rainfall and runoff records of the Gray Haven drainage area in Baltimore, Maryland.

542
ESTIMATING THE GROUND-WATER CONTRIBUTION TO STORM RUNOFF BY THE ELECTRICAL CONDUCTANCE METHOD,

Adrian P. Visocky
Ground Water, Vol 8, No 2, pp 5-10, Mar-Apr 1970. 7 fig, 12 ref.

Descriptors: *Storm runoff, *Base flow, *Monitoring, *Water quality, Leaching, Infiltration, Rainfall-runoff relationships, Surface-groundwater relationships, Hydrographs, Peak discharge.

The feasibility of determining the groundwater contribution to stream flow during periods of storm runoff by continuous monitoring of a stream's electrical conductance was investigated. The groundwater contribution can be estimated if stream flow and the conductance of surface water and of groundwater are known. The conductance method was tested on

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a 95-square-mile basin in north-central Illinois. Continuous records of stream flow, stream-flow conductance, and groundwater stage within the basin were collected. A rating curve of base flow versus mean groundwater stage was constructed, and groundwater discharges determined from the rating curve were compared with those computed from conductance data. The conductance method normally gave a lower estimate of the groundwater contribution than did the rating-curve method. However, analyses of storms which were preceded by extended dry periods resulted in much lower estimates of groundwater discharge by the rating-curve method than by the conductance method. The conductance method offers a simple alternative for use in areas where observation wells are unavailable or where rating curves are difficult to construct.

543
URBAN EFFECTS ON WATER YIELD,

Arvi O. Waananen
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, p 169-182, Oct 1968. University of Texas Press, Austin and London, 1969. 14 p, 7 fig, 2 tab, 16 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Storm runoff, *Water supply, Land use, Water yield, Hydrology, Hydrographs, Peak discharge, Hydrograph analysis, Meteorology, Sewers, Storm drains, Sewage disposal, Waste disposal.
Identifiers: Urban hydrology.

Urban development has a significant impact on hydrologic relations. The results of various studies demonstrate the type and magnitude of many of the effects on yield. These may be summarized as including: (1) increase in total yield from stormflow and in annual discharge; (2) decrease in base flow of those streams that remain under generally natural conditions; (3) modification of low flow of streams influenced by the importation of water, the use of which results in discharge of wastewater. This includes the increase of low flow in streams that receive septic-tank drainage, or effluents from sewage-treatment plants, or from industrial plants; (4) decrease in recharge to the underlying ground-water basins; and (5) increase in precipitation in urban areas and corresponding increase in yield. The principal effect of urban development on yield is an increase in direct runoff. The cumulative effect of increase in stormflow from urban areas, particularly in regions of strip cities and the megalopolitan complexes developing in several areas, may be substantial on downstream receiving channels.

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544
LOS ANGELES COUNTY FLOOD CONTROL SYSTEM AND THE EARLY 1969 STORMS,

Walter J. Wood
Civil Eng, Vol 40, No 1, pp 58-61, Jan 1970.

Descriptors: *Rainfall-runoff relationships, *Urbanization, *Overflow.
Identifiers: *Los Angeles, Flood control.

The Los Angeles flood control system, comprised of 19 dams, 72 debris basins, 390 miles of channels, and 1200 miles of storm drains, faired well during the floods of January and February 1969. Although the rainfall intensities did not equal that from the storm of 1938, the high runoff is attributed to the urbanization of the affected area and to the quicker delivery of valley flows by the network of storm drains and collector channels. The storm experience reaffirmed the adequacy of the general design of the system. The effective handling methods of dams, debris basins, and channels in relation to runoff are discussed.

545
A LABORATORY STUDY OF SURFACE RUNOFF DUE TO MOVING RAINSTORMS,

Ben Chie Yen and Ven Te Chow
Water Resources Res, Vol 5, No 5, p 989-1006, Oct 1969. 18 p, 7 fig, 13 ref. NSF Grant GK-1155.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Rainfall disposition, Hydrographs, Hydrograph analysis, Distribution patterns, Mathematical models.

The movement of a rainstorm determines the spatial and temporal distributions of the rainfall over a watershed and hence affects the characteristics of the flow on the watershed. In this study the importance of the movement of rainstorms on the time distribution of the surface runoff from watersheds is demonstrated through the use of a laboratory watershed experimentational system. Experiments were performed on the impervious square watershed for 2 rainfall intensities, 4 surface slopes, and 14 rainstorm velocities. Analysis of the mechanics of water flowing on watersheds is attempted to explain the influence of movement of rainstorms on the characteristics of surface runoff hydrographs.

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THE HYDROGEOLOGIST'S RESPONSIBILITY-METROPOLITAN WATER RESOURCE PLANNING,

Arthur J. Zeizel

Trans Am Geophys Union, Vol 49, No 3, pp 543-547, Sep 1968. 2 ref.

Descriptors: *Urbanization, *Water resources development, Planning, *Water management (applied).
Identifiers: *Urban hydrology.

As the population of the United States is changing from a predominantly rural to urban society, so the traditional role of the hydrogeologist is changing. Needs for this services are reflecting the requirements of comprehensive water resources management programs. This trend toward urbanization is also creating complex water problems and related land problems. Comprehensive water resources planning offers a means of solving these problems and improving the living environment. Its emphasis is on alternative management measures that can best be planned and evaluated by interdisciplinary study teams, teams that should include the hydrogeologist. Urban drainage management programs need additional supporting research in urban hydrology, and the hydrogeologist can contribute broadly in planning these research and management activities, particularly for projects in stormwater storage, infiltration, and reuse. Hydrogeologists can also assist in solving engineering problems encountered during construction of dams, tunnels, reservoirs, lakes, and canals. The inadequate communication that now exists between the hydrogeologist and the planner can be improved by a closer working relationship.

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Section 10

TUNNELS: TECHNOLOGY AND EQUIPMENT

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547
CHICAGO SANITARY DISTRICT IN NEW POLLUTION FIGHT,

Civil Eng, Vol 37, No 10, p 98, Oct 1967.

Descriptors: *Tunnel construction, *Storm runoff, *Sewage, *Tunnels.
Identifiers: *Chicago, Illinois.

As part of Metropolitan Chicago's ten-year program to combat water pollution, a deep tunnel sewage plant is being proposed for completion by 1972 to store excess floodwaters from severe rainstorms in underground chambers. Stormwater runoff will be prevented from entering sanitary sewers, and the water will later be released under controlled conditions. The estimated cost of the deep tunnel project is $750 million, which is much less than the $3-billion it would cost to construct separate storm and sanitary sewage systems. Other proposed programs include chlorination of all facilities by 1968, elimination of visible solids by 1969, and construction of a tertiary waste-treatment plant in Hanover, Ill. by 1971.

548
BREAKTHROUGH ON SECOND MERSEY ROAD TUNNEL AS WORK COMMENCES ON DUPLICATE,

Civil Eng Public Works Rev, Vol 65, No 765, p 378, Apr 1970.

Descriptors: *Tunneling, *Tunneling machines, *Tunnel linings, *Linings, *Concretes, *Steel, *Epoxy resins, Construction equipment.
Identifiers: *Great Britain, *Mole, *Mini Mole.

A mole tunneling machine was used to excavate through sandstone rock between Liverpool and Birkenhead. The tunnel was lined with a segmented type of lining made up of reinforced concrete acting compositely with an inner steel skin. It was then covered with a high-build epoxy protective coating. A duplication of the tunnel is to be built for which a Mini Mole has been desinged for driving a 2,202- yard pilot tunnel. A description of the Mini Mole is given.

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549
STANDARD EQUIPMENT, MODIFIED TECHNIQUES DRILL HOLES IN ROCK,

Construct Methods Equip, Vol 52, No 3, pp 100-101, Mar 1970. 4 fig.

Descriptors: *Rock excavation, *Drilling equipment, *Pipelines, *Tunnels, Tunnel construction.
Identifiers: *Sanitary sewers, *Skokie, Illinois.

Kenny Construction Co. in Skokie, Illinois undertook the horizontal boring of over 500 feet of major-size holes through tough rock. The tunnels will carry fire lines, pipelines for petroleum products, and sanitary sewers. The job was completed successfully with conventional overburden drilling machines. Special effort and skill was used in applying and maintaining cutting heads, keeping the bore aligned, and strengthening an auger to carry cuttings back to an ejector.

550
EXCAVATOR OPENS BORE WITH CLEAN SWEEP FORE AND AFT,

Construct Methods Equip, Vol 50, No 10, pp 64-65, 67-68, Oct 1969. 2 fig.

Descriptors: *Drilling, *Tunnels, *Tunnel construction, Control systems, Hydraulic equipment, Tunnel linings, Concrete construction, Tunneling machines.
Identifiers: *Sewer tunnel, *Akron, Ohio.

Drilling and shooting operations drove a tunnel borer through sandstone while an hydraulic-excavator worked in the earth section of sand, clay, and gravel to complete a sewer tunnel in Akron, Ohio. The excavator had a boom-mounted blade dig and then sweep muck to a conveyor that dumped into a skip on rails. Hydraulic jacks thrust the excavator forward and steered it laterally and vertically. Laser beam sightings kept the machine on course. Techniques used to bore the tunnel are described in detail. Once the tunnel was driven, sewer pipe was pulled in and laid on a poured concrete cradle. Concrete was then pumped down shafts into the space between the pipe and tunnel lining.

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551
JACKS SAVE DAY FOR TEXAS TUNNELER,

Construct Methods Equip, Vol 51, No 9, pp 90-93, Sep 1969. 7 fig.

Descriptors: *Tunneling, *Tunnel construction, *Tunneling machines.
Identifiers: *Pipe jacking, *Reaming auger, Houston, Texas.

To tunnel and line three oversized utility conduits under a Houston street, the subcontractor resorted to pipe-jacking instead of machine-tunneling when crews were unable to hold the boring rig on the center-line. The subcontractor planned to use a rig that was custom-built for a Dallas storm-drain project. With the addition of a shield over the auger, the job was attempted in Houston's soft earth. After the centering trouble stopped work, the remaining tunnels were completed by mining with pneumatic shovels and jacking the liners into place with the subcontractor's designed equipment.

552
PIPELAYER MINIMIZES TRENCHING AND BACKFILLING,

Construct Methods Equip, Vol 51, No 8, pp 42-45, Aug 1969.

Descriptors: *Tunneling, *Tunnel construction, *Tunneling machines, *Installation, Pipelines.
Identifiers: *Badger Minor, *Tugmaster, *Galveston, Texas.

The first domestic water system for the Gulf Coast resort area near Galveston is being installed with two trenchless pipelaying methods known as the "pull through" and the "slow in" techniques. Basically, both involve tunneling through the ground and pulling long strings of pipe through the bore with very little disturbance of the ground at the surface. The principal pieces of equipment used on this job are the Badger Minor and the Tugmaster. The functions of these pieces are described and the two methods of pipe installation are explained.

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553
THE ART OF TUNNELING,

Construct Methods Equip, Vol 51, No 7, pp 143-146, Jul 1969. 1 fig.

Descriptors: *Tunneling.
Identifiers: *Mechanical tunneling, *Tunneling techniques, *Tunneling analysis.

Present and future demands for tunneling are enormous, especially for construction of rail lines, highways, sewers, and water-lines. These demands require that costs be cut and processes speeded up. Mechanical tunneling seems to answer these needs, but problems with it remain to be solved. Mechanical moles do not run at the high speed desired, and hard rock often resists machines' efforts. Other problems cited include: inadequate muck-handling systems, a need for development of geological techniques to provide tunnelers with better information as to what is lying ahead, a need for better rock-mechanics techniques for measuring subsurface stresses around boreholes and tunnels, and improvement in methods for supporting tunnels and shafts against cave-ins. The following new techniques for tunneling are discussed: use of surface-active chemical agents or lasers to weaken the rock face, electron beams for cutting rock, pulsed supersonic water jets from an air-powered cannon, and electrohydarulics--a method of converting electrical energy into mechanical energy.

554
PRODUCTION UP, COST DOWN,

Construct Methods Equip, Vol 51, No 5, pp 54-58, May 1969. 8 fig.

Descriptors: *Sewers, *Installation, Control systems, Comparative costs, Concrete pipes.
Identifiers: *Chicago, *Mole.

A mechanical mole is breaking the way for the placement and jacking of a two-mile sewer project in the Metropolitan Sanitary District of Greater Chicago (MSD). Long jacking distances are achieved by overmining a few inches and using bentonite slurry as a pipe lubricant. Part of the good production rate can be attributed to installation of track for mucking equipment inside the pipe before it is lowered through access shafts to crews below. Workings of the mole and jack are explained. An electric-gas laser provides accurate control for rapid mining and jacking operation, as its beam is sloped to follow the required grade. The laser also aligns the pipe vertically and horizontally. District engineers com-

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pared costs of installing the 5½-foot precast-concrete pipe using the jacking method against the cost of installing the 5½-foot monolithic concrete sewer in a tunnel using conventional methods of machine mining, and the jacking method was found to be less expensive.

555
SEWER MOLE TRIMS COST OF TUNNEL RIBS AND CONCRETE,

Construct Methods Equip, Vol 48, No 5, pp 93-95, May 1966.

Descriptors: *Tunneling, *Tunneling machines, *Investigations, *Tunnel construction.
Identifiers: *Sewer tunnel, St. Louis, Missouri.

In a comparative study between the mechanical tunneling method and the drill-and-shoot method, five distinct advantages in mechanical boring were reported by Victor J. Scaravilli, a contractor on a St. Louis sewer tunnel. A description of the 23,000-foot sewer tunnel which the S&M Constructors of Cleveland are boring for the Metropolitan St. Louis Sewer District is included.

556
PAVED WAY FOR TRANSCONA'S LONG HOLE,

Eng Contract Record, Vol 82, No 10, pp 58-60, Oct 1969. 1 diag.

Descriptors: *Sewers, *Tunnels, *Tunneling, *Tunnel design, Planning, Construction.
Identifiers: *Storm sewer, Canada.

BACM Industries Ltd. in Winnipeg built the largest and longest sewer tunnel ever contracted in Manitoba. This storm relief project is described in a brochure they mailed to all residents in the area. The basic construction plan involved the sinking of 10 shafts to a depth of 34 feet at regular intervals, the sewer being tunnelled outward from each shaft and connected to form one long tunnel. The soft-mining method was employed, and no problems were encountered except for the high water table created during spring because of flooding conditions above ground. This was overcome by boxing off the area and using sump pumps to divert the water until workers were finished in that area. Tunneling procedures used are discussed, including the open cut method employed for a portion of the storm relief sewer.

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557
JET, MOLE TEAM SEEKS TUNNELING BREAKTHROUGH,

Eng News-Record, Vol 184, No 4, p 48, Jan 22, 1970.

Descriptors: *Tunneling machines, *Construction equipment.
Identifiers: *Mole.

A mole that uses high velocity jets of water to cut rock has been produced. The machines are pulsed devices in which gas, after being compressed in a cylinder, is suddenly released to act as a piston. The piston drives against water in a pressure head to force it out through a nozzle in a jet. Two versions of this tunneling device are examined.

558
LASER STEERS BIG MOLE IN BAD ROCK UNDER LAKE,

Eng News-Record, Vol 184, No 2, pp 26-28, Jan 8, 1970. 1 diag.

Descriptors: *Tunneling, *Tunneling machines, *Tunnels, *Control systems.
Identifiers: *Mole, *Laser beam control, *Lake Huron.

A mole tunneling machine, the biggest and most sophisticated ever built by Lawrence Manufacturing Company, is rapidly boring a six-mile tunnel out under Lake Huron for water conveyance to Detroit. Dimensions and operating techniques for the mole are described. Called an Alkirk Hard Rock Tunneler, the rig is unusual because of the 24-in.-dia. pilot bit and anchor jutting out of its main cutterhead which mounts carbide cutters. Laser guiding of the mole is used; in effect, the laser beam controls the machine. Should something interrupt the beam, or the laser itself fail to function, four potentiometers act as a holding mechanism that maintains the mole on the last recorded position for fifteen minutes. Completion of the tunnel is expected to be by 1971, but ground conditions and legal entanglements have placed the project behind schedule. It is hoped that the mole will improve this situation.

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559
THOMPSON RIVER MOLE BORE IS THE LONGEST IN HARD ROCK,

Eng News-Record, Vol 183, No 5, p 18, Jul 31, 1969.

Descriptors: *Tunneling, *Tunneling machines, *Tunnel design, *Construction equipment, *Tunnels.
Identifiers: *Mole, *Australia.

A 12-mile tunnel, which will divert water from the Thompson River through 3,600-ft. Mount Gregory to the Yarra River, is a 24 million dollar project. The project has three stages: 1) excavation of the Thompson and Yarra adits (totaling 3,260 feet); 2) excavation of the 1,390 foot Easton adit, and a 2.9 mile section of the main tunnel between the Easton and Thompson adits; and, 3) boring of the 9.1 mile main tunnel using the mole.

560
MOLE BREAKS THROUGH AFTER 293-FT. DAY AND 1,114-FT WEEK,

Eng News-Record, Vol 183, No 4, pp 28-29, Jul 24, 1969.

Descriptors: *Bids, *Tunnel construction, *Tunneling machines, Tunnel design, Cost comparisons.
Identifiers: *Mole.

The Utah Construction and Mining Co.'s mole boring machine, called Jarva Mark 11-1200, averaged 109 feet per day at an estimated $15/ft. cutter cost. Remarks made by the project manager which encompass the operation of the mole and the construction design, are included. A cost comparison of the different contract bids is given.

561
PIPES JACKED BEHIND MINI-MOLE,

Eng News-Record, Vol 182, No 20, pp 45-46, May 15, 1969.

Descriptors: *Sewers, *Cost comparisons, *Tunneling machines, *Tunneling.
Identifiers: *Mini Mole, *Chicago, *Mole.

A mining machine, which jacks concrete pipe sections immediately behind it, is being used to build a sewer in suburban Chicago. The technique, commonly used to avoid cut-and-cover construction across highways and

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railroads, entails building a two mile sanitary sewer under a $2.9 million contract. The procedure involved is explained, and a cost comparison study of mining and jacking the 66-inch diameter pipe into place, with a 78-inch-ID reinforced concrete sewer using conventional methods of machine mining, ribs, lagging and monolithically placed concrete, is given.

562
MOLE MAKES MONKEY OF MOUNTAIN,

Eng News-Record, Vol 181, No 50, p 19, Dec 12, 1968.

Descriptors: *Nevada, *Drilling, *Tunneling machines, *Construction equipment.
Identifiers: *Mole.

A mole machine, working in everchanging igneous formations that range in compressive strength from 1500 to 1700 psi, is driving a tunnel through a Nevada mountain. Called the Jarva Mark 11/14, the unit develops 866,000 lb. of thrust, and has an adjustable cutterhead that will handle tunnels from 11 to 14 feet in diameter.

563
PIPELAYER PLOWS SEWER IN QUICKLY,

Eng News-Record, Vol 181, No 5, p 44, Aug 1, 1968.

Descriptors: *Tunneling machines, *Tunnel construction, Tunneling.
Identifiers: *Great Britain.

A British company has applied the principle of the cablelaying plow to place pipes, and claims to have halved the cost of a sewer project in northeast England. The track-mounted machine, called a Badger Major, forces a passage through the ground without removing any soil. Then plastic pipe is snaked through the tunnel, which has a wall surface free of sharp stones that might damage the pipe. A hydraulic winch, guided by an infrared beam emitted from a portable transmitter mounted atop of the winch, hauls the plow forward. The rig will work in all types of ground except rock.

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564
MOLE BORES AT 16 FEET PER HOUR,

Eng News-Record, Vol 179, No 42, p 29, Oct 19, 1967.

Descriptors: *Drilling, *Drilling equipment, *Tunnel construction.
Identifiers: *Mole, West Germany.

A mechanical mole excavating under West Germany's Swabian Jura range has a cutting head made up of four rotating steel-toothed cutting wheels mounted on a rotating base. On the vertical axis, the operator of the mole steers by raising or lowering the cutting head; and horizontally, the mole is steered with the aid of small crawler tracks. A laser control system keeps the mole on course.

565
DEEP TUNNEL STORAGE MAY SOLVE CITY STORM WATER PROBLEM,

Environ Sci Technol, Vol 3, No 3, pp 209-211, Mar 1969.

Descriptors: *Storm runoff, *Pollution abatement, *Sewage treatment, *Runoff, *Cost comparisons, *Cost analysis, *Water quality, Overflow, Biochemical oxygen demand.
Identifiers: *Deep tunnel plan, *Chicago, Combined sewers.

The Metropolitan Sanitary District of Greater Chicago (MSD) has a plan devised for the control of pollution from storm and combined sewer water runoff -- the Chicagoland Deep Tunnel Project. This plan would: capture flow from a 300 square-mile section; cost approximately $1.02 billion ($.02 billion more than the present sewage treatment facilities' cost); and, almost completely remove BOD from the stormwater runoff at ¼ the cost of available alternatives. The Harza Engineering Co. and Bauer Engineering Inc. are the two consulting firms working on the project which may develop into a $2.2 billion water quality program. Comments by Vinton Bacon, general manager of the sanitary district, are made on the urgency of the project, the necessary reasons for the project, and the benefits from the project. A cost list is given as well as a short description of the tunnel system layout.

566
MODERN TUNNELING METHODS USED ON BOLTON SEWER,

Surveyor, Vol 85, No 4049, p 38, Jan 16, 1970. 1 fig.

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Descriptors: *Tunneling, *Sewers, *Tunnel construction, *Tunnel design, *Tunneling machines.
Identifiers: *Great Britain.

Fifteen years ago, a Radcliff sewer connection by tunnel was more expensive than a riverside route on the surface. However, developments in tunneling made it possible for a tunnel route to provide savings over the sewer's probable life. So, a ¾-mile long sewage tunnel was constructed. Blasting was used for the greater part of the length, and excavated materials were removed by means of an electrically-driven small gauge railway. Instead of employing compressed air for shaft sinking, a recently developed boring technique was used. The method is fully described along with other construction and installation procedures.

567
METRO TORONTO TO START $22 MILLION SEWER PROJECT,

Water Pollution Control, Vol 108, No 3, p 38, Mar 1970.

Descriptors: *Design, *Tunnel construction, *Tunnel linings, *Urbanization, Contracts.
Identifiers: *Interceptor sewer, *Storm sewers, *Canada.

McNally Construction was recently awarded a $5 million contract for the first phase of work on a 10-foot diameter mid-Toronto storm sewer interceptor. $22 million is the estimated cost of the 8.5 mile project which consists of a 100-foot below surface tunnel. Concrete will be used for tunnel lining and can be poured at any time except when boring under the Don River when it must be poured immediately to prevent cave-ins. A pumping station will be rebuild to connect the low and high level interceptors to the project interceptor, thus relieving pressure on the two older storm sewers.

568
MOLE SETS FAST PACE IN NEVADA ROCK,

Western Construct, Vol 43, No 12, pp 38-39 and 52, Dec 1968.

Descriptors: *Mechanical equipment, *Nevada.
Identifiers: Mole.

The rotary mining machine, driving the River Mountains' Tunnel of the Southern Nevada Water Project, is advancing 200 feet per day through barrier mountains bounding Lake Mead. The Jarva mole, which is 12 feet in diameter and has a cutting head with 26 hardened steel disk cutting

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wheels and 1 center and 4 tri-cone gage cutters of carbide steel, is used to drill through the rock. The business end of the mole is held in place during operation by four hydraulic feet behind the cutting collar.

569
THE IMPACT OF THE DEEP TUNNEL PLAN ON THE WATER RESOURCES OF NORTHEAST ILLINOIS,
Harza Engineering Co and Bauer Engineering, Inc.

Rep to Chicago Metrop Sanit Dist, Feb 1969. 20 p, 6 fig, 1 append.

Descriptors: *Water pollution control, *Storm runoff, *Tunnels, *Hydrologic aspects, Storm drains, Pumped storage, Groundwater, Aquifers, Illinois, Cities, Urbanization.
Identifiers: *Chicago, Deep tunnel plan, Combined sewers.

The possible effects of the proposed Chicago deep tunnel urban runoff retention scheme on the water resources of northeastern Illinois were estimated by surveying the hydrogeology, surface water hydrology, and groundwater development of the area. Chicago has a combined sewer system, and storm runoff overloads cause discharge of raw sewage to waterways including recreational areas of Lake Michigan. A system of deep tunnels and protective recharge wells is proposed for temporary storage of peak combined loads. The system is expected to release treated storm runoff at a steady rate, greatly regulating the streamflow of receiving streams. High groundwater heads must be maintained to prevent loss of contaminated water from the tunnels, requiring good groundwater management practices for the entire area.

570
CHICAGOLAND DEEP TUNNEL SYSTEM FOR POLLUTION AND FLOOD CONTROL: FIRST CONSTRUCTION ZONE, DEFINITE PROJECT REPORT,
Harza Engineering Co and Bauer Engineering Inc, May 1968.

Work performed for Metropolitan Sanitary District of Greater Chicago. 199 p, 10 map, 15 dwg, 26 tab, 14 chart.

Descriptors: *Multiple-purpose projects, *Pollution abatement, *Flood control, Overflow, Pumped storage, Operations, Sewerage, Water quality, Reservoir operation, Water treatment, Costs, Financing.
Identifiers: *Deep tunnel plan, *Calumet Area, Illinois, *Chicago, Illinois, Storm overflows.

The deep tunnel system is a multipurpose project to capture polluted storm overflows, treat them, and gradually return them to the waterways. The system, when not in use, pumps water to generate power. Chapter

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one briefly describes the program for the entire Chicago area. Selection of the Calumet area as the first construction zone is justified. The investigations program for the zone is described. Chapter Two gives the general concept of the plan, summarily describes project features, and discusses operation of the entire system. Chapter Three discusses existing waterflows. It examines the service area, waterways, the existing combined sewer system, flooding problems, hydrological aspects of combined sewer overflows, and quality of overflows. Chapter Four through Eight discusses project features at length; chapter Four covering the interception and conveyance structures; Five, the mined storage reservoir; Six, the pumping-generating station; Seven, the surface reservoir and regulating facilities; and Eight, water treatment facilities and processes. Chapter Nine discusses overall system operation. Chapter Ten defines alternatives and provisions for expansion. Chapter Eleven outlines project implementation and cost estimates. The last two chapters summarize and justify the project, and discuss its financing.

571
UNDERFLOW PLAN FOR POLLUTION AND FLOOD CONTROL IN THE CHICAGO METROPOLITAN AREA,
Depart of Public Works, City of Chicago, Metro Sanit District of Greater Chicago, and Depart of Public Works and Buildings, State of Illinois.

In: Combined Sewer Overflow Abatement Technology. Water Pollution Control Research Series, Report 11024--06/70, pp 139-218, Jun 1970. 20 fig, 9 tab, 8 ref.

Descriptors: *Project planning, *Overflow, *Waste water treatment, *Tunnels, Water pollution control, Flood control, Storm runoff, Sewers, Cost analysis.
Identifiers: *Chicago, Combined sewers.

The spillages of polluted water from combined sewers in time of storms has been the subject of this report. Three separate schemes have been described for solving these flooding and pollution problems in the Chicago area, namely: Underflow Storage Plan, the Deep Tunnel Plan, and the Chicago Drainage Plan. A complete description of the Underflow-Storage Plan has been presented which will reduce the spillage of pollutants to the surface waterways by over 98.5% and provide the necessary flood control to handle the 100-year frequency storm. Recommendation for the starting of the First Phase of this plan is emphasized, and the estimated costs involved are given.

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572
COMBINED UNDERFLOW-STORAGE PLAN FOR POLLUTION AND FLOOD CONTROL IN THE CHICAGO METROPOLITAN AREA,
Depart of Public Works, Chicago, Ill. Bureau of Eng

City of Chicago Dep Public Works, Bur Eng Rep, Sep 1969. 43 p, 13 exhibit, 6 tab.

Descriptors: *Storm runoff, *Waste water treatment, *Water pollution control, *Tunnels, *Illinois, Urbanization, Sewers, Sewage treatment, Drainage systems, Storm drains, Cost analysis.
Identifiers: Combined sewers, Chicago.

The basic concept of the Chicago Underflow-Storage Plan for Pollution and Flood Control is the use of a pattern of underground tunnels. These tunnels would be sized to provide a linear distribution of storage volume, and a conveyance capacity in a single pattern of cleansable tunnels without the necessity for supplemental storage or power development. All water remaining in the underground tunnels after each storm period will be pumped directly to the existing treatment works. The underflow-conveyance capacity takes advantage of the lowered water levels to be established in the Illinois Waterway at Lockport for flood control and improved navigation. The basic features of the Underflow-Storage Plan include: (1) 18,000 acre-feet of underground storage; (2) a combined outflow capacity by underflow and overflow of about 43,000 cfs; (3) sufficient underground storage for any storm having a frequency of recurrence up to 100 years. The total capital cost of the proposed Combined Underflow-Storage Plan is estimated to be $650,000,000.

573
FLOOD AND POLLUTION CONTROL: A DEEP TUNNEL PLAN FOR THE CHICAGOLAND AREA,
Metropolitan Sanitary District of Greater Chicago, Ill.

Prefeasibility Report, May 1966. 61 p, 11 map, 5 tab, 7 append.

Descriptors: *Flood control, *Pollution abatement, *Underground storage, *Cost comparisons, *Estimated costs, Design criteria, Sewers, Drains, Reservoirs, Feasibility studies, Overflow, Project planning, Comparative benefits, Estimated benefits, Pumped storage.
Identifiers: *Deep tunnel plan, *Chicago.

The prefeasibility report reviews six alternative underground storage plans and recommends a comprehensive deep tunnel plan. Engineering design criteria for the plan are considered, which include lateral sewers, new main sewers, vertical drains, an underground reservoir, pumped-storage power, a surface reservoir, and pollution treatment. The costs

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of underground excavation, of plan components, and of contingency and overhead are given. Comparative flood control benefits are discussed in terms of basement flooding, flooding of industrial areas, land enhancement, and flood reduction on the waterway system. Alternative costs are given. The report gives comparative costs for two methods of storing and treating combined overflows. Possibilities of a better scheme of separating storm and sanitary sewers must be investigated. Potential benefits and costs of tertiary and space treatment require further investigation. Appendices discuss extensively hydrology, geology, water quality, aquifer protection, power, costs, and benefits.

574
CHICAGO TUNNEL DRAINAGE PROJECT: PRELIMINARY EVALUATION OF FEASIBILITY, Metro politan Sanitary District of Greater Chicago, Ill.

Preliminary Study, May 1964. 33 p, 5 map, 9 tab, 3 chart.

Descriptors: *Project planning, *Drainage programs, *Underground storage, *Flood protection, Sewerage, Storage capacity, Construction, Reservoirs, Construction costs, Annual costs, Financing, Pollution abatement, Sediment control.
Identifiers: *Chicago, Illinois.

Approximately a third of the preliminary study describes the project plan, another third economics, and the final third problems for investigation. It recommends that an underground storage system, combined with storage in a higher level sewer system, be designed for the Chicago flood of record. Capacities, types, and construction of proposed storage structures are discussed. The pumped storage facilities of the project would release water to the lower reservoir during peak power load periods and pump it back to the upper reservoir during off-peak hours. Layout, storage capacity, and alternative locations are discussed.

575
DEVELOPMENT OF TUNNELING METHODS AND CONTROLS FOR WATER RESOURCE PROJECTS,

Ellis L. Armstrong
Paper presented at the ASCE—Water Resources Eng Conf, Feb 1969.

Descriptors: *Tunnel construction, *Tunneling, *Tunneling machines, Tunnel failure, Tunnel linings, Tunnels, Cost comparisons, Laser, Cost trends, Rock bolts.
Identifiers: Tunnel supports, Blasting.

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Improvements in equipment and methods during the past 15 yr have kept tunnel excavation costs from appreciable increases while the general construction cost index has doubled. Tunnel drilling rates have increased to about 300 ft/wk today. The concept of boring machines to drill tunnels has made the greatest advance in the last 5 years. A table lists the major completed mole tunneling projects. Cost savings up to 40% over conventional drill-shoot-muck cycle methods can be proven. The requirement for and types of tunnel supports being used are discussed. Improvements and advances are expected in tunnel linings because the excavation rate has surpassed the lining rate. A laser beam is an excellent control method for precision drilling with a boring machine. Tunneling safety has progressed to a satisfactory level.

576
STORM DRAINAGE ASPECTS OF THE DEEP TUNNEL PLAN,

W. J. Bauer
Proc AISI Seminar, Ill Inst Technol, Oct 8, 1968. 29 p, 10 fig, 5 tab.

Descriptors: *Water pollution control, *Storm runoff, *Pumped storage, *Tunnels, *Illinois, Hydroelectric power, Costs, Cost-benefit analysis, Storm drains.
Identifiers: *Chicago.

The proposed Chicago deep tunnel plan would provide temporary storage of storm runoff from combined sewers to allow steady low-volume treatment and prevent discharge of raw sewage to surface waters. The total cost is estimated to be 242-446 million dollars. Operating costs are expected to be very low because the facility will be large enough to use profitably as a peak-demand pumped storage hydroelectric plants. Storm runoff will be only a small part of the total movement of water. The design and cost analysis of the project are described briefly.

577
RECENT TUNNEL EXCAVATION WITH BORING MACHINES,

D. E. Cannon
Civil Eng, Vol 37, No 8, pp 45-48, Aug 1967. 3 tab.

Descriptors: *Tunneling machines, *Drilling, *Routing, *Rock excavation, *Tunneling.
Identifiers: *Mole, *Machine comparison.

Mole boring machines are making tunnel excavation records on the U.S. Bureau of Reclamation's San-Chama Project for additional water supply

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routes to Rocky Mountain cities of north central New Mexico. A series of three tunnels are required for this project. Geology reports indicated that the rock to be encountered--shale and sandstone--could be economically excavated by a mole. Drilling was performed from the surface along the tunnel alignments at roughly one mile intervals. A main concern was whether igneous dikes or sills existed at tunnel elevation which might preclude using a boring machine. Results of the exploration program were encouraging and did not indicate presence of igneous intrusions. Advantages cited of boring machines over conventional tunneling methods include: higher excavation rate, reduction in concrete needs, fewer personnel requirements, safer operations, reduction in required supports and in clean-up time. Disadvantages of mole boring include: high initial investment; long delivery period; restriction to softer rocks; and the requirement for a well maintained ventilation system, an accurate guidance system, and expert surveying technicians.

578
'MOLE' KEEPS TRAFFIC ON THE MOVE,

Don Carter
Public Works, Vol 101, No 2, pp 82-83, Feb 1970.

Descriptors: *Drainage, *Storm runoff, *Tunneling machines, Tunnel construction, Repairing.
Identifiers: *Tulsa, Oklahoma, *Mole, Storm sewers, Laser beam control.

The first application of large bore horizontal drilling in Oklahoma occurred in Tulsa to alleviate the storm sewer complex by tunneling a drain which will carry off the water from accumulated storm runoffs. The problems encountered such as breakdowns, cave-ins, and ventilation are discussed. The laser beams and targets used to set vertical and horizontal guides, and grade alignment are mentioned as the most unique parts of the machine.

579
TUNNELING SOLVES TOUGH SEWER - CONSTRUCTION PROBLEM,

T. W. Clapham
Am City, Vol 85, No 2, pp 105-114, Feb 1970.

Descriptors: *Sewers, *Tunneling, *Tunnel construction, Tunnel linings.
Identifiers: *Interceptor sewer, *Little Rock, Arkansas.

The encasement tunneling technique was employed when constructing a major section of a ten-mile sanitary interceptor sewer in Little Rock, Arkansas. The tunnel, totalling 1,776 feet in length, is discussed in relation to

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its sectional variations in length, diameter, and depth. Round-shaped, corrugated steel plates with flanges along two sides, permitting them to be bolted together from the inside to form adjacent rings, were used for building the encasement. After each tunnel was complete the concrete sewer pipe was installed.

580
MECHANIZATION OF UNDERGROUND DRAINAGE WORK,

J. Dunglas
Houille Blanch (HOBLAB), Vol 23, No 6, pp 529-538, 1968.

Descriptors: *Equipment, *Mole drainage, *Piping systems (mechanical).
Identifiers: *Deep drainage.

The advantages of mechanized pipe-laying equipment for deep drainage systems are reviewed and technical features of trenching machines with optical depth-setting and built-in pipe laying systems are described. The adaptation of drainage system design to allow for use of mole-plow type machines is examined.

581
WHAT'S AHEAD FOR TUNNELING MACHINES,

George Hill
J Construct Div, Am Soc Civil Engrs, Vol 94, No CO2, pp 211-231, Oct 1968. 7 graphs, 4 tab, 2 diag.

Descriptors: *Tunneling, *Tunneling machines, *Tunnels, *Data Collections, *Construction, *Drilling, Cost analysis.
Identifiers: *Tunnel use, Tunnel forecasting.

Ten years of tunnel construction data from 1955 to 1965 are reviewed to establish particular characteristics of the past-tunneling market. These characteristics include: (1) total footage of tunnel construction completed each year; (2) a breakdown of these tunnels according to use (water transportation, vehicle tunnels, railroad and subway tunnels and mining tunnels); and, (3) a profile of the 1955-1965 history of tunneling activity and growth rates which were used in conjunction with expert opinions and announced future tunneling expectations to develop a forecast of 3,000 miles of worldwide-tunneling activity from 1966 to 1976. To estimate the impact of tunneling machines on the total market, a detailed cost analysis is outlined for Drill and Blast versus Mechanical Boring. The economic comparison showed tunneling machines to be an effective economic alternative in a significant por-

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tion of the future tunneling. It is estimated that tunneling machines will complete 1,000 miles of the total 3,000 miles forecasted between 1966 and 1976.

582
THE DEEP TUNNEL PLAN FOR THE BOSTON AREA,

David R. Horsefield
J Boston Soc Civil Engrs, Vol 55, No 4, pp 231-252, Oct 1968.
2 tab, 2 graphs, 2 maps, 29 ref.

Descriptors: *Storm runoff, *Overflow, *Water pollution sources, *Discharge (water), Surface runoff, *Water analysis, *Statistics, *Water quality, *Standards, Cost comparisons, *Tunnel design, *Costs, *Tunnel construction, *Sewers, *Massachusetts, Rainfall intensity, Pollution abatement.
Identifiers: *Combined sewers, *Deept tunnel plan, *Boston.

The Boston drainage system is discussed. The inadequacies of the combined sewer system are explored and it is concluded that the overflow of mixed sewage and stormwater from combined sewers into the waters of Boston Harbor and adjacent waters constitutes a serious hazard to public health. The deep tunnel plan is compared in regards to cost analysis with other pollution control methods. As a solution to the combined sewer problem, the deep tunnel plan will be employed so as to eliminate pollution from waters of the Boston area and to provide a more healthful environment.

583
HYDRAULIC DESIGN OF UNLINED ROCK TUNNELS,

Carl J. Huval
J Hydraulics Div, Am Soc Civil Engrs, Vol 95, No HY4, p 1235-1246, Jul 1969. 12 p, 5 fig, 2 tab, 24 ref, 2 append.

Descriptors: *Tunnel hydraulics, *Tunnels, *Hydraulic design, *Tunnel design, Hydraulics, Mannings equation, Roughness coefficient, Hydraulic structures. Overexcavation, Diversion structures, Hydroelectric power, Water tunnels (conveyance), Water tunnels (testing), Bibliographies, Rocks.
Identifiers: *Unlined tunnels.

Many unlined rock tunnels have been built for flood flow diversion and for hydropower tunnels where the rock is of sound quality and not greatly jointed and fractured. The number of unlined rock tunnels will increase in the years ahead because new methods of drilling, blasting, and muck removal have been developed and improved to make tunnel construction more

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economical. Methods of tunnel stabilization, such as grouting and use of rock bolts, have been improved so that many kinds of rock and difficult driving conditions can be handled more flexibly. Savings of unlined rock tunnels in time and cost of construction have been demonstrated by the ready acceptance of this type of tunnel in Sweden, Norway, Australia, and the United States. Unlined rock tunnel resistance coefficients can be predicted by using a rock overbreak parameter. The important considerations entering into design of unlined rock tunnels are summarized. The present method of predicting hydraulic resistance is inadequate. A study of tunnel rock overbreak experience leads to a relation between rock overbreak and tunnel size. This measure of rock overbreak provides a simple correlation of flow resistance test results based on the fully rough flow equation.

584
THE CHICAGO AREA DEEP TUNNEL PROJECT-A USE OF THE UNDERGROUND STORAGE RESOURCE,

V. A. Koelzer, W. J. Bauer, and F. E. Dalton.
J Water Pollution Control Fed, Vol 41, No 4, pp 515-534, Apr 1969.
20 p, 17 fig, 1 tab.

Descriptors: *Water pollution control, *Storm drains, *Underground storage, *Illinois, Water pollution sources, Municipal wastes, Industrial wastes, Sewage, Sewage treatment, Sewage disposal, Subsurface drainage.
Identifiers: Chicago.

The Greater Chicago area is plagued with recurring water pollution and flood problems stemming from 3 sources--industry, wastewater treatment plant effluent, and combined storm and sanitary sewer overflows. A solution to all three sources is the Deep Tunnel Project. It will capture stormwater overflows from combined sewers, dropping them through vertical shafts to a tunnel network. The polluted water will be conveyed for temporary storage in a large mined underground reservoir 800 ft. (242 m) below the surface. Preliminary design studies including project features, feasibility, costs, performance, and benefits, as well as operation, are discussed. Tunneling methods are included.

585
MOLE ANCHORS IN PILOT HOLE AND PULLS ITSELF AHEAD,

Michael Kolbenschlag
Construct Methods Equip, Vol 52, No 4, pp 87-88, 90-91, 94-95, Apr 1970. 5 fig.

Descriptors: *Tunneling machines, *Drilling, *Tunnels, *Drill holes.
Identifiers: *Mole, *Mole structure, Laser beam.

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Instead of advancing by having the cutterhead jacked against the face, as most tunneling machines do, a Detroit hydraulic rig used a reverse technique. This mole drilled a pilot hole in the center of the face, locked in place an anchor concentric with the pilot-drill stem, and then pulled itself forward hydraulically against resistance of the anchor. The main cutterhead and pilot drill advanced simultaneously. Water and fault zones complicated early stages of work on the water tunnel, but the contractor hoped to make up time with the new method. Complete descriptions are given of the structure of the machine, mucking operations, laser guidance, and the mole's power source.

586
SUCCESSFUL OPERATION OF THE HABEGGER TUNNEL-BORING MACHINE IN HARD ROCK,

E. Lauber and H.W. Brodbeck
Schweiz Bauz (SWBAAJ), Vol 86, No 51, p 917-924, Dec, 1968. Transl from Ger Bur Reclam Transl 812, Apr 1969. 21 p, 14 fig, 2 tab.

Descriptors: *Tunneling machines, *Tunneling, *Tunnel construction, *Boring machines, Tunnels, Engineering geology, Rock excavation, Rocks, Foreign construction, Pressure tunnels.
Identifiers: Switzerland.

The Habegger hard-rock tunneling machine was used in boring the high-pressure water tunnel for the Julinwerk Tiefencastel Project, Switzerland. Experiences in tunneling, machine operation, and rock cutting are discussed. Improvements in designing cutters and developing cooled cutters are described. The machine steering system and a helium laser directional guide held horizontal and vertical deviations within 4 cm over 800 m. A scraper conveyor system was modified to successfully leave a clean floor while working in groundwater. Comparing mechanical with conventional tunneling indicated that rock excavation costs are approximately equal. Problems of what is hard rock in regard to tunneling machines, rock properties for evaluation of rock cutting, and wear of cutters are covered.

587
HYDRAULIC DESIGN OF SELF-CLEANING SEWAGE TUNNELS,

D.K. Lysne
J Sanit Eng Div, Am Soc Civil Engrs, Vol 95, No SA1, pp 17-36, 1969.

Descriptors: *Tunnels, *Tunnel design, Tunnel hydraulics.
Identifiers: *Tunnel cleaning method.

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When planning sewerage facilities for large areas, there is now a tendency to use tunnels in place of trunk sewers, making it feasible to transport sewage over longer distances. The author describes a method for the hydraulic design of such tunnels, designed to be self-cleaning; and he gives design graphs for convenience. It is pointed out, however, that the self-cleaning feature does not necessarily determine the optimal tunnel area. Economic considerations may be the determining factor in regard to the self-cleaning feature, particularly for larger tunnels.

588
LASER BEAM ON MOLE SPEEDS SEWER WORK,

Alex Mair
Eng Contract Record, Vol 83, No 2, pp 44-45, Feb 1970.

Descriptors: *Instrumentation, *Tunneling machines, Tunneling, Operations.
Identifiers: *Mole, *Laser beam control.

A tunnel in Edmonton is being produced at an average of 120 ft/day. A tunnel mole and the use of a laser beam have hastened the procedure. The practical limit on the distance the beam can travel depends on two things: changes in direction of the line, and the amount of dust and fog in the air in the tunnel. The mole consists of a set of rotating arms with cutting teeth and a bucket wheel for catching the loosened material. The workings of the tunnel operation are given.

589
GROUNDWATER STUDIES--CHICAGOLAND DEEP TUNNEL SYSTEM.

I.S. Papadopulos, William R. Larsen, and Forest C. Neil.
Ground Water, Vol 7, No 5, p 3-15, Sep-Oct 1969. 13 p, 16 fig, 4 tab, 10 ref.

Descriptors: *Hydrogeology, *Storm runoff, *Cities, *Illinois, Waste water treatment, Waste water disposal, Groundwater, Water levels, Seepage, Discharge (water), Hydrologic data, Aquifers, Pumped storage, Analog models.
Identifiers: *Chicago, Deep tunnel plan.

The Deep Tunnel System planned by the Metropolitan Sanitary District of Greater Chicago will provide flood and pollution control for the combined sewer areas of the Chicago region. Elements of the Deep Tunnel System that are of main concern to the groundwater resources

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of the area are: the conveyance tunnels; and the mined storage reservoir, which will convey and store polluted stormwater overflows. The Silurian and the Cambrian-Ordovician aquifers, in units of which these elements will be located, will be protected from any deleterious effects of the System by ensuring that a positive hydraulic head, causing an inward flow, is continuously maintained around the tunnels and the mined reservoir. In the Cambrian-Ordovician aquifer, this necessitates that groundwater levels are maintained by artificial recharge. Extensive groundwater studies were conducted to (1) demonstrate the feasibility of aquifer protection by recharge, (2) determine the needed amounts of recharge water, and (3) estimate the seepage of groundwater into the tunnels and mined reservoir. The studies included field investigations, analog computer analyses and office evaluation of the collected data and analog results. The results indicated (1) the proposed aquifer protection is feasible, (2) the recharge requirements will vary from 1.4 mgd in 1976 to 6.0 mgd in 2010, and (3) seepage into the tunnels will be small, in amounts that can be easily controlled.

590
INVESTIGATION PROGRAM FOR AQUIFER PROTECTION REQUIREMENTS, CHICAGOLAND DEEP TUNNEL PLAN,

I.S. Papadopulos and R.E. Aten
Ground Water, Vol 6, No 3, pp 4-9, May-Jun 1968.

Descriptors: *Tunnel design, *Investigations, *Storage, Overflow, Testing.
Identifiers: *Chicago, Illinois.

This plan envisions temporary storage of combined sewer overflows in a systems of tunnels excavated in solid rock, deep under the City. After the end of a storm, stored water would be pumped to the surface where it would be treated to remove pollution before being discharged into waterways. Preliminary investigations indicated that aquifer protection can be provided by a system of recharge wells. Further detailed studies, now in progress, include detailed exploratory drilling, controlled aquifer tests in selected zones, pumping tests for specific capacity in a zone to be tunneled, recharge injection tests, and analog model analysis.

591
SHAFT BUILDERS MATCH METHODS WITH MACHINES,

Gerald Parkinson
Construct Methods Equip, Vol 51, No 4, pp 72-73, 76-77, 80-81, Apr 1969. 11 fig.

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Descriptors: *Installation, *Sewers, *Storm drains, *Tunneling, *Shafts (excavation), *Slurries, Concrete construction.
Identifiers: *Mole, *Mexico.

In Mexico City, an area that once engulfed a lake and inherited the problems of building on unstable ground, contractors worked to install a new system of sewers and storm drains. To prepare for three big moles that performed the tunneling, deep access shafts were sunk into the ground that varies from jelly-like volcanic ash to solid rock. Most of the contractors adopted variations of the slurry-trench system to construct concrete walls for the access shafts. One company used a method called "controlled flotation," by which the shaft is formed and concreted in a series of steps--all performed at ground level, and then it is sunk toward its final position as wall sections are added on top. This method is described in detail as are variations used in the slurry-displacement method. Several solutions to groundwater problems are outlined.

592
BUILDING FOR THE FUTURE--THE BOSTON DEEP-TUNNEL PLAN,

C.A. Parthum
J Water Pollution Control Fed, Vol 42, No 4, pp 500-510, Apr 1970.
2 tab, 2 graphs, 1 diag.

Descriptors: *Overflow, *Storm runoff, *Tunnels, *Sewage disposal, *Sewers, *Underground storage, Sewage, Separation techniques, Chlorination.
Identifiers: *Deep tunnel plan, *Boston, Combined sewers, Holding tanks.

A deep tunnel storage plan has been proposed to prevent pollution due to discharge of wastewater overflows and mixed wastewater and stormwater from the combined sewers of Boston and adjacent municipalities. Other methods such as complete sewer separation, chlorination tanks, and holding tanks were considered, but the deep tunnel system appeared most economical. Construction costs were estimated at $66 million. The proposed system consists of 17.2 miles (27 km) of 33-ft (10-m) diam deep tunnels in a radial pattern, a pumping capacity of 2,400 cfs (4,100 cu m/min), and a 45,000-ft (13,700-m) ocean outfall with diffusers. The system is designed to handle runoff from the 15-year-frequency storm of 24-hour duration within 2 days, without surcharging, and the maximum recorded storm for Boston if surcharging is permitted.

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593
HYDRAULIC PROPERTIES OF SMALL UNLINED ROCK TUNNELS,

Seppo Priha
J Hydraulics Div, Am Soc Civil Eng, Vol 95, No HY4, p 1181-1209, Jul, 1969. 29 p, 27 fig, 9 tab, 10 ref, 2 append.

Descriptors: *Water tunnels (conveyance), *Tunnel hydraulics, *Tunnels, *Roughness (hydraulic), *Hydraulic properties, Model tests, Pressure tunnels, Hydraulic models.
Identifiers: *Unlined tunnels, Finland.

Factors influencing hydraulic characteristics of small unlined tunnel cross sections are presented. Investigations were performed in rock tunnels constructed by the Helsinki City Waterworks for conveying raw water. The length of the Silvola Reservoir entrance tunnel is 1.8 km; the theoretical cross section is 4:5 sq m. The length of the Silvola-Vanhakaupunki raw water tunnel is 7.6 km; the theoretical cross section is 6 sq. m. Vertical shafts divided both tunnels into 3 parts, in all of which cross-sectional measurements and pressure loss measurements for different discharges were accomplished using measuring weirs and Siemens Venturi meters. All 3 tunnels were excavated by the so-called Swedish method in the most usual type of rock in Finland, composed mostly of granite and gneiss.

594
HYDRAULIC PROPERTIES OF SMALL UNLINED ROCK TUNNELS,

David Ellis Wright (Discussion)
J Hydraulics Div. Am Soc Civil Engrs, Vol 96, No HY4, pp 1047-1050, Apr 1970. 3 ref.

Descriptors: *Rock properties, *Hydraulic properties.
Identifiers: Unlined tunnels.

The writer congratulates Seppo Priha, the original author, for presenting further data on the hydraulic resistance of unlined rock tunnels. He also asks several questions in order to clarify certain facts relating to the original article. Next he discusses various assumptions and derivations in the original such as: (1) the effect of section spacing on the variation of areas; (2) the variation of overbreak with tunnel size; (3) the relation between the resistance coefficient and the variation of area; and (4) the effect of lining slabs on resistance.

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595
HYDRAULIC DESIGN OF UNLINED ROCK TUNNELS,

Skrikrishna V. Chitale, K.S. Rajagopalan, and David Ellis Wright (Discussion)
J Hydraulics Div, Am Soc Civil Engrs, Vol 96, No HY4, pp 1060-1065, Apr 1970. 1 fig, 3 ref.

Descriptors: *Rock properties, Hydraulic design, Roughness (hydraulic).
Identifiers: *Unlined tunnels.

S.V. Chitale and K.S. Rajagopalan comment on Figures 2 and 3 of the original article. Fig. 2 shows a plot of resistance coefficients for unlined rock tunnels, and considerable scatter of data is apparent. The authors list reasons for this scatter. Fig. 3 gives tunnel overbreak for various tunnel sizes. The authors note the difficulty involved in using this figure to estimate overbreak depth because of the presence of considerable scatter, and they suggest a way to improve this situation. David Ellis Wright notes that progress will be made in designing unlined rock tunnels only if a critical comparison is made of results on prototype tunnels. He lists requirements to be satisfied in order that these results be of wider design use. He also defines terms such as tunnel size, overbreak, relative roughness, and equivalent sand grain diameter, which he uses in his commentary on the original paper. His comments include opinions on the resistance equation, the relation between resistance and roughness, partly-lined conduits, and data in Table 2 of the original paper.

596
STABILITY OF TUNNELS UNDER ROCK LOAD,

L.V. Rabcewict
Water Power, Vol 21, No 6, 7, 8, p 225-229, 266-273, 297-302, Jun, Jul, Aug, 1969. 19 p, 41 fig, 22 ref.

Descriptors: *Tunnel construction, *Tunneling, *Tunnel linings, Tunnel failure, Tunnel design, Theoretical analysis, Bibliographies, Model studies, Tunnels, Structural design, Stability.
Identifiers: *Austrian Tunneling Method, *Tunnel supports, Austria.

The salient feature of the New Austrian Tunneling Method is a semi-rigid lining applied to the rock before it is damaged by loosening. The lining, designed to reach permanent equilibrium after adjusting to rearrangement forces, may be any material or combinations of materials suited to the purpose. Tunnels should be driven full face where possible in a minimum of time. Practical experience and

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theoretical investigations have proved that by using the method, rock surrounding a cavity can be transformed into an effective carrying member. Failure by shear is the only mode of collapse of a tunnel lining when the lining extends around the entire periphery of the tunnel section. Principles for designing linings based on failure by shear are explained and proved by model tests. Some theoretical analyses of the strength of linings and anchors are presented and a design method based on data collected on shear failure is discussed. The effect of contact between lining and rock on tunnel behavior is examined. A type of strengthening consists of system anchoring combined with shotcrete, taking advantage of the property of rock to stabilize by yielding, is described. A tunnel and an underground powerhouse constructed in accordance with the New Austrian Tunneling Method are described.

597
A FLOODED TUNNEL INTERCEPTOR SYSTEM FOR THE METROPOLITAN ST. LOUIS SEWER DISTRICT,

W.G. Shifrin, G.K. Hasegawa, and V.C. Lischer, Jr.
J Water Pollution Control Fed, Vol 39, No 3, pp 313-333, Mar 1967.
2 tab, 3 maps, 5 diag, 1 graph, 3 ref.

Descriptors: *Tunnel construction, *Drilling equipment, *Tunneling, *Sewers, Drilling, Operations, Design.
Identifiers: *St. Louis, Missouri, *Interceptor sewer, Combined sewers.

Preliminary studies showed that a flooded tunnel interceptor system would be the most advantageous type for an area of St. Louis, Missouri.

Interceptors were designed to carry ultimate peak dry-weather flows only, since the city has many combined sewers. The interceptors will exclude backwater from the Mississippi River at low to moderately high river stages. A boring machine was used for parts of the tunneling during construction. Operation of the system will depend on river stage, rainfall, and the operation of an interconnected flood protection system. Drawdown of the wet well at the terminal pumping station will be necessary periodically to promote cleansing of the tunnels. The system is furnished with telemetering devices and central controls.

598
AUGER TEAMS WITH SHIELD TO CUT MIXED TUNNEL FACE,

Lorraine Smith
Construct Methods Equip, Vol 52, No 1, pp 104-106, Jan 1970.

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Descriptors: *Tunneling, *Tunneling machines, *Tunnel construction.
Identifiers: *Reaming auger, *Pipe jacking.

A tunneling rig, which more than tripled production of similar equipment through rock when first used on a storm drain in 1968, has been specially built to bore through white limestone known as "Austin chalk". A special reaming auger and shield to allow the rig to work through a combination of soft limestone and crumbling clay was designed by Joe B. Byrd, of the Boring & Tunneling Co. of America, Inc. A detailed analysis of the boring by the rig followed by the jacking of concrete pipes is given.

599
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,

Harry Sutcliffe and Cole R. McClure
Civil Eng, Vol 39, No 11, p 51-55, Nov 1969. 5 p, 3 fig, 3 photo.

Descriptors: *Tunnel linings, *Pumped concrete, *Tunnel construction, Construction, Tunneling, Aggregates, Underground structures, Durability, Concretes.
Identifiers: *Tunnel supports.

A growing need for underground construction exists in transportation, pumped storage, pollution control, and defense works. The rate of growth of tunnel construction is limited only by the higher cost when compared to above-ground construction. A substantial portion of the cost of underground work is in the support and lining of the excavation, and making this area more economical is important. Any acceleration of the rate that support or lining can be placed permits the use of faster tunneling machines and reduces costs. Gunite, a pneumatically applied cement mortar used in canal linings, has been used with wire-mesh reinforcement in tunnels to prevent slaking and spalling of the ground, with good durability and resistance to abuse. The spraying of large-aggregate concrete was only mildly successful until European research with chemical accelerators provided a means of controlling the rate of strength buildup of the sprayed material. Use of accelerators started the changes in application practices and furthered the acceptance of shotcrete in underground work. First used in combination with steel ribs and wire mesh shotcrete is used more frequently unreinforced.

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JOURNAL LIST

Abbreviation	Full Title
1. Abwass	1. Abwasser
2. Am City	2. The American City
3. Appl Microbiol	3. Applied Microbiology
4. Australian Civil Eng	4. Australian Civil Engineering
5. Bell System Tech J	5. Bell System Technical Journal
6. Ber Abwassertech Ver	6. Berichte der Abwassertechnischen Vereiningung
7. Civil Eng	7. Civil Engineering
8. Civil Eng Public Works Rev	8. Civil Engineering and Public Works Review
9. Construct Methods Equip	9. Construction Methods and Equipment
10. Consulting Engr	10. Consulting Engineer
11. Effluent Water Treat J	11. Effluent and Water Treatment Journal
12. Eng Contract Record	12. Engineering and Contract Record
13. Eng J	13. Engineering Journal
14. Eng News-Record	14. Engineering News-Record
15. Environ Sci Technol	15. Environmental Science and Technology
16. Gas Wasserfach	16. Gas- und Wasserfach
17. Gesundh Ingr	17. Gesundheits Ingenieur
18. Giorn Genio Civile	18. Giornale del Genio Civile
19. Ground Water	19. Ground Water
20. Houille Blanch	20. Houille Blanche
21. Ind Water Eng	21. Industrial Water Engineering
22. Inst Civil Engrs (London)	22. Institution of Civil Engineers (London)
23. Inst Engrs (Australia)	23. Institution of Engineers (Australia)
24. Inst Public Health Engrs	24. Institution of Public Health Engineers
25. Inst Sewage Purification, J Proc	25. Institution of Sewage Purification, Journal and Proceedings
26. J Am Water Works Assoc	26. Journal of the American Water Works Association
27. J Appl Meteorol	27. Journal of Applied Meteorology
28. J Boston Soc Civil Engrs	28. Journal of the Boston Society of Civil Engineers
29. J. Construct Div, Am Soc Civil Engrs	29. Journal of the Construction Division, American Society of Civil Engineers
30. J Forest	30. Journal of Forestry

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31. J Geophys Res	31. Journal of Geophysical Research
32. J Hydraulics Div, Am Soc Civil Engrs	32. Journal of the Hydraulics Division, American Society of Civil Engineers
33. J Hydrol	33. Journal of Hydrology
34. J Inst Munic Engrs	34. Journal of the Institute of Municipal Engineers
35. J Irrigation Drainage Div, Am Soc Civil Engrs	35. Journal of the Irrigation and Drainage Division, American Society of Civil Engineers
36. J New England Water Works Assoc	36. Journal of the New England Water Works Association
37. J Sanit Eng Div, Am Soc Civil Engrs	37. Journal of the Sanitary Engineering Division, American Society of Civil Engineers
38. J Soil Water Conserv	38. Journal of Soil and Water Conservation
39. J Urban Planning Develop Div, Am Soc Civil Engrs	39. Journal of the Urban Planning and Development Division, American Society of Civil Engineers
40. J Water Pollution Control Fed	40. Journal of the Water Pollution Control Federation
41. J Water Works Assoc	41. Journal of the Water Works Association
42. Abwass	42. Abwasser
43. Kunststoffe - Plastics	43. Kunststoffe - Plastics
44. Meteorol Mag	44. Meteorological Magazine
45. Military Engr	45. Military Engineer
46. Mod Power Eng	46. Modern Power and Engineering
47. Munic Eng (London)	47. Municipal Engineering (London)
48. Oesterr Abwasser - Rundschau	48. Oesterreichische Abwasser - Rundschau
49. Oesterr Wasserwirtsch	49. Oesterreichische Wasserwirtschaft
50. Pipes Pipelines Intern	50. Pipes and Pipelines International
51. Rozpr Hydrotech, Polska Akad Nauk	51. Rozprawy Hydrotechniczne, Polska Akademia Nauk
52. Public Works	52. Public Works
53. Roads Road Construct	53. Roads and Road Construction
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ABSTRACTS: A compilation of abstracts summarizing articles from a variety of technical publications constituting the problem of urban drainage was developed by the Franklin Institute Research Laboratories. The present work includes 599 abstracts of documents published for the most part from July 1968 through June 1970. The abstracts are classed in ten sub-topic categories and arranged alphabetically by author and numerically by abstract number within each category. Each item includes a bibliographic citation, an abstract, and a set of indexing descriptors and identifiers. A cumulative subject index at the end of the volume provides the necessary access to individual concepts. An author index and journal list are also included. This work was submitted in fulfillment of Contract 14-12-904 between the Federal Water Quality Administration and the Franklin Institute Research Laboratories.

KEY WORDS

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Urbanization
Drainage systems
Overflow
Rainfall-runoff relationships
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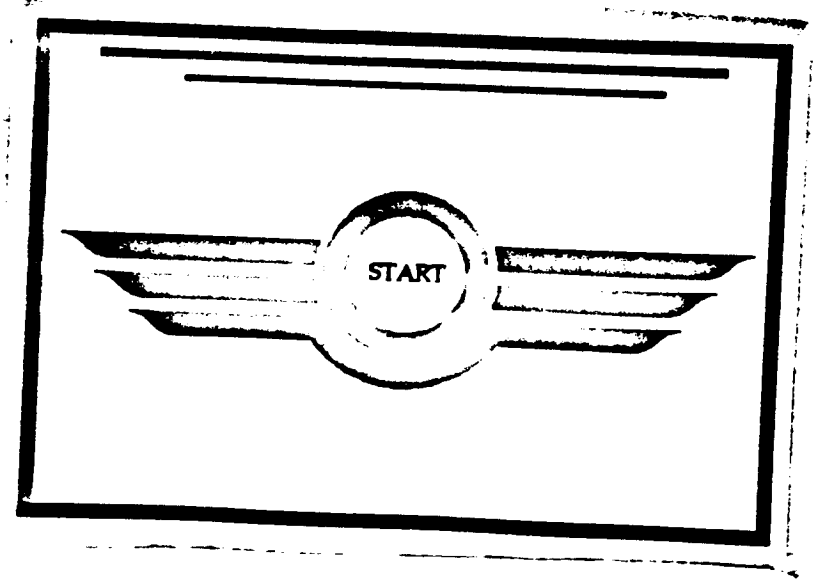

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URBANIZATION AND WATER QUALITY

VOL 12

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March 1994

A Guide to Protecting the Urban Environment

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Foreword

Despite the gains achieved by Clean Water Act requirements and the installation of municipal sewage treatment systems in most communities, water pollution still remains a problem. Although industries and municipal treatment systems continue to affect water quality, states estimate that nonpoint source pollution causes one- to two-thirds of the impairment or threats to waterbodies.

Nonpoint source pollution results from land runoff, precipitation, atmospheric deposition, drainage, seepage, and hydrologic modifications. In urban areas nonpoint source pollution is created when sediment, toxic substances, nutrients, pathogens, and even garbage wash off fields, lawns, and impervious surfaces into our nation's waterbodies.

This guide is intended to help decisionmakers, such as local government officials and planners, understand the causes of nonpoint source pollution and design and implement a program to control this pollution. The guide provides a framework for developing a nonpoint source program tailored to an individual community. It includes examples of successful runoff management programs that illustrate the variety of strategies state and local governments have adopted.

Technical guidance and expertise, however, are essential components in this process. *Urbanization and Water Quality* lists a number of sources for such expertise: publications, contacts, and summaries of several federal programs mandated by the Clean Water Act and Coastal Zone Management Act. Applied within the community's structure, this information can help improve and protect the quality of nearby waterbodies.

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Chapter 1

How Urban Runoff Affects Your Community: The Problem

The thirsty earth soaks up the rain,
And drinks, and gapes for drink again.
Abraham Cowley (1618-1667)

While centuries of poets have praised the virtuous qualities of rain, urban decisionmakers are forced to face the harsh reality — rain and its close relative, snow, are the major carriers of nonpoint source pollution. Such pollution occurs in developed areas when water runs off the land and streets — gathering pollutants in its path and depositing them in nearby waterbodies.

Urban runoff carries pollutants from many sources and activities — automobiles, oil and salt on roads, atmospheric deposition, processing and salvage facilities, chemical spills, pet wastes, industrial plants, construction site erosion, and the disposal of chemicals used in homes and offices. In fact, pollutant levels in urban waterbodies are generally much greater than in forested watersheds.

Runoff water quality worsens as urbanization increases:

- Trees that once intercepted rainfall are gone.
- Natural dips or depressions that had formed temporary ponds for rainwater storage are lost by grading and filling for development.
- Thick, absorbent layers of natural vegetation and soils are replaced by paved (impervious) surfaces such as roads and roofs.
- Eroded paths such as streambanks become channels, increasing the amount of sediment carried by runoff.

As asphalt and concrete replace vegetation, runoff increases and reaches waterbodies faster and with greater force. And when the land loses its capacity to absorb and store rainwater, the groundwater table drops and stream flows decrease during dry weather.

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The Symptoms

Local governments must be alert to the obvious symptoms of water pollution. They include

- scum and algal mats floating near lake shores,
- excessive plant growth choking waters used by boaters and swimmers,
- sediment-clogged drainage ditches and sewers,
- decreasing depth of a lake,
- fewer fish and wildlife,
- contaminated water supply for drinking, recreation, or industry,
- fish kills that may destroy sport fisheries or close beaches,
- fish advisories caused by bacteria or toxic substances found in fish, and
- extreme flooding or streambank erosion.

The Sources

Pollution from urban runoff can affect water in various ways, depending on the pollutant. The impacts and sources of pollutants have been researched by many organizations, including the Metropolitan Washington Council of Governments, from which much of this information was extracted (see Table 1).

■ **Sediment.** Sediment — organic and inorganic material suspended and settling in water — clogs storm drains; fills river channels, lakes, wetlands, and reservoirs; and increases the potential for flooding downstream. Sediment may fill in water supply reservoirs, eventually requiring costly dredging or new water sources.

These suspended solids make the water appear muddy, decreasing its value for fishing and recreation. As sediment settles to the bottom, phytoplankton, fish, and invertebrates have difficulty feeding and reproducing. Other aquatic life may be smothered or deprived of essential sunlight. Sediment can also carry other materials — such as nutrients, pesticides, and trace metals — that can harm both aquatic life and human health.

Sediment and erosion are at their peak when the soil is disturbed along with the vegetation that stabilizes it. And once sediment enters a stream, it can take many years to travel through the waterway. As silt, clay, and sand move downstream, they erode the streambank, affecting fish and wildlife habitat along the way.

■ **Nutrients.** Nutrients — excessive levels of phosphorus and nitrogen — pose a severe problem as urban development intensifies. Nutrients encourage undesirable algal blooms and excessive aquatic weed growth. This nutrient-rich process, called eutrophication, greatly decreases the water's quality.

In lakes, for example, decomposing plants can cause surface scums and unpleasant odors, discolor water, and decrease oxygen. This breakdown limits swimming, boating, fishing, and other recreational uses; reduces fish and wildlife habitat; and contaminates water supplies. The water-holding capacity of lakes and reservoirs may also decrease.

Urban runoff carries nutrients from roads, sidewalks, and parking lots, and from lawns, golf courses, parks, cemeteries, homes, and commercial sites. In some areas, improperly maintained household septic systems add to the problem.

■ **Bacteria.** Urban runoff often contains high levels of harmful bacteria and viral strains, including fecal streptococcus and fecal coliform from human and animal wastes. When these levels exceed public health standards, as they often do, water is unsafe to drink, beaches are closed, and harvesting shellfish beds is restricted.

Older, more intensively developed areas produce the most bacteria from organic wastes and sanitary sewer overflows. In addition, pet and bird wastes increase the nutrient and bacteria content of runoff.

■ **Oil and grease.** Oil, grease, and other petroleum-based substances contain hydrocarbons, some of which are harmful to sensitive animal species and aquatic life. Hydrocarbons attracted to sediment settle in the bottom of waterbodies, where they may harm bottom-dwelling organisms and be transferred through the food chain.

Hydrocarbons also degrade fisheries habitats and damage the appearance of the water's surface. They lower dissolved oxygen by limiting the interaction of water and air. Oil and grease problems are highest in the runoff from parking lots, roads, and service stations. Oil held in the soil can eventually seep through to the groundwater and be carried to the streams.

■ **Heavy metals.** Heavy metals — including lead, copper, cadmium, zinc, mercury, and chromium — can be toxic to aquatic life and contaminate drinking water supplies. Heavy metals affect sensitive animal species, plants, and fisheries and enter the food chain through animal tissue ingested by humans and other animals.

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Table 1.—Pollutants typically found in urban runoff.*

COMMON URBAN RUNOFF POLLUTANTS	SOURCE	AVERAGE CONCENTRATIONS	NONPOINT SOURCE IMPACTS
Sediment	Urban/ Suburban	average 80 mg/L	Fills in ponds and reservoirs with mud, contributes to decline of submerged aquatic vegetation (SAV) by increasing turbidity and reducing the light available for photosynthesis. Acts as a sink for nutrients and toxicants and as a source when disturbed and resuspended
Total Phosphorus	Urban/ Suburban	1.08 mg/L 0.26 mg/L	A contributing factor cited in eutrophication (nutrient over-enrichment) in receiving waterbodies and subsequent algal blooms. Algal blooms contribute to the decline of SAV by reducing light available for photosynthesis, further degrade water quality by decreasing the level of dissolved oxygen (DO), and may cause changes in the composition of plankton and fish species
Total Nitrogen	Urban/ Suburban	13.8 mg/L 2.00 mg/L	Like total phosphorus, contributes to eutrophication and algal blooms
Chemical Oxygen Demand	Urban/ Suburban	183.0 mg/L 35.6 mg/L	Decreases the concentration of dissolved oxygen. Low DO concentration and anaerobic conditions (complete absence of DO) can lead to fish kills and unpleasant odors. Primarily released as organic matter in the "first flush" or urban runoff after a storm
Bacteria	Urban/ Suburban	average — 200 to 240 000 MPN/L	High concentrations can lead to closure of shellfish harvesting areas and prevent swimming, boating, or other recreational activities
Zinc	Urban/ Suburban	0.397 mg/L 0.037 mg/L	Most commonly found toxic metal in the mid-Atlantic coastal region, chronically exceeds EPA water quality criteria. Primary cultural source is the weathering and abrasion of galvanized iron and steel
Copper (Nationwide Urban Runoff Program average)	Urban/ Suburban	0.105 mg/L 0.047 mg/L	Chronically exceeds EPA water quality criteria. Primary cultural source is as a component of antifouling paint for boat hulls and, in urban runoff, from the leaching and abrasion of copper pipes and brass fittings. An important trace nutrient, it can be bioaccumulated and, thereby, create toxic health hazards with the food chain and increase long-term ecosystem stress
Lead	Urban/ Suburban	0.389 mg/L 0.018 mg/L	Lead from gasoline burning in automobiles is less of a problem today because of unleaded gasoline use. However, lead from scraping and painting bridges and overpasses remains. Chronically exceeds EPA water quality criteria. Attaches readily to fine particulates that can be bioaccumulated by bacteria and benthic organisms (e.g., oysters and mussels) while feeding. Lead has adverse health impacts when consumed by humans
Oil and Grease	Urban/ Suburban	average 2-10 mg/L	Toxicity contributes to the decline of zooplankton and benthic organisms. Accumulates in tissues of benthic organisms, a threat to humans when consumed directly or when passed through the food chain. Primary cultural source is automobile oil and lubricants
Arsenic	Urban/ Suburban	average 6.0 µg/L	An essential trace nutrient. Can be bioaccumulated, creates toxic health hazards within the food chain and increases long-term stress for the entire ecosystem. Accumulates within tidal, freshwater areas, increasing the toxicity for spawning and juvenile fish. Primary cultural source is fossil fuel combustion.
Cadmium	Urban/ Suburban	average 1.0 µg/L	Urban runoff contributes a major portion to the mid-Atlantic coastal region. Primary cultural source is metal electroplating and pigments in paints. Can be bioaccumulated, creates toxic health hazards within the food chain and increases long-term toxic stress for the entire ecosystem.
Chromium	Urban/ Suburban	average 6.0 µg/L	Primary cultural source is metal plating and as a component of paint pigments. An essential trace nutrient, it can be bioaccumulated, creating toxic health hazards within the food chain and increasing long-term toxic stress for the entire ecosystem.
Pesticides	Urban/ Suburban	average <0.1 µg/L	Primary urban source is runoff from home gardens and lawns. Can bioaccumulate in organisms and create toxic health hazards within the food chain. Observed levels currently below standards

*Based on mid-Atlantic Coast data. *Source: Metropolitan Washington Council of Governments, 1983.*

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Most metals found in urban runoff come from corroding, decaying surfaces, often accelerated by acidic rain, and from dissolving or leaching materials. Among the sources of metals are roofing materials, downspouts, leaded gasoline, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires. Maintenance of bridges and other structures can also contribute paint scrapings and abrasives.

■ **Toxic substances.** Toxic chemicals, including pesticides and polychlorinated biphenyls (PCBs), can seriously impair water quality and threaten human and animal health. In addition to pesticides, toxic wastes are found in fertilizers, herbicides, and household substances such as paints and cleaning materials. Proper use and disposal of these substances are mandatory.

■ **Chlorides.** Chlorides or salts are toxic to many freshwater aquatic organisms, which can tolerate only a certain level of salinity. Increased levels of sodium and chloride in surface and groundwater can also affect soil structure, stressing plant respiration and lessening viability.

The main source of chlorides is road salting to remove ice and snow. Chlorides run off roads, parking lots, and sidewalks, and find their way into wetlands, streams, lakes, and groundwater. Because of their high mobility, chlorides can have a major impact on groundwater.

■ **Temperature.** Even a slight rise in water temperature can adversely affect some aquatic life and insects in and around a waterbody, including stoneflies, mayflies, and trout. This is particularly true of streams that alternate between cold and warm water.

Runoff can raise stream temperatures as a result of passing over an urban landscape warmed by structures and paved surfaces. Less shade because of fewer trees also raises stream temperature. Runoff stored in shallow ponds and heated by the sun between storms, especially pollution controls that hold runoff for extended periods, can also harm aquatic life.

■ **Trash and debris.** Floatable wastes collect at impasses in streams and lakes, disturbing water flow and impairing the aesthetic quality of the environment. This debris, from street litter and careless disposal practices, washes into waterbodies both over land and through the storm drain system.

■ **Impervious surfaces.** Paved surfaces absorb less rainfall, thus directly increasing water velocity. More sediment will be deposited downstream; and the rapid, forceful flow may drastically erode streambanks, making the area vulnerable to flooding. Increases in paved surfaces can be directly linked to the accelerated loss of aquatic habitat. Heavier sediment loads clog streambeds with sand and silt, destroying habitat. Pool and riffle stream areas also become severely degraded, leaving poor conditions for both the fish community and the macroinvertebrate insect community on which fish depend for food.

■ **Disturbance of stream habitats.** Development inevitably requires that roads and pipelines cross streams, rivers, and wetlands. Construction activities can upset ecosystems and habitats; permanent structures such as culverts can block the movement of fish, preventing recolonization.

Wildlife habitat may also be affected by the replacement of vegetation by roads and structures. Installation of concrete-lined storm drainage channels, for example, often requires removing tree canopies and results in a loss of riparian and aquatic habitats.

Open spaces play an important role in controlling nonpoint source pollution in most urban areas. Therefore, the whole watershed should be considered in making conservation decisions. Maryland, for example, has a Forest Conservation Act that protects existing forests while allowing continued development. It requires a developer to map existing forests and submit a forest conservation plan. This type of program can serve as a reference for urban communities facing similar decisions.

In the past, communities have treated pollution crises as they arose. They have built treatment plants to control point sources of pollution, and used various best management practices (BMPs) to address urban runoff (see Chapter 4). But today, communities are realizing that the hydrology and ecology of their entire watershed influence water quality (see Fig. 1).

Communities are also recognizing that the greatest loss from water pollution is that people can no longer use and enjoy the natural resource. They can't swim, boat, fish, picnic, or just enjoy a lake or river. As a result, the economic impact on the community is significant — people must go elsewhere for recreation, taking with them dollars that could be spent on gas, food, lodging, and entertainment. Pollution may also cause property values to fall, eroding the tax base.

With this increased awareness and knowledge, communities of all sizes are building two-pronged water quality programs: (1) they are identifying and correcting existing problems, and (2) they are focusing on preventing future problems. Communities are finding that a comprehensive nonpoint source management program will help them avoid many of the problems caused by urban pollutants *before* they occur.

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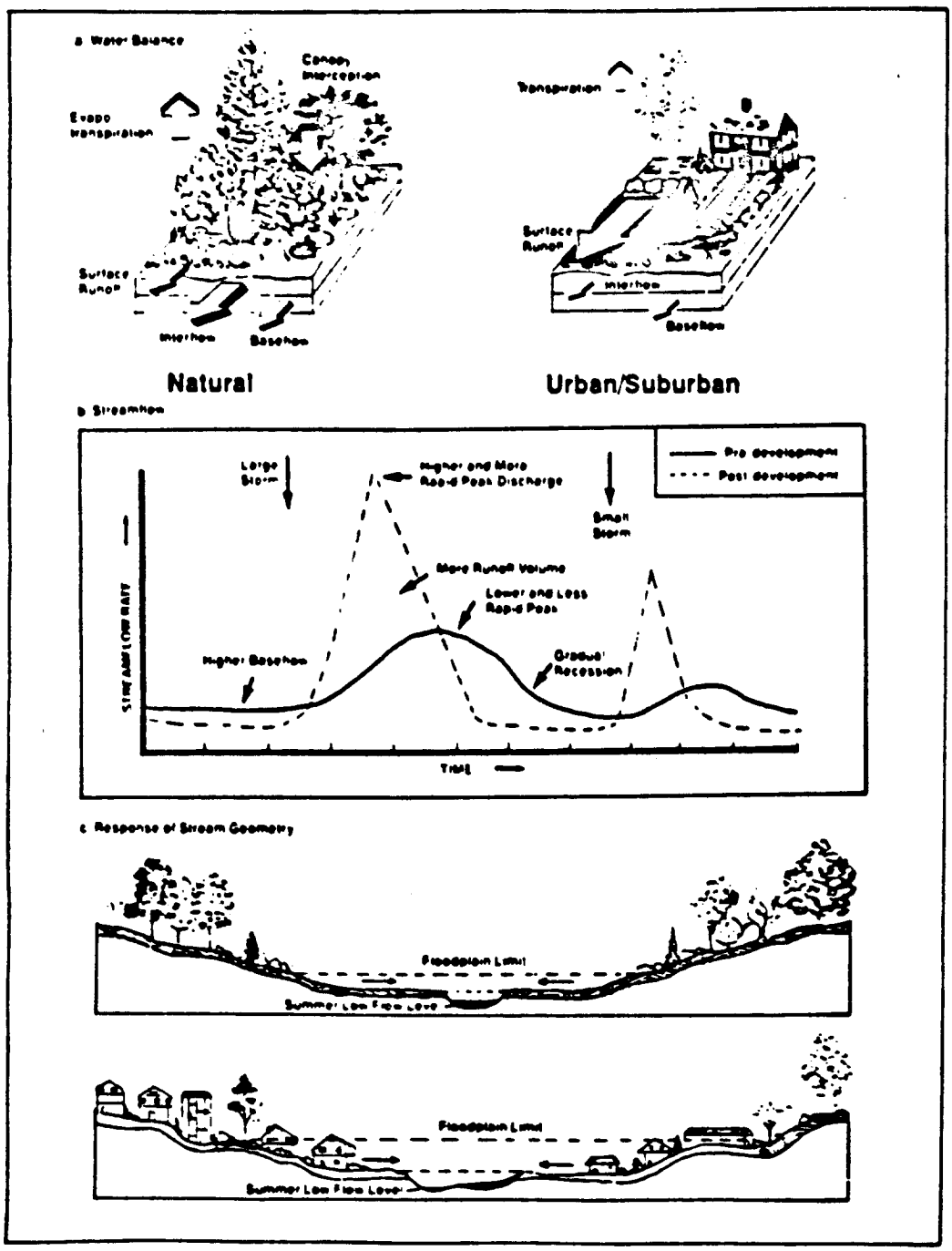

Figure 1.—Changes in watershed hydrology as a result of urbanization. *Source: Metropolitan Washington Council of Governments, 1987.*

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Chapter 2

Controlling Urban Runoff: Designing a Nonpoint Source Management Program

With urbanization inevitably comes nonpoint source pollution. This pollution stems from the basic processes of urbanization and the individual lifestyles of citizens.

A nonpoint source management program is one element within a community's overall management plan, just as the effects of urban runoff are one concern. But each piece connects within the community puzzle, if only within the budget. Therefore, the task of controlling nonpoint source pollution must be accomplished by the entire community, planning and working together.

Conservation techniques on undeveloped land — floodplains, wetlands, stabilized streambanks, and slopes — go far in assuring water quality. These natural features play important roles in managing nonpoint source pollution in local communities and should be included in any comprehensive management approach.

This chapter describes a step-by-step approach to designing a nonpoint source management program, a process that a community can adapt to its own situation. Subsequent chapters contain information on the pollution prevention and control methods that can be applied to managing urban runoff.

Figure 2 charts some of the elements of a successful nonpoint source management program. While most programs begin with defining the problem, a program requires continued revisiting, reevaluating, and adjusting. A central element in all phases of program development and implementation is educating and involving the public. In fact, the program's success depends on public support and buy in. Chapter 5 discusses techniques to be incorporated at every phase of the program to keep the public aware and supportive.

The following is a step-by-step guide to constructing a successful nonpoint source management program:

Step 1: Define the current or potential problem.

Step 2: Evaluate existing programs and resources.

Step 3: Build program infrastructure.

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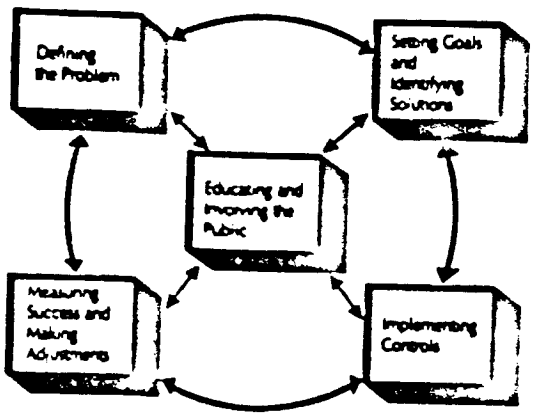

Figure 2.—Elements of a successful watershed project. *Source: U.S. Environmental Protection Agency, The Watershed Protection Approach: A Project Focus, 1994.*

Step 4: Identify potential options.

Step 5: Evaluate options and alternative strategies.

Step 6: Set program goals.

Step 7: Select a final strategy.

Step 8: Develop a work plan.

Step 9: Adopt and implement the work plan.

Step 10: Monitor, evaluate, and revise the program.

A Nonpoint Source Management Program

Step 1: Define the current or potential problem.

Whether you are reacting to citizen complaints or planning ahead to prevent potential problems, you will need substantive, reliable data to define your community's current or future problems.

Enlist staff, interns, and/or volunteers to determine what information is needed, why it is important, and how to obtain it. Emphasize accuracy in collecting data and keep meticulous records on when, where, and how the data were collected.

Organize and store data for ease of use and accessibility, preferably in a computer database, complete with backup copies.

Your most important task is to first get to know your entire community to evaluate it for actual and potential nonpoint source pollution problems. All factors are important — from the people who live there to the community's physical position within its watershed.

Research and inventory your resource area and community to completely understand the community's strengths and weaknesses in relationship to the watershed. You'll find most of this information at your local soil and water conservation district or your state water quality authority. The U. S. Geological Survey, your regional planning commission, and local universities can also help. Table 2 lists further sources of various data.

Table 2.—Sources for natural resource assessment, inventories, and other data.

TYPE OF INFORMATION NEEDED	CONTACTS
Water Quality Data	U.S. Geological Survey, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, state water quality agencies, fish and game departments, departments of health, and tribal environmental offices
Land Use Data	U.S. Department of Agriculture's Soil Conservation Service and Agricultural Stabilization and Conservation Service, U.S. Forest Service, Bureau of Indian Affairs, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, state cooperative extension services, land office, tribal environmental or agricultural offices, local government offices such as city planners and county commissioners
Economic Data	County extension service, councils of government, economic research services, chambers of commerce, state department of commerce, tribal councils, real estate agents, private consultants
Demographic Data	Councils of governments, census reports, chambers of commerce, state statistics bureaus, almanacs

Source: Terrene Institute, Clean Water in Your Watershed: A Citizens Guide to Watershed Protection, 1993.

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An important resource for community programs is section 319 of the Clean Water Act. This provision requires each state to assess and design a management program to control potential nonpoint source pollution problems. Contact the responsible state agency to pinpoint local problems and determine if resources have been allotted.

■ **Identify and map your watershed.** Include smaller watersheds within its jurisdiction and specific sites needing attention because of development or other special circumstances (see Fig. 3).

- Locate wetlands and other critical areas.
- Identify vegetation strips and other areas that can control pollution or urban runoff.
- Map your community's drainage pattern downstream and the location of groundwater aquifers and those used for drinking water (see Fig. 4).

■ **Identify the land uses within the watershed.** Map and calculate the number of acres within the watershed for each type of use. Check with your zoning commission first, and if you need more detail, go to

- land ownership and variance zoning records,
- site approvals,
- building permits, and even
- aerial photos.

You may not be able to obtain comprehensive, absolutely accurate and precise land use information — but the more details you gather now, the better your community will understand the land use in and around its watershed.

Categories can be defined broadly — residential, commercial, industrial, agricultural, and open space — and further subdivided as necessary.

For example, low-density residential has a different impact on water quality than high-density residential. Among industrial uses, a mining company may cause more nonpoint source pollution than a sugar processing plant. And forests differ from wetlands.

Some questions to ask:

- How much of the agriculture is dairy, soybeans, pasture, rangeland, or other?
- Are open spaces forest, meadow, or wetlands?

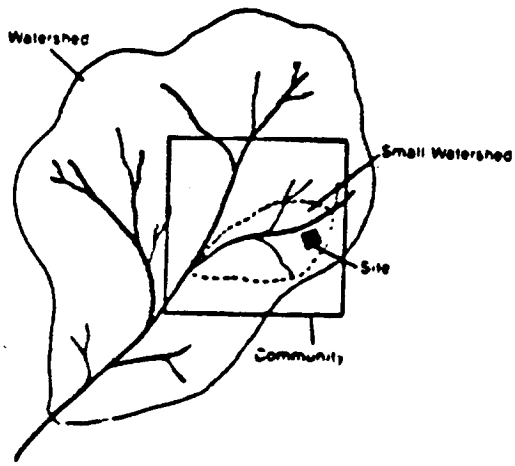

Figure 3.—Watersheds nest within each other; a site within a small watershed lies within the community and is part of the larger watershed.

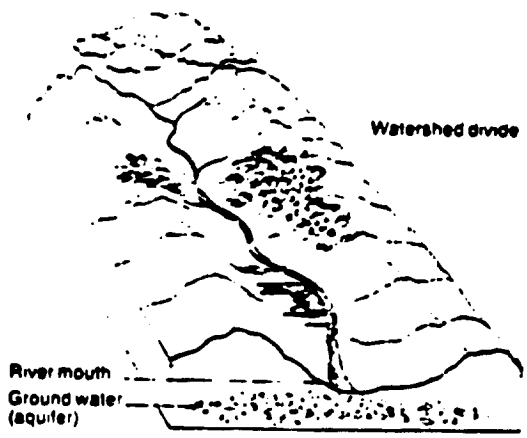

Figure 4.—A watershed graphically depicted. *Source: Puget Sound Water Quality Authority.*

- How rapidly are the urban areas developing?
- How are urban areas divided for development (commercial, residential, industrial, other uses)?

■ **Investigate environmental factors.** Assess geology, topography, soil characteristics, vegetation, groundwater recharge areas, flood-prone sites, and hydrologic and biological characteristics.

Get help in determining what principles of geology, topography, soil, and vegetation are important in

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understanding water quality. Study USDA Soil Conservation Service (SCS) soil maps, Federal Emergency Management Agency (FEMA) floodplain maps, and U.S. Geological Survey topographic maps. You can find assistance locally from the USDA Extension Service, soil and water conservation district, and university and high school science departments.

■ **Determine current waterbody quality.** Obtain basic information on your waterbodies — pollutant concentrations, vegetative cover, and aquatic life — and determine if the state has monitored or designated them by classes. Water quality standards specify the concentrations of various pollutants allowable according to how the waterbody is used. Water quality designated uses include fishing, boating, water supply, priority wetlands or floodplains, and productive or open shellfish beds.

The state water quality agency should be able to provide current data, including documentation of any known water quality problems. If the state has information for your waterbody, a baseline database on its water quality may exist. If not, determine how to establish baseline data; perhaps your local college or university can help.

Investigate ongoing efforts to collect data, such as those obtained from citizen monitoring groups (see Chapter 5).

■ **Determine actual threats to surface and groundwater.** Is an industrial park being developed with the potential for construction runoff and, later, operational discharges from high traffic parking and maintenance lots? Is land use changing significantly — or at a rapid rate? Is there a known trouble spot?

Threats to groundwater include high water tables, uncapped abandoned wellheads, discharges associated with industrial development, and failing and inappropriately located septic systems.

■ **Identify other problem areas.** Identify specific sites that need attention, using land use maps to define areas of greatest imperviousness. Additional actions can include

- researching water quality and biological resources;
- walking along streams to visually assess excessive erosion, lack of riparian cover, water quality conditions, and physical stream conditions;
- identifying point sources by obtaining copies of National Pollutant Discharge Elimination System (NPDES) permits for discharge levels;
- obtaining data related to flood control or stormwater best management practices;
- obtaining information from local resource managers familiar with water resources; and
- checking sections 319 and 314 (Clean Lakes) assessments and 305(b) reports made by your state water quality agency on impaired waterbodies (EPA requires these reports from each state).

■ **Research the local economy.** An accurate picture of the local economy is important to make growth projections and to assess what funds might be available to protect water quality.

- Determine what portion of the watershed's population is rural and what portion is urban.
- Describe factors specific to the area, such as a large plant opening or a long-time employer closing.
- Assess the growth trends in the community and in the watershed. Development is a major cause of both short- and long-term nonpoint source pollution. Understanding population and growth trends also helps determine the areas most vulnerable to water quality deterioration.
- Assess income levels compared to national and regional averages and calculate the local tax base and revenues available from government grants and other sources. Current and projected tax revenues and other income sources will determine the amount of resources available to manage water quality.

■ **Evaluate industry and infrastructure.** Are industrial plants and infrastructure, such as sewage and stormwater systems, potential nonpoint source polluters? Assess age, state of environmental technology and practices, and other features. Seek guidance from experts in this assessment.

Assess the condition of roads, bridges, airports, marinas, and other parts of the transportation network.

- Note needed or ongoing repairs or new construction, and specify possible nonpoint source pollution hazards.
- Observe current road and ditch maintenance practices and note opportunities for improvement.

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DETERMINING FINANCING STRATEGIES

Communities must answer several questions before selecting the best financing option for the situation:

- *Are funds sustainable? Will they last over the long term or are they only a short-term band-aid approach?*
- *Are funds easy to obtain? Is the application complicated? Does it require multiple approvals?*
- *Are funds difficult to administer? Will you need additional staff to track and prepare reports or assess and collect fees?*
- *Does a correlation exist between the funding and the problem? Will those who pay for the benefits receive them?*
- *Will the funding be used appropriately? Will it be a quick fix or will it have secondary benefits?*
- *Have legal restrictions been placed on the use of the funds?*

STORMWATER UTILITY FINANCING

The stormwater utility is a creative approach to funding that also addresses political and institutional questions. One of the most important benefits of a stormwater utility is that it can provide a steady stream of funds to develop, operate, and maintain a comprehensive stormwater management system. This, in turn, permits the development of integrated, long-range planning from one source.

Establishing a stormwater utility can be complicated. It requires collecting water and analyzing its quality, assembling land use and economic information, and establishing an equitable billing system. Moreover, establishing the utility can prove expensive because of costs for engineering, legal, and financial studies; new staff, and information management systems. Local officials must educate citizens to overcome public resistance to a new utility charge.

Many cities have such programs, including Bellevue, Washington, and Billings, Montana (see Appendix C for contact information).

Step 2: Evaluate existing programs and resources.

■ **Identify existing ordinances and enforcement authorities.** Identify state and local laws that authorize government to proceed with control methods. For example, zoning ordinances might authorize setbacks or buffer strips, limit development on impervious areas, or establish erosion and sediment controls. Existing programs and authorities should be used — and strengthened — to benefit water quality.

Determine if your governmental unit has the legal authority to protect its floodplains and enforce ordinances using fines, permits, inspections, stop work orders, or other methods to make a nonpoint source program work. Communities often set fines for septic violations, for example.

■ **Investigate funding options.** Review funding options and select those that best suit your community. For an overview of traditional and innovative funding mechanisms, refer to EPA's "A State and Local Government Guide to Environmental Program Funding Alternatives" (Appendix B).

Federal sources

- Federal Construction Grants Program — States provide seed money loans to local governments for water quality projects to be repaid from local fees or taxes. This program, however, is being gradually replaced by the State Revolving Loan Fund.
- State Revolving Loan Fund — Administered by a state agency, loans can be used to fund projects to control nonpoint pollution and be repaid from local revenue.
- EPA Clean Lakes Program Grants — Publicly owned lakes may qualify for federal grants available through state environmental agencies.
- Section 319, Clean Water Act — EPA provides grants to specific nonpoint source projects that demonstrate progress in controlling and abating nonpoint source pollution.

State and local sources

- Special use taxes — State or community levies, fees, or taxes on cigarettes, boat licenses, hotel rooms, or permits.

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CALIFORNIA NONPOINT SOURCE STATE REVOLVING FUND LOANS

California was one of the first states to use state revolving funds for nonpoint source projects. Projects included demonstration projects, retention/detention basins, wetlands for stormwater treatment, and a variety of best management practices. Eligible programs also include training, public education, technology transfer, and development of ordinance and management practices.

Loans can cover 100 percent of the project cost. Repayment, which can take as long as 20 years, begins one year after the program begins. Interest rates are determined by the state's general obligation bond rate.

The loan request begins with an eight-page application and background information. The local government passes a resolution establishing repayment arrangements. The State Water Board places the project in the SRF Intended Use Plan approved through a public hearing process.

- BMP tax credits — Used for installing best management practices or similar controls.
- Drainage fees — Used to compensate for excessive runoff from a site.
- Bonds — Paid for by fees from developers or users.
- Special assessments — Levied through utility districts established by communities.

Step 3: Build program infrastructure.

■ **Identify all participants and determine their objectives.** Participants with a vested interest might include state and local agencies, governing bodies such as legislatures and city/county councils, local or national public environmental groups, trade associations, citizens, and business leaders. Establishing a working relationship with the lead state nonpoint source pollution agency is particularly important for information, resources, and support.

■ **Match the resources with the problems.** Determine what governmental units fit into your proposed plan and which methods of funding will work best. You may not need a staff as much as you need the ability to coordinate the available resources.

TYPES OF NONPOINT SOURCE PROGRAM FINANCING

A number of creative strategies for financing water quality programs have been implemented in recent years. Examples of the most successful are

- **Real estate transfer fee:** *Nantucket, Massachusetts, has funded a land purchase program through a 2 percent transfer fee on all property sold on the island. From the land bank's beginning in 1984 until June 1993, the fee has collected nearly $27 million.*
- **License fees:** *In Iowa, the Groundwater Protection Fund includes revenue from increases in pesticide dealer license fees. Chemical manufacturers are also assessed a 75 cent per ton tax on nitrogen-based fertilizers.*
- **Impact fees:** *In Florida local governments can assess development impact fees when issuing permits to cover infrastructure costs associated with new development.*
- **Sales tax:** *Washington increased state sales tax on cigarettes by 8 cents a pack to finance water pollution control programs: 50 percent for marine, 10 percent for nonpoint source, 10 percent for freshwater, 10 percent for groundwater, and 10 percent for discretionary programs.*
- **Stormwater utility fees:** *Some governments have created a stormwater utility service to achieve multijurisdictional solutions. Charges are based on the amount of a property owners' impervious surface and generally range from $1 to $4 a month.*
- **Environmental trusts:** *Minnesota established a trust with proceeds from the state lottery; half of the net proceeds will remain in the fund for five years.*
- **State revolving funds (SRF):** *These funds were authorized by the Water Quality Act of 1987 specifically to improve water quality. The SRF money is loaned to local governments, who repay it with revenue raised from local fees or taxes. SRF funds recycle a set amount of money to finance numerous projects over an extended period.*

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Local governments. Identify the units within your community with the authority, knowledge, and resources to coordinate a nonpoint source control program — for example, departments of public works, public health, or the environment. In small communities, the conservation commission, planning board, or code enforcement office might have the authority. Other relevant governmental units might include regional planning commissions or the departments of park maintenance, road maintenance, waste disposal, or health.

Existing municipal programs can be modified to address urban runoff concerns. For example, a pretreatment inspection program for a publicly owned treatment works (POTW) can be expanded to look at runoff at each industrial facility. Similarly, fire and safety programs can be expanded to inspect runoff collection points. This coordination should be high priority since it can be much more cost effective to use existing program resources than to start a new program.

Find out what actions neighboring cities and counties, particularly in your watershed, are taking to control nonpoint source pollution. While you cannot control other jurisdictions, even though their actions might affect your water quality, you should be well informed of their problems and methods of controlling them.

State agencies. Determine agencies responsible for nonpoint source management, groundwater, water quality standards, floodplains, wetlands, coastal zone management, land conservation, land planning, endangered or threatened species, and scenic and wild river protection.

Find out what help the lead nonpoint source agency can offer and fit this resource into your control strategy. State nonpoint source coordinators may not be able to help with all problems — they have their own agendas, determined by state and federal priorities. With the diversity of funding sources for nonpoint source control, the community may need to enlist the support of several different agencies.

Federal resources. U.S. EPA and USDA can provide technical advice and materials. In addition, the Army Corps of Engineers can provide technical guidance, information, and permits. The U.S. Fish and Wildlife Service is a source for biological information, and the National Park Service and U.S. Geological Survey can provide watershed information.

VIRGINIA STORMWATER MANAGEMENT

Virginia's stormwater management ordinance is an example of state-enabling legislation (Code of the Commonwealth of Virginia: Title 10.1, Chapter 6, Article 1.1). Municipal ordinances can be established by reference to the state law or tailored to local needs. Specifically, the components of Virginia's legislation are

- *statement of purpose;*
- *definition of terms;*
- *authorization for local programs;*
- *guidelines for developing technical criteria and administrative procedures;*
- *statement on the status of state projects and lands;*
- *specification of the state's oversight responsibilities;*
- *authorization for establishing more stringent local requirements;*
- *procedures for submitting plans and approving and exempting land uses;*
- *authorization for collecting performance sureties, recovering administrative costs, and assessing service charges;*
- *description of the appeals process;*
- *specification of civil penalties and enforcement options;*
- *authorization for cooperation with federal and state agencies, and*
- *statement exempting the legislation from limiting the authority of other agencies.*

The Virginia legislation includes all minimum critical elements and provides the legal authority for local governments to adopt their own stormwater management ordinances. The Virginia law places the primary burden on new development by defining existing runoff levels and the corresponding level of water quality effects, erosion, and flooding as a point of reference. Local governments can require performance bonds or escrow accounts for development. If proper stormwater controls are not installed, resources will be available to complete required activities without burdening taxpayers.

Cognizant of EPA's municipal stormwater requirements, the Virginia law also authorizes local governments to cooperate with federal agencies.

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Appendix C lists these and other information sources, including some interstate programs or compacts, such as the Chesapeake Bay Program, the Gulf of Mexico Program, EPA's National Estuary Program, FEMA's National Flood Insurance Program, and NOAA programs.

■ **Determine public attitudes and perceptions.** Alert citizens can be your best allies and informants. Use citizen complaints about water quality to spot current problems. Citizens often express such complaints in phone calls or letters to council members or the local newspaper editor. Look for newspaper articles on local lake or river problems.

If necessary, use a survey to assess public attitudes and perceptions regarding water quality issues and to determine the level of support and cooperation the program might elicit. Formal citizen monitoring projects are extremely successful components of many state and area water quality programs.

Step 4: Identify potential options.

The following chapters will help you think about your options for controlling urban runoff. Add to them the information you have garnered through your exploration of the agencies and organizations already working in the nonpoint source pollution arena. Your state nonpoint source coordinator can point to techniques that will work in your area.

- List each option to be considered for your plan (and your specific problems).
- For each option, list reasons favoring its use and those in opposition.
- Estimate the cost, including maintenance and longevity, for each option.

Step 5: Evaluate options and alternative strategies.

By now, you should have mechanisms in place to share information and thoughts about the process with many groups and individuals — both those knowledgeable in the field and interested citizens. At this point, you certainly need to know how your community is thinking. In addition to local stakeholders, make sure to include federal and state landowners and other groups such as the Department of Defense and the Conservation District.

Some jurisdictions use the consensus method, requiring support from all members, to make water policy decisions. Collecting information, airing viewpoints in group discussions, and analyzing the problems and solutions lead to acceptable compromises. The consensus process frequently produces a more creative and binding outcome, important when a community commits to a long-term project.

In exploring the merits of each option for controlling nonpoint source pollution, carefully consider the following issues:

- benefits and costs to the community;
- feasibility of implementation;
- public support and/or opposition;
- funding sources;
- staff to administer, enforce, and monitor;
- potential for problems and adverse reactions;
- technical support; and
- long-term maintenance ability.

■ **Models.** Computer models can be used as a design tool to project possible scenarios for pollution control programs, but they should be used with care and expertise. Modeling can be an expensive exercise that does not always relate to the real world. Models now in use include several versions of SWMM, a Stormwater Management Model developed by EPA, and its companion, RECEIV, and AGNPS, the Agricultural Nonpoint Source Model. Many states and regional governmental units are using GIS (Geographic Information System), another computerized tool, to predict erosion and other factors. Local governments can adapt GIS to their own needs.

Step 6: Set program goals.

After analyzing the information collected, determine the focus of your program. This step takes you back to the original premise: Does your community have an immediate problem, or has it simply recognized the wisdom of preventing future nonpoint source problems?

Thus, your program goals will be driven either by the need (1) to take immediate action, or (2) to achieve community support for a long-term preventive program. Of course, you may have to balance both concerns.

The basic steps in setting realistic goals, however, are based on setting priorities and matching them with available resources:

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- Identify and list your community's most serious problems.
- List all other problems, both immediate and potential.
- Rank all problems for immediate, medium-range, and long-term action.
- Establish a series of objectives and a timeline for achieving each goal.

Visible progress is important to build community support. As you set program goals, try to identify at least one objective that can be accomplished quickly to assure your community that progress is being made.

Step 7: Select a final strategy.

The strategy selected should meet several objectives. At a minimum, it should

■ **Establish the legal, financial, and administrative framework for the nonpoint source management program.**

■ **Develop a comprehensive public education/participation program that ensures community buy-in to the nonpoint source management process.** Far from being an isolated element, public education, understanding, involvement, and support are vital elements in each stage of a project—from defining a problem, to developing workable solutions, to adjusting and monitoring the progress (see Fig. 5).

■ **Restrict construction/development in highly erodible areas — steep slopes and erodible soils.** Some slopes are not amenable to runoff control and some soils are impermeable — unable to absorb runoff. These areas should be identified and conventional ground-disturbing construction prohibited.

■ **Reproduce predevelopment hydrological conditions.** In addition to controlling runoff, a nonpoint source control program should, to the extent possible, diminish the hydrological changes brought about by development. Successful planning requires recognizing and addressing the serious implications of such changes.

■ **Reduce or remove pollutants.** Because control methods differ markedly in removal mechanisms, their performance in removing pollutants can vary significantly. Applying best management practices is one method of achieving goals (see Chapter 4 for discussion of BMPs). However, BMPs change with time and conditions and should be monitored and modified as necessary. Retrofitting includes constructing new BMPs or modifying existing practices in developed areas. Control practice effectiveness should constantly be reevaluated considering new technology, maintenance, repair, or upgrading needs.

■ **Use strategies appropriate to the watershed and the site.** Many control methods do not work because they are unsuited to the geographic area or site. Inappropriate methods can cause maintenance problems or nuisance conditions; in some cases, inappropriately located methods may not function at all. Decisionmakers need to understand a site's special characteristics. For example, plans may need to be modified after field reviews of the site's physical condition.

TARGETING

Implement a comprehensive management program by stages based on water quality problems — particularly when resources are limited. By ranking problems according to your specific area needs and targeting them for control, you can realize the greatest water quality benefits for resources expended. See Chapter 4 for discussion of best management control practices.

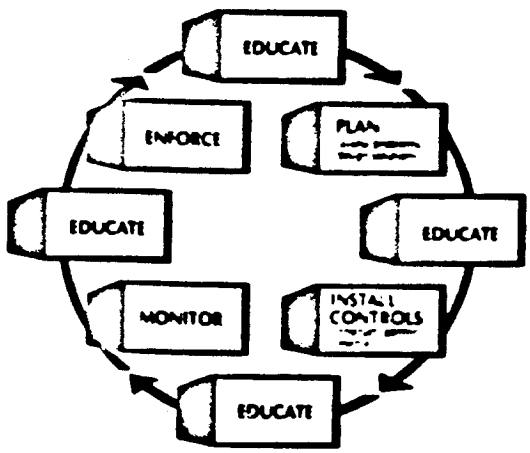

Figure 5.—Comprehensive public education/participation program. *Source: Terrene Institute, Clean Water in Your Watershed: A Citizens Guide to Watershed Protection, 1993.*

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■ **Protect and preserve vegetative treatment systems with nonpoint source benefits.** Buffers and natural systems filter out many pollutants in urban runoff before they become a problem. Communities should identify and preserve these natural vegetative treatment systems, because once they are altered, they cannot be easily replaced.

■ **Protect critical aquatic habitats and natural wetlands.** Determine the aquatic species most threatened by nonpoint source pollution in the watershed. What can be done to protect their habitats? Is the preferred technique compatible with other uses of the water? Should more than one control method be used?

■ **Be responsible for maintenance of controls.** Controls are effective only if regularly maintained, and maintenance costs can be significant. Over 20 years, structural BMPs can exceed their initial construction costs, passing on costs to future residents or taxpayers. While some effective BMPs require significant maintenance, others — particularly some nonstructural BMPs — are not expensive to maintain. Anticipate future maintenance needs and consider the cost factor compared to other needs and resources.

■ **Positively affect the environment.** Control methods significantly affect the natural environment and adjacent community, either positively or negatively. Small investments in design, landscaping, and maintenance can make a control method an attractive, or at least an unobtrusive, feature in a community. Without such effort, controls can become unsightly nuisances. If that occurs, public support for nonpoint source control is jeopardized.

Step 8: Develop a work plan.

After defining the goals and the strategy, develop a specific work plan. The work plan should express the community's goals in definitive terms, yet be broad and flexible in their execution. It should ultimately be a practical, easy-to-use guide to decisionmaking over the long term.

The work plan should also include specific measurable objectives to meet community goals (e.g., nitrogen concentration will drop 10 percent by 2000 from 1990 levels) and fit into the existing infrastructure. The plan should complement existing plans, translating local goals, priorities, and resources into action.

Consider other plans in developing a work plan for your community:

- comprehensive land use plan
- stormwater management plan
- roadway/transportation plan
- zoning map
- water and sewer network
- open space conservation plan
- preservation of critical areas

Also consider

- legal authorities
- local/state agencies
- existing land use patterns and zoning

The following is an outline for developing a nonpoint source pollution control work plan:

I. Formulate goals, objectives, assumptions.

II. Describe the size and scope of plan.

III. Identify legal authority.

IV. List the responsible agency or agencies.

V. Describe staff and training needs.

VI. Describe existing conditions and resources, using data relating to the community, including water quality problems and opportunities for improvement.

VII. Describe demand pattern for water. Analyze how water use patterns relate to demographic and economic groups; measure impact on residents, nonresidents, and tourists; assess impact of fees and other charges on demand patterns; analyze why existing opportunities (i.e., recreation, fishing) are not being used.

VIII. Provide needs analysis. Analyze supply and demand relationship; develop program standards; describe water quality needs, state need for a plan/program, and local government's ability to meet program needs.

IX. Analyze present policies and programs as they relate to program goals and outcomes. Recommend and justify the option selected.

X. Appendix. Include background studies (pertinent information collected), data and methods, bibliography (sources), and acknowledgments and credits.

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Step 9. Adopt and implement the work plan.

The work plan must be adopted by the community's governing body. Information gained in developing the work plan should be used to further the effort to educate and involve the public and community decision-makers. Whether a public referendum is required to pass the plan and financing mechanism or a committee or city council will make the final decision, inevitable differences of opinion can be resolved through a continued program of public information, education, and political savvy.

■ **Implementation.** After local adoption, follow an implementation plan that describes the necessary actions and who is responsible. Schedule actions by time period, group, and responsible agency. Relate costs to the general budget. Describe needs for training, legislation, public participation, and state approval process, if necessary.

■ **Training.** A successful water quality program requires a high degree of staff involvement. A program must have technical staff to develop specific controls, administrative staff to oversee the project, clerical staff to maintain records, and volunteers to carry out citizen education and monitoring functions. Staff and volunteers should help develop the plan and begin training soon after its adoption.

Workshops sponsored by federal, state, regional, and county agencies and by private environmental groups are good ways to gain expertise. In addition, local university extension curricula may offer courses that relate to the program. On-the-job training can also be effective if supervised by professional water quality specialists (see Appendix C).

Step 10: Monitor, evaluate, and revise the program.

While some revisions will occur early in the planning process, evaluation and modification should continue indefinitely. Incorporate a monitoring and evaluation plan into the work plan and see that staff or volunteer programs are in place to carry out this ongoing process.

To make sure the control method is working, develop a monitoring program that relates results to initial goals set early in the planning process. The monitoring program must have clear goals, such as

- evaluating BMP efficiency;
- specifying problems with receiving water quality;
- identifying priority sources (for example, gas stations or malfunctioning septics);
- validating results against other studies or models; and
- complying with applicable regulations, including local requirements.

Compliance may be a good area in which to involve citizens. Citizens have made valuable contributions to local monitoring programs. However, volunteer monitors must be well trained, supervised, and motivated to ensure that the data is accurate and useful. The local government should carefully supervise program activities and conduct the analyses (see Chapter 5).

A monitoring program should consider, at a minimum, the following parameters:

- beneficial uses that need protection;
- expected impacts on water resources and assorted habitat; and
- an approach to measuring impacts.

Prepare an annual report of your progress for the county or city council and other governing bodies. This serves not only as a program evaluation tool but also keeps the community informed. In addition, the state government may be able to include the report as part of its annual report required by the Clean Water Act.

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Chapter 3

Planning to Prevent Urban Runoff

A successful nonpoint source management plan begins by identifying general concepts and goals in the total community development or comprehensive plan. Specific controls (see Chapter 4) to prevent pollution should be part of each site plan.

Damage that occurs as part of the development process is, at worst, irreparable and, at best, costly to clean up. Therefore, urban runoff pollution prevention should be part of the overall plans for roads, parks, utilities, and other public facilities as well as for each site.

Such plans should consider the larger drainage basin, the immediate watershed, the municipality, and, finally, the specific site. Water quality plans must work in harmony with local legislation and programs of other political jurisdictions.

Developing a Land Use Plan

Land use planning begins with the local government, but it must also adhere to state mandates and comprehensive planning. A good nonpoint source program coordinates federal and state laws with local programs in a plan that improves and protects water quality according to community needs. Local government should provide the broad legal authority to develop comprehensive plans and programs.

Land use planning can prevent pollution problems by protecting water quality, open spaces, stream valleys, and floodplains. At the same time, planning should support local economic needs. Through comprehensive planning, communities can address water quality issues by setting development goals — for environmental quality, a sustainable economy, viable commercial areas, population density, housing patterns, recreational facilities, tourism, and property values — that work together to ensure the overall "quality of life."

Land use planning reduces pollutant loads in two ways:

- by controlling the type, size, and location of development in a given area, and
- by reducing pollution generated at specific levels of development.

While comprehensive planning provides general guidance in managing nonpoint source pollution, specific practices are put in place through zoning laws that regulate development.

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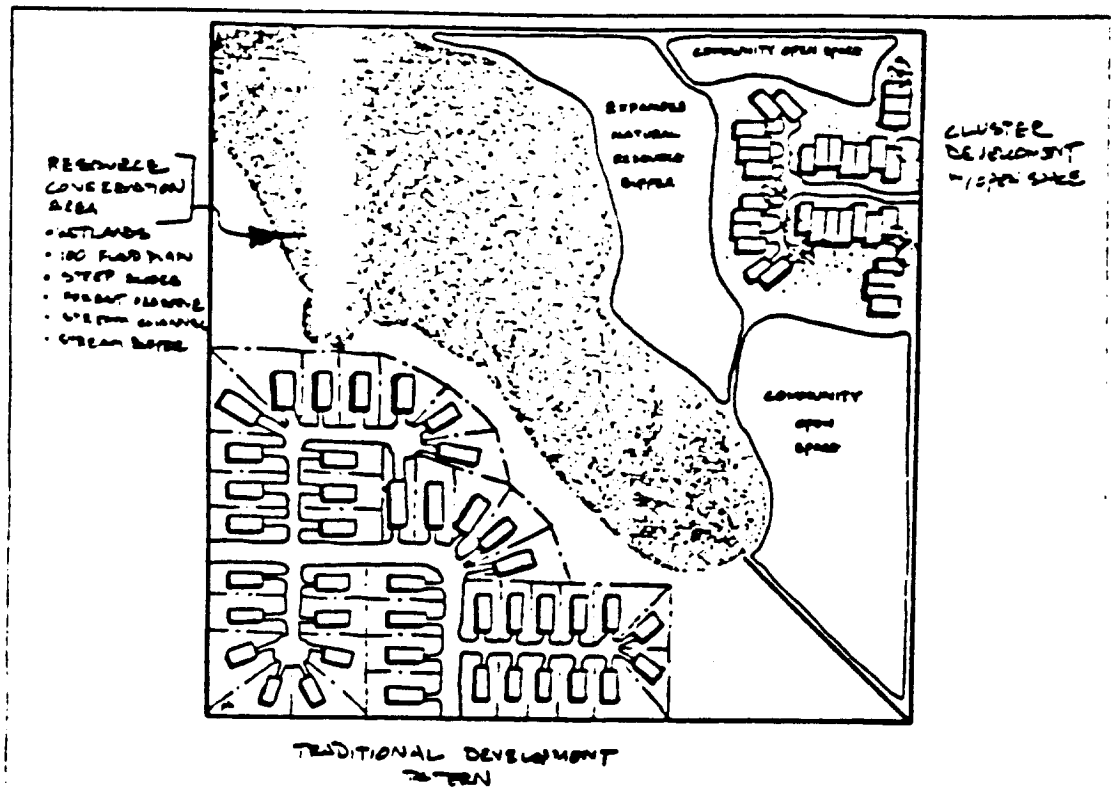

Figure 6.—Cluster versus traditional development preserves open space and reduces land disturbances.
Source: Metropolitan Washington Council of Governments, 1983.

■ **Zoning process.** Zoning specifies the density and type of land use that can occur in a given area. It is the working arm of a comprehensive plan that controls overall local development and considers water quality and other environmental goals along with a myriad of community concerns. Zoning ordinances apply only to uses that begin after the ordinance is enacted, and therefore affect only future practices.

Because zoning ordinances also regulate authorized uses (e.g., building, lot sizes, designs), they can be structured to control nonpoint source pollution. This control is particularly relevant on highly erodible steep slopes and shores or in high-density areas where developers must provide adequate drainage systems for their projects.

Several types of zoning apply to water quality issues:

Cluster development. Clustering preserves the existing topography and provides the community with more open green space by concentrating residential development on a limited portion of the site. This leaves substantial area for amenities such as playgrounds, parks, and woods (see Fig. 6).

Preserving open space and the existing tree canopy reduces impervious surfaces and the resulting runoff. Further, following the land's natural contours reduces disturbances that cause erosion, improves aesthetics, and preserves sensitive habitats.

Keeping the same population density, developers can save on necessary facilities such as roads and utility lines, since cluster development reduces the lengths of paved roadways and utilities needed.

Cluster development minimizes the need to convert agricultural land to residential use. It also allows development to match actual site capacity. Homeowners and the public can enjoy many of the amenities of rural living within an urban environment. Cluster development also helps maintain property values, one of zoning's basic goals.

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Planned unit development (PUDs). Through comprehensive development planning, PUDs provide a mix of zoning classifications including compatible commercial, residential, and even light industrial development. PUDs, which sometimes include clustered development, range in size from a few acres to over 1,000.

PUDs harmoniously blend varying uses to create an attractive, interrelated unit that preserves both property values and aesthetics. As with cluster development, a PUD's goal is to maintain density while maximizing open space. The ideal PUD locates residences and offices within walking distance of each other, dramatically reducing traffic.

A PUD's main water quality benefit is large-scale urban runoff management planning. Local governments control PUDs through negotiations between the developer, the public, and the public review authority. PUDs must maintain open space to facilitate stormwater drainage and sometimes require developers to provide special structures to handle runoff.

Incentive or bonus zoning. This method is used to promote cluster development. It permits the developer higher density than normal in return for maximizing open and/or public use space or other amenities.

Downzoning. Downzoning changes an established zone to a lower density level or less intense use. Typically, industrial zoning permits the most intense land use, followed by light industrial, commercial, and residential.

Downzoning is used on strips of land adjacent to waterways to provide a buffer between industrial sites and the streambank or on a whole area surrounding a waterbody to reverse or prevent pollution.

Phase-in zoning. Phase-in zoning is used when present development is incompatible with water quality goals but abrupt change would be too disruptive to the economy and the community. For example, to protect a lake surrounded by heavy industrial development, the community might close and decontaminate plants when their useful life is finished, rather than allowing them to be sold or leased to another industry, and prohibit new plants from opening.

Large-lot zoning. Large-lot zoning applies to large residential developments, generally 5 to 20 acres. Regulations call for designs that take advantage of common management to achieve water quality goals. These may include reducing the quantity and impact of septic system leachate to a water supply, building stormwater detention basins, or preserving open land to facilitate aquifer recharge.

Conditional zoning. Conditional zoning can be used in a standard zone or where zones are not clearly delineated. It carefully monitors and limits potentially harmful activities by permitting certain activities only under special conditions. For example, a conditional zoning might allow multiunit apartments in a single-family housing zone only if no septic tanks were used.

Floating zone. A floating zone is defined by characteristics rather than geographical location. The proposed use must be compatible with the surrounding uses and conform to the zone's expressed purposes.

Under a floating zone, for example, multifamily dwellings that conform to specific code requirements regarding septic tanks, grading, and open space preservation could be acceptable in an area zoned for single-family dwellings. Alternatively, a floating zone might restrict certain development in a wetland or around a well or aquifer recharge zone. A developer would need to show that the project does not fall within the area subject to floating zones or take adequate steps to protect water quality within the zone.

Overlay zoning. An overlay zone is a mapped district that places restrictions or requirements in addition to those of the underlying zone. Overlay zones are used to meet a special public interest that is not met by the existing zone or by rezoning. For example, these zones can protect specific water sources such as ponds, wells, or wetlands lying within residential, commercial, or industrial zones. In Figure 7, the stream valley corridor buffer overlay zones provide special protection for water resources located within the existing zones, reducing the impact of uses on water and natural habitat.

In another example, Maryland counties use overlay zoning within the Chesapeake Bay Critical Area — a 1,000-foot land buffer surrounding the tidal portion of Maryland's bay tributaries — to protect land and water resources. The critical area overlay zone is designed to foster more sensitive development activity for shoreline areas while minimizing the adverse impacts of develop-

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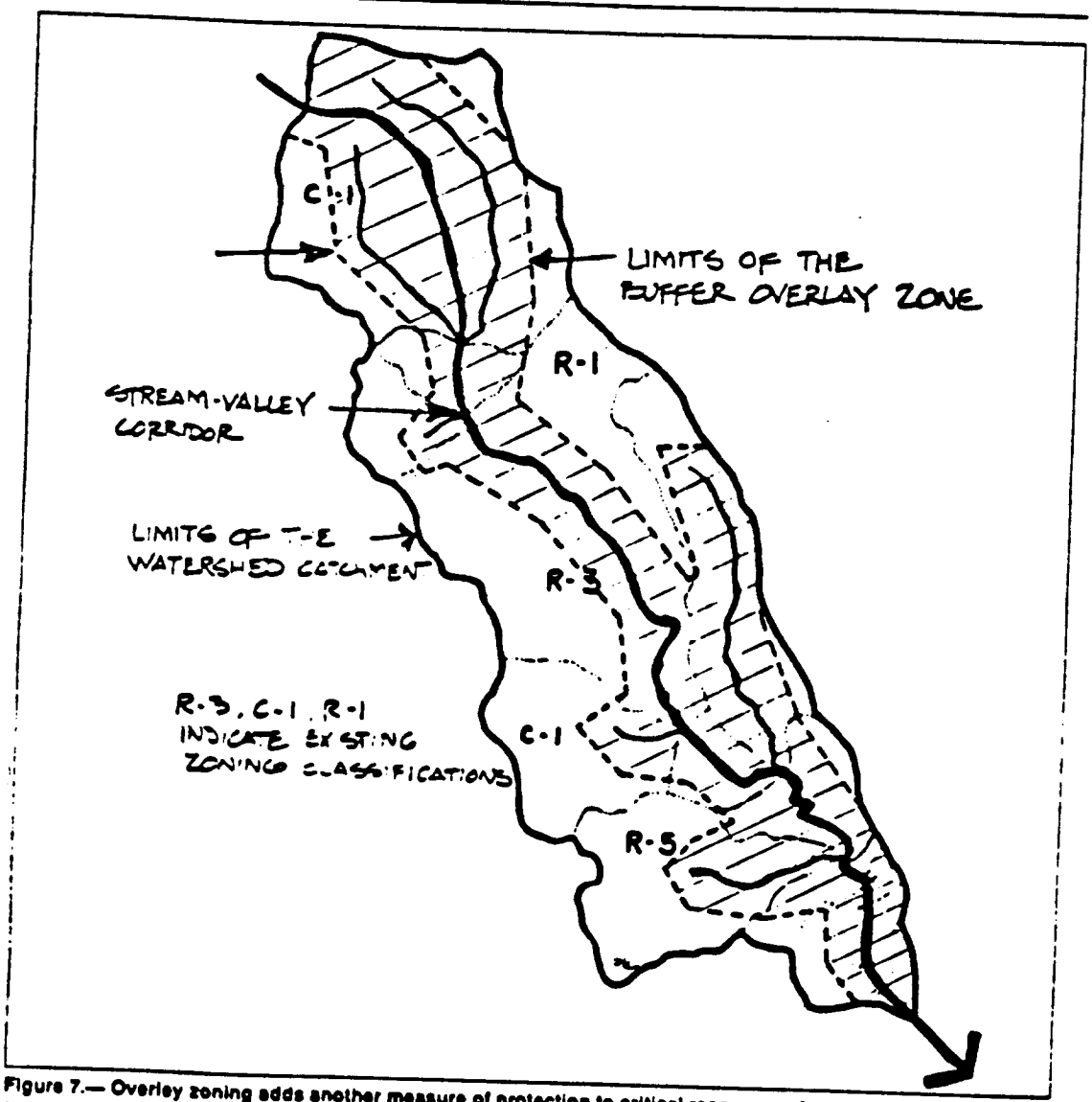

Figure 7.— Overlay zoning adds another measure of protection to critical resources. *Source: Metropolitan Washington Council of Governments, 1983.*

ment on water quality and natural habitats. Zones are known as intensely developed areas (IDAs), limited development areas (LDAs), and resource conservation areas (RCAs).

Floodplain zoning. Building in floodplains — areas subject to periodic inundation by runoff — is considered unsafe. Except for roads or other transportation facilities, development is generally restricted. Local governments or FEMA can provide floodplain maps.

Open space preservation. This zoning protects community open spaces by creating public parks or undeveloped strips of land adjacent to waterbodies. This important zoning provides open space to allow urban runoff to seep into the ground and recharge the water table. Open space preservation also protects critical aquatic habitats such as wetlands, reduces flooding, and enhances aesthetics.

Not all open space uses benefit water quality. A zoo, for example, requires high maintenance to

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dispose of manure, care for parking lots, and clean up litter. In addition, open space should be used differently depending on its location within the watershed.

Aesthetic zoning. Aesthetic zoning places design restrictions on new or historic buildings, preventing development or renovation from blighting the community or destroying its style or scale continuity. Aesthetic zoning can also protect water quality by requiring open space or limiting development size and the pressure it places on the watershed. For example, restrictions can protect attractive shores and swimming, boating, fishing, and other recreational uses.

Performance zoning. Performance zoning limits development to the resources of the specific property. While the overall intensity of use meets zoning requirements, the gross density can vary, depending on the property's characteristics. Performance zoning can set a maximum use intensity (density factor) on the buildable portion of the site. This avoids many small zoning districts providing different levels of protection. The environment is protected from disturbance of unstable or rare resources, but flexibility is allowed in less sensitive areas.

In using zoning as part of an environmental program, planners should consider all options to ensure that the zoning solution is appropriate and feasible. For example, downzoning a heavily developed area to protect a waterbody might not be economically feasible, but incentive zoning could be applied to future development or an overlay zone used to augment existing zoning.

Zoning regulations promote legal issues and challenges. Courts often strike down unnecessarily restrictive or discriminatory ordinances. In addition, zoning is a political issue, often requiring a referendum or other formal adoption mechanism. Therefore, zoning plans must be carefully structured to address a variety of needs and constituencies.

■ **Subdivision review.** Land use is regulated by many zoning categories. However, before separately owned parcels of land can actually be developed, they are subject to subdivision review.

The subdivision review process includes several stages in which various government entities and agencies review development plans to ensure that the developer has met all the standards and requirements placed on the land and has obtained all necessary permits and approvals.

ZONING + SITE PLAN REVIEW

A small, primarily rural Maryland community is devising a plan to protect the water supply of its rapidly growing town.

Subdivision regulations have been amended to give the town council authority to regulate the density of development based on anticipated demands and effects on the water supply and quality. Aquifer recharge areas have been identified and an overlay zoning district established.

A site plan for a development must be prepared by a professional hydrogeologist for review and approval by the town council and the planning commission. The plan must delineate the development within the recharge area and project water demand and its effect on aquifer recharge. If the council determines that the development does not lie within any recharge area, the development plan may proceed through normal processing.

The council or planning commission may reject any plans that

- *impose adverse effects upon the aquifer recharge rate or water quality (the developer may resubmit modified plans),*
- *would create a water demand on the site greater than the groundwater recharge rate, or*
- *cause more than a 10 percent decrease in a site's recharge rate (immediate rejection).*

Other economic and water quality considerations may also be grounds for rejection.

These requirements include building lots, streets, sewers, grading, and relationships to other properties and the comprehensive plan. The review can also include runoff control, drainage, and erosion control requirements, and provisions for parks, buffer areas, open spaces, and maintenance responsibility. These features are often phased in as the project progresses, with completion required by the time the lots are sold.

Before subdivision review was part of the normal planning process, developers often sold lots without such basic design features as roads, parks, and open spaces. The community had to pay for further improve-

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ments. Reviews guarantee that developers meet requirements before construction can begin or proceed.

Subdivision review is a good time to review the design of permanent urban runoff management structures. This allows the entire parcel to be reviewed as a whole rather than in small separate parcels that may not individually require comprehensive treatment.

Site plan review is a stage in the subdivision process. It enables government to review the technical aspects of a proposed development. While not always required, site plan review ensures that new development or expanding current uses comply with zoning, environmental, health, and safety requirements. A site plan shows the proposed development in context and provides a good picture of how it will fit in with the surrounding areas. It shows existing topography, natural features, wetlands, and runoff facilities. The detailed project site includes internal roads and parking areas, building placement, recreational areas, and landscaping.

■ **Land acquisition.** To protect water quality and the environment, jurisdictions can purchase property uniquely valuable to the community. Land purchases protect wells, wetlands, and strips bordering waterways. Publicly owned land is used for parks and recreation and preserved as open space to recharge the groundwater.

While acquiring land to gain control of critical areas can be an effective technique, it is costly. Acquiring contiguous pieces of property often takes many years. Converting private lands to public ownership also removes them from the tax rolls — and requires ongoing management and maintenance expense.

In addition, land purchase is a divisive issue because of the cost and the frequent resistance to taking land out of development. Communities should prioritize potential land purchases and carefully evaluate each parcel's importance, such as ability to recharge groundwater, existing land uses, and development trends. Communities can then plan to fully purchase lands most critical to preserving water quality, and use partial purchase arrangements for less critical land.

Several types of purchase arrangements and financing mechanisms are possible.

Fee simple interest. The most expensive type of acquisition is outright purchase, where the jurisdiction gains full or "fee simple" title and the maximum measure of control over land uses. The community can benefit by establishing parks, recreation facilities, or a conservation district.

Partial interests. More limited interests can be tailored to specific public objectives, including environmental protection. Partial interests generally take several forms:

- *Conservation easements and restrictions.* The easement holder can prohibit actions on the property, such as restricting certain high-density development or prohibiting hazardous materials or septic tank systems. Easements apply to all subsequent landowners for the full term, which might be specified, or in perpetuity. Property owners gain benefits because easements take land off the tax roles or assess it at sharply reduced levels.

WISCONSIN STEWARDSHIP PROGRAM

The Stewardship Program, created in 1989, is part of Wisconsin's century-old history of acquiring and protecting environmentally sensitive lands.

Through the program's streambank protection category, the Wisconsin Department of Natural Resources (DNR) or nonprofit conservation organizations protect water quality and fisheries from urban and rural runoff through land purchases and easements along streams.

In 1992, for example, the department purchased a 43-acre corridor easement for $39,500. The corridor included a 7,000-foot frontage along the Milwaukee River and 27 acres of wetland and lowland woods. The easement protects water quality and fish habitat and assures public access to the shoreline.

While landowner resistance has resulted in only a modest number of easements, DNR has reported a renewed interest in the program, with some 40 landowners giving permission for easement appraisals. The addition of a fee acquisition authority by the legislature should also enhance landowner acceptance.

Source: Wisconsin Stewardship Program Progress Report, April 1993.

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Conservation easements — such as the Maryland Environmental Trust, Eastern Shore Conservancy, Western Maryland Conservancy, and Wisconsin's Stewardship Program — are becoming more prevalent.

- *Purchase of development rights.* In this case, the right to develop the property is purchased, while ownership remains with the landowner. The landowner cannot develop the property, based on the restrictions in the deed.

- *Restrictive covenants.* A restrictive covenant attaches to the property and applies to future landowners. However, unlike an easement in which a local government can enforce restrictions, a restrictive covenant can be enforced only by other property owners similarly restricted.

  To protect water quality, a local planning board might require a restrictive covenant limiting paved surfaces as a condition to granting site plan approval for a proposed subdivision. Or, a government might purchase a parcel outright, place restrictive covenants on the title limiting future development rights, and sell the deed-restricted property back to a private party. Such restrictions can be used to prohibit specific land uses, densities, or activities that pose a threat to water quality.

While partial interests do not provide governments with total control, they have certain advantages:

- the community is not burdened with maintaining the property;
- the property remains on the tax rolls; and
- lower costs allow the community to obtain interests in more parcels.

Financing. Since full or partial purchase of land is costly, the community should carefully consider the alternatives. A number of strategies can be used to finance purchases, including those listed in Chapter 2.

- *Donations or "bargain sales."* Motivate individuals by allowing a charity or tax deduction to donate or take a loss on property sold to the local government.

FINANCING LAND ACQUISITION

Through a land bank program, Nantucket Island — off the coast of Massachusetts — has acquired 1,105 acres from purchase or gift as of June 1993. This represents 3.5 percent of the island's total acreage (see page 17, Nonpoint Source Program Financing). The land bank has targeted two coastal preserves with a large amount of shore frontage for acquisition as open space public lands. The program, funded by a 2 percent real estate transfer fee, receives favorable support from residents.

- *Purchase by conservation groups.* Encourage private conservation groups to purchase the land.

- *Increased water and sewer fees.* Dedicate "user fees" added to utility bills to land purchase.

- *Increased local property or property transfer taxes.* Levy fees on real estate transfers and trust funds set up to acquire land with the proceeds, placing the burden on developers.

- *Municipal bonds.* Issue bonds to raise money for land acquisition, depending on state law and federal limitations.

Protecting Critical Resources

■ **Floodplains.** Floodplains provide flood storage, runoff infiltration, vegetative filters, and protection for wildlife and streambanks. Naturally vegetated floodplains are a valuable habitat for plants and wildlife and allow streams to find their natural courses.

Generally, state and local governments work through FEMA's National Flood Insurance Program to preserve national floodplains. States have passed enabling legislation providing various levels of assistance and coordination to local governments, which adopt measures to reduce or eliminate flood damage in return for flood insurance. When enforced, these measures prevent and/or limit development in floodplains, allowing them to continue to provide flood storage, runoff infiltration, and erosion protection.

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NATIONAL FLOOD INSURANCE PROGRAM

NFIP was created by Congress in 1968 to reduce the loss of life and property and the cost of rising disaster relief from flooding. These goals are achieved by

- *requiring that new and substantially improved buildings be constructed to resist flood damages;*
- *guiding future development away from flood hazard areas; and*
- *transferring the costs of flood losses from the taxpayer to floodplain property owners through flood insurance premiums.*

The courts have consistently upheld the land use management criteria of the NFIP and over 18,000 communities participate in the program.

The floodway, which maintains the flood-carrying capacity of rivers and streams, is the most important provision of the NFIP. The floodway is the area of the watercourse plus adjacent floodplain land that must be preserved to allow the base flood (100-year flood) discharge without increasing flood heights more than a designated amount. Communities must prohibit any development within a floodway that would increase flood heights.

A floodway — a de facto preservation tool — also protects critical riparian habitats, minimizes degradation of surface water quality, and provides for groundwater recharge.

A community that preserves and manages its floodplains also preserves a natural control for nonpoint source pollution and a no-cost alternative to detention basins and other structural controls (see Chapter 4). As an added benefit, homeowners may also enjoy lower flood insurance rates.

■ **Wetlands.** Once considered wastelands, wetlands are now highly valued for a multitude of benefits. In some cases, wetlands are even being constructed to control nonpoint source runoff. Wetlands support plants that remove suspended sediment and dissolved nutrients from runoff and provide a habitat for a variety of wildlife. They also store excess runoff and absorb destructive waves that can erode shorelines. Section 404 of the Clean Water Act protects the nation's wetlands by requiring permits to fill and dredge them.

Although wetland protection and use are critical to any comprehensive plan to reduce nonpoint source pollution, using wetlands to filter pollutants has drawbacks. Wetlands can easily become sinks, allowing trapped toxic pollutants to seep into groundwater. A nonpoint source management plan should, therefore, consider wetlands in the context of the entire drainage system.

■ **Stream buffers.** These undeveloped zones at the edge of waterbodies preserve vegetation to reduce erosion and trap sediment, nutrients, and other pollutants before they reach the water. Buffers can also shade streams to reduce temperature, improving fish and wildlife habitat. Local jurisdictions usually pass laws to establish these buffers.

■ **Stabilized hillsides and steep slopes.** Vegetative or structural controls secure banks by retaining soil, holding back runoff, and maximizing infiltration. To protect slopes, local governments have purchased the land, used a site plan review process, or passed special ordinances.

■ **Aquifers or wellheads.** A valuable water resource, these structures require protection to preserve water quality. Sources as diverse as toxic wastes, manure, pesticides, road salt, and oil can cause contamination.

EPA has estimated, for example, that 20 percent of the one million underground petroleum storage tanks may be leaking and could contaminate water supplies. Since municipal pumping systems draw substances discharged toward the well, areas surrounding wells are particularly vulnerable. Toxins can easily enter an aquifer through an open, unsealed wellhead, making wellheads a chief source of groundwater contamination. Therefore, many county health departments are identifying abandoned wellheads without adequate caps or seals.

Many jurisdictions protect areas around wells, ranging from a few hundred feet to several miles, with special ordinances, permits, and prohibitions against specific types of development and activities. In some cases, communities have purchased the land surrounding a well to assure protection. The Wellhead Protection Program, part of the 1986 Safe Drinking Water Act Amendments, provides technical assistance to communities to protect wellheads.

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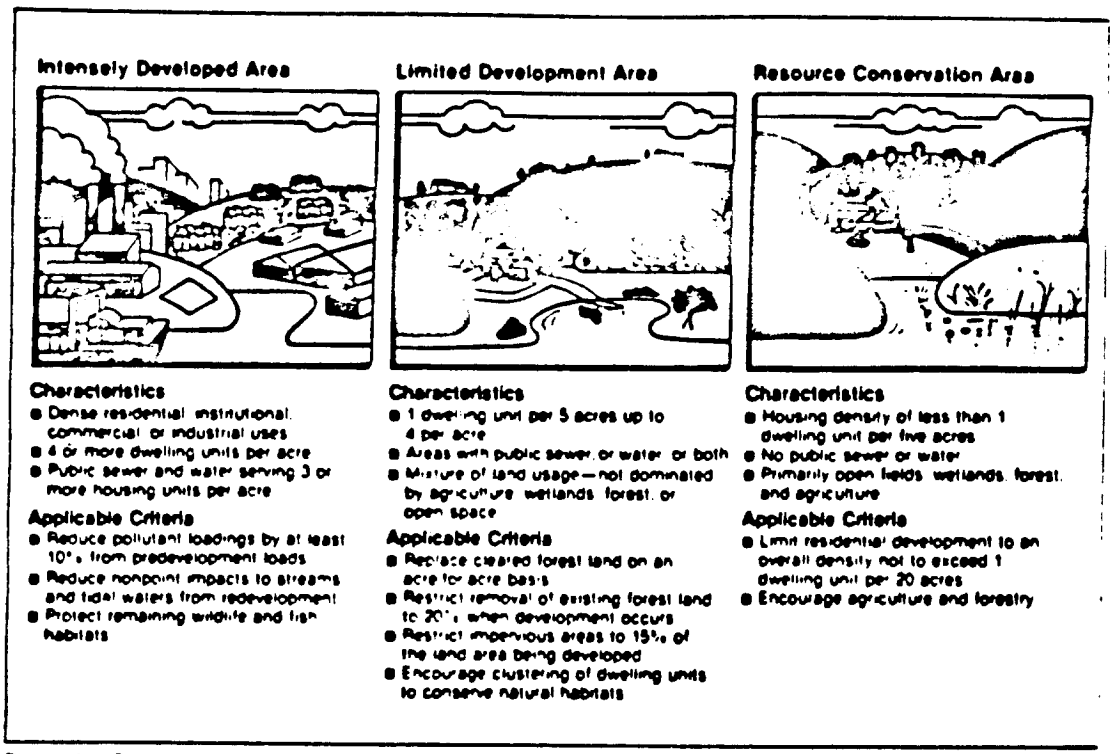

Figure 8.—Characteristics of land classifications in Maryland's critical areas, and criteria for management.
Source: U.S. Environmental Protection Agency, Maryland's Critical Area Program.

Successful Land Use Programs

While land use controls vary according to location, a number of communities have successfully used these strategies to curtail nonpoint source pollution.

As mentioned earlier in this chapter, Maryland's Chesapeake Bay Critical Areas Program is one way local communities can implement state programs designed to protect water quality. The Critical Areas Commission, which established criteria to classify and protect lands in a 1,000-foot strip surrounding the tidal portions of the bay's tributaries, requires jurisdictions to write and adopt local programs. They must include both state and local comprehensive plan requirements for zoning, site planning, subdivision review, and other activities. The Critical Areas program addresses development, resource use, and resource protection.

Local jurisdictions must assign their lands in the critical area to one of the following development categories (see Fig. 8):

- intensely developed — four or more dwelling units per acre;
- limited development — one to four dwelling units per 5 acres; or
- resource conservation — less than one dwelling unit per 5 acres.

These definitions also include other characteristics, such as land usage and sewerage. Development requirements have been specified for all three categories. For example, only 5 percent of the land in a limited development or resource conservation area may be reclassified to more intense use.

Dade County, Florida, has developed a Wellfield Protection Ordinance that prohibits underground storage tanks and other potentially polluting activities in the recharge zone of public wells. The ordinance is based on a mathematical groundwater flow model that predicts the speed that groundwater travels in recharge areas. In Massachusetts, the Cape Cod

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Planning and Economic Development Commission is using a similar principle to protect its well fields.

In 1988, Washington state developed a Local Planning and Management of Nonpoint Source Pollution administrative code (chapter 400-12) that outlines procedures for state watershed management. The state code was originally developed by the Puget Sound Water Quality Authority that monitors an environmentally sensitive area encompassing 12 watersheds.

The Washington program stipulates local watershed plan development, to be funded primarily through grants from the state Department of Ecology. Under the regulation, a watershed management committee prepares plans and addresses all major watershed nonpoint sources. Unlike traditional citizen advisory committees, these local bodies have significant decisionmaking responsibility. They operate under the general aegis of a lead agency — usually a county — responsible for convening the committee and overseeing plan development. The planning committee, government entities affected by the plan, and the Department of Ecology must approve each plan.

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Chapter 4

Urban Nonpoint Source Control Methods

Construction and development activities can be one of the worst sources of urban nonpoint source pollution. Improper construction erosion and sediment control can cause large volumes of sediment to impair sewers, streams, lakes, and stormwater control devices. When this excessive sediment enters small streams, wetlands, and lakes, it can damage or destroy wildlife habitat by smothering stream and lake bottoms, filling impoundments with sediment, increasing dredging costs, and impeding navigation.

After construction is complete, many changes in land use and site drainage characteristics can cause a host of additional problems. Changes include increased impervious surfaces and pollutant loadings, as well as different runoff patterns and increased volumes and temperature. Cold water fisheries may be destroyed, streambank erosion and flooding may be increased, and beneficial uses of waterbodies — such as swimming, fishing, and boating — may be impaired. To avoid or reduce these problems, a dual focus on proper construction site erosion and sediment control and postdevelopment runoff control is necessary.

A number of control practices can be used to reduce the impact of development or redevelopment. Local conditions will determine what practices are appropriate for a given situation. In most cases, standard erosion and sediment control practices can be used, although they may need to be adjusted for areas with steep slopes, intense rainfall, or highly erosive soils. Management strategies for postconstruction runoff controls are generally site specific — they must be specifically designed to fit the individual development site and local conditions. Often a combination of techniques offers the most protection.

Practices used to control sediment and erosion during construction, when the soil is not stabilized, are different from practices used for long-term runoff control after construction. During the site development process — before construction begins — an erosion and sediment control plan should be developed for each activity during construction. This plan should be developed in conjunction with a stormwater management plan to address the runoff from the newly completed project or development.

Tools of the trade are usually referred to as best management practices (BMPs). The term BMP is used to describe the most effective practice or combi-

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nation of practices to control runoff and nonpoint source pollution. A BMP may be a system that reduces the pollutants that enter urban runoff or a method that reduces the amount of pollutants in the runoff before it enters a waterbody. BMPs are generally grouped into categories — structural or nonstructural — depending on the operating principle or physical mechanism used to reduce nonpoint source pollution. Nonstructural controls decrease erosion potential, while structural controls prevent and mitigate erosion and sediment movement.

Nonstructural BMPs are a cost-effective way to manage stormwater runoff and prevent nonpoint source pollution. These controls take advantage of the land's natural features and use, relying on planning, design, maintenance, education, economic incentives, and even regulation to prevent runoff contamination (see Chapter 3).

A variety of urban BMPs can be used to mitigate some of the adverse impacts caused by development. More detailed information on selecting and using BMPs can be found in the resources listed in Appendix B.

Preconstruction Planning

■ **Basic development practices.** Land use strategies for local government to plan an overall nonpoint source control program were discussed in Chapter 3. But requirements for developers before construction begins, particularly at the site plan review stage, can help prevent problems from occurring on individual sites. A developer can be required to submit a detailed plan for managing runoff and for returning the site to a predetermined hydrological condition after completing construction.

Since few control methods can handle the large loads of sediment that erode during construction, a combination of control systems should be planned for and put in place. In some cases, the measures used during construction can be modified to control runoff over the long term.

Use the following check list, singly or in combinations, to develop an urban runoff management plan.

- Respect contours and natural features of the landscape — for example, avoid stream valleys and steep slopes.
- Use downzoning to restrain development.
- Specify minimum lot sizes.
- Limit development by soil type or proximity to waterbody.
- Restrict or prohibit development in sensitive areas identified in the comprehensive plan.
- Limit density of development.
- Limit percentage of lot that can be disturbed.
- Limit percent of impervious cover.
- Preserve natural 100-year floodplain (area that will receive a flood at least once within 100 years); allow no modification of the natural floodplain; and ensure that development is consistent with the comprehensive plan.
- Prohibit clearing or grading on steep slopes (more than 25 percent recommended) and limit road grades (equal to or less than 7 percent recommended).
- Prohibit development in nontidal wetlands and require a buffer zone for these areas.
- Retain upland and riparian trees as a certain percentage of predevelopment tree cover.
- Require waterway disturbance permits for structures such as roads and utilities so they do not restrict fish migration or riparian areas.
- Reserve a minimum percent of open space on each new development site.
- Designate the percent of the land that can be exposed at one time during construction; specify the duration of exposure and the developer's revegetation/stabilization responsibilities.
- Impose time restrictions on construction — e.g., prohibit disturbances during spawning season.
- Revegetate immediately or as soon as possible following construction.
- Provide for stormwater collection or treatment, such as use of sediment control basins, wetlands, or wet ponds, to accommodate large storms.
- Route clean water around the site.
- Maintain infiltration capacity, using natural drainage conditions where possible. This may mean limiting impervious area to a fixed percentage of lot size and limiting runoff to predevelopment rates and characteristics.
- Control erosion and sediment through the watershed protection ordinance.

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- Limit the grade of constructed slopes.
- Stabilize existing steep slopes by sodding and pegging to establish grass cover, building retaining walls, and planting woody vegetation on the most extreme slope.
- Dispose of construction wastes such as oil, cement, and debris.
- Require inspection during and after construction.
- Require long-term maintenance and review of plans for adjacent parcels.
- Ensure that development plan meets all existing ordinances.

■ **Groundwater considerations.** When considering options for postdevelopment stormwater control, groundwater should be considered in choosing a BMP. Activities that have a significant impact on groundwater should be controlled by design standards. For example, a standard could require runoff collection systems for roads and parking lots to control at least the first flush — the first 1/2 inch of rainfall that typically contains most contaminants — during any storm.

Controlling Development

Local governments should consider the total environment in selecting a nonpoint source pollution strategy that will provide the maximum benefit to the environment and to consumers. These benefits usually depend not only on the method itself but also on its design, maintenance, and congruence with the surrounding landscape.

A community's success in preventing pollution depends largely on how well it has planned for controls during and after the development process (see Fig. 9).

BMP	Low flow maintenance	Streambank erosion control	Aquatic habitat creation	Wildlife habitat creation	No thermal enhancement	Landscape enhancement	Recreational benefits	Hazard reduction	Aesthetics	Community acceptance
Dry extended detention	○	●	◑	●	●	◑	◑	◑	◑	◑
Extended detention w/marsh	○	●	●	●	○	◑	○	◑	◑	◑
Wet extended detention	○	●	●	●	○	●	●	◑	◑	●
Wet pond	○	○	●	●	○	●	●	◑	◑	●
Infiltration trench	●	◑	○	○	●	○	○	●	○	●
Infiltration basin	●	◑	○	●	●	◑	◑	●	○	◑
Porous pavement	●	◑	○	○	●	○	○	●	○	●
Water quality inlet	○	○	○	○	●	○	○	●	○	●
Grassed swale	◑	○	○	◑	●	◑	○	●	◑	●
Filter strip	◑	○	○	●	●	◑	○	●	◑	●
Shallow marsh	○	○	●	●	○	◑	○	◑	◑	◑

○ Seldom provided ◑ Sometimes provided (w/design modifications)
● Usually provided

Figure 9.—Comparison of nonpoint source control methods in benefiting the surrounding environment and community. *Source: Metropolitan Washington Council of Governments, 1992.*

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Factors	BMP: Pond Systems (Wet & Dry ED Ponds)	Infiltration Systems (French Drains, Dry Wells, Porous Pave, Trenches)	Wetland Systems (Stormwater Wetlands)	Filter Systems (Sand & Peat/Sand Filters, Grassed Swales)	Water Quality Inlets (Oil/Grit Separators)
Slope	◐	○	◐	○	●
High Water Table	●	○	●	○	●
Close to Bedrock	◑	○	◑	◑	○
Proximity to Foundations	●	○	●	●	○
Space Consumption	○	●	○	●	●
Maximum Depth	●	○	◑	○	○
Restricted Land Uses	●	●	○	●	○
High Sediment Input	◑	○	◑	○	○
Wetlands/Forest Permits	●	●	○	●	●
Stream Warming	○	●	○	●	●

○ May Preclude The Use Of A BMP
◑ Can Be Overcome With Careful Site Design
● Generally Not A Restriction

Figure 10.—Screening techniques for urban BMPs. *Source: Metropolitan Washington Council of Governments, 1992.*

■ **Site conditions.** In developing a comprehensive nonpoint source water quality protection plan, the first step is to assess the site's geographic elements and morphology (see Fig. 10).

Soil. Permeability — the ability of the soil to absorb runoff — is crucial in selecting an appropriate control method. This characteristic particularly affects infiltration methods, which can affect groundwater quality (see Fig. 11).

Slopes. Steep slopes preclude the use of several types of control methods and certain types of development. For example, porous pavement and grassed swales must be situated on sites with slopes of 5 percent or less, whereas infiltration trenches are not practical when slopes exceed 20 percent.

Size of the watershed area. The success of some control methods depends on the watershed size. For example, detention ponds normally do not work unless the watershed area is greater than 10 acres. Alternately, infiltration and vegetative controls are most successful in areas less than 10 acres (see Fig. 12).

Water table. A high water table can reduce the effectiveness of an infiltration basin. If a seasonally high water table extends to within 4 feet of the bottom of an infiltration basin, the site generally is not considered suitable. The depth of infiltration and pond controls are limited by their proximity to the water table.

Distance to bedrock. As with a high water table, a bedrock layer too close to the surface (2 to 4 feet from the bottom of an infiltration basin) will prevent the infiltration basin from draining properly. Similarly, controls that use ponds generally will not work if the bedrock lies within an area that must be excavated to provide stormwater storage.

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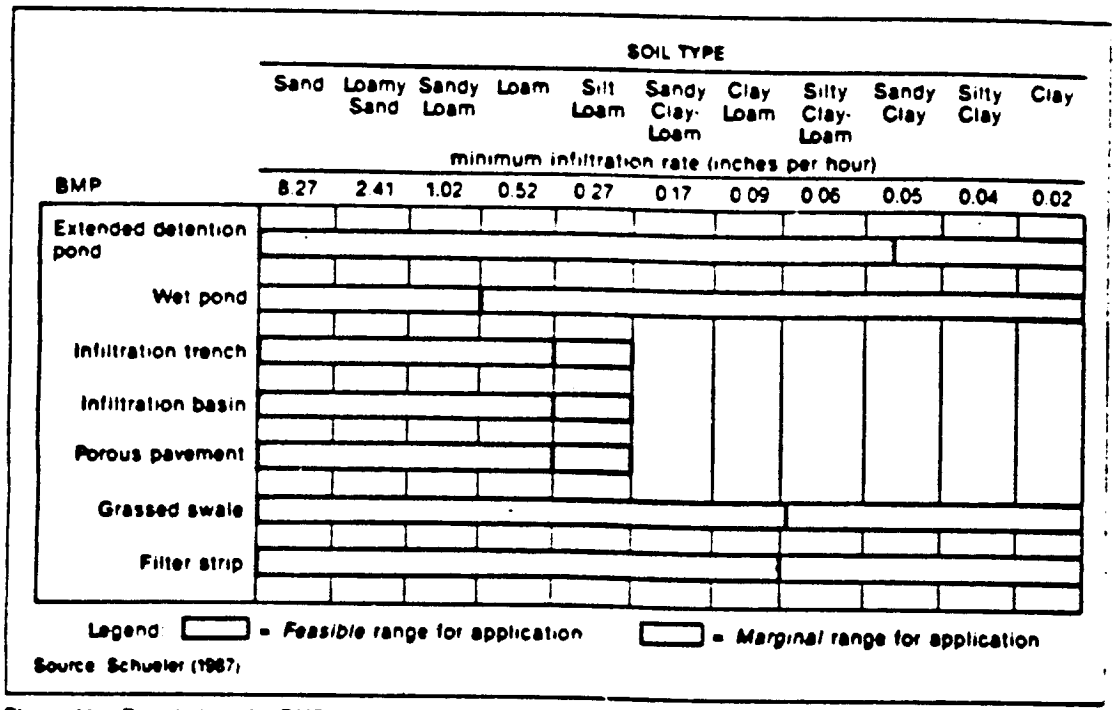

Figure 11.—Restrictions for BMP application based on soil permeability. *Source: Schueler, 1987.*

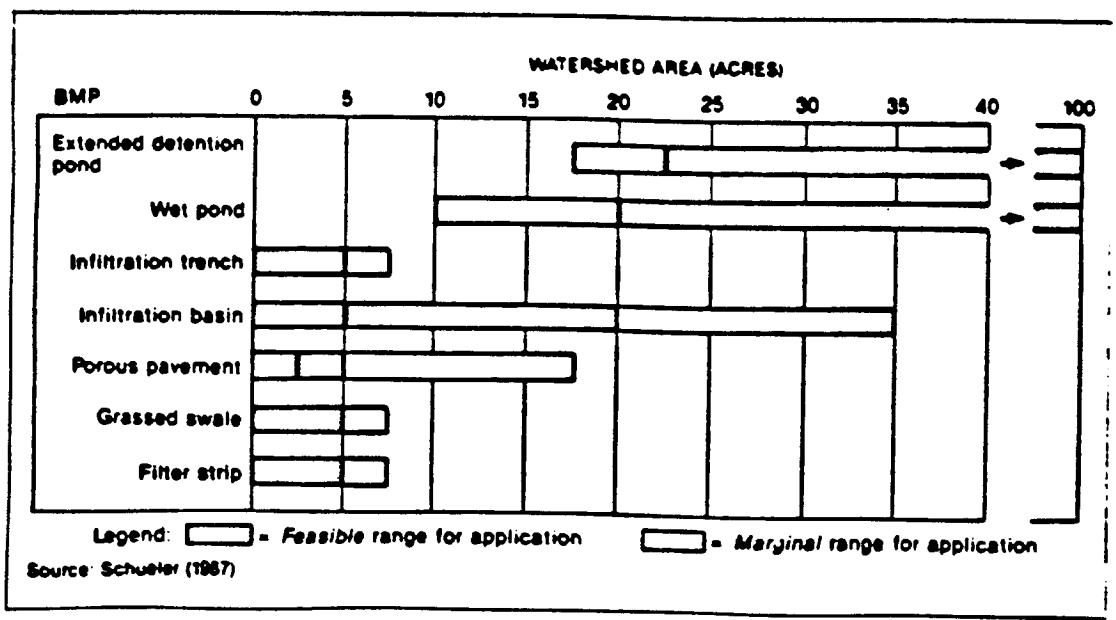

Figure 12.—Feasible BMPs for different watershed sizes. *Source: Schueler, 1987.*

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Proximity to foundations and wells. Infiltration basins should be at least 100 feet away from drinking water wells to prevent groundwater contamination. Wellhead protection areas may require even greater distances to properly protect public water supplies. To prevent seepage, they should be installed at a reasonable distance (100 feet) from a building foundation.

Land use. A very small or intensively developed site may preclude the use of space-consuming controls such as detention ponds and porous pavement. In addition, some controls are appropriate only to particular types of land uses. For example, sand filters are suitable for parking lots, while grassed swales are effective only in low density residential areas.

Effects of temperature. Shallow marshes and wet ponds heat up rapidly during the summer, and their runoff into colder streams can harm aquatic life.

■ **Predevelopment status.** The second step in selecting a control method is to determine which option comes closest to duplicating the site's hydrology prior to development. Consideration involves a number of factors:

Control of peak flows. Some local regulations require that a nonpoint source control method be able to control the peak flow from a two-year storm — a storm expected to produce a flood every two years. Some jurisdictions require control of even larger storms. Ponds are an excellent method for achieving this goal; infiltration basins are somewhat less effective.

Control of first flush. First flush is the disproportionately large amount of pollutants usually found in runoff during the early part of a high intensity or large volume storm, caused by the rapid runoff of accumulated pollutants. First-flush control — the first 1/2 inch of rainfall — can also be required for a runoff area. However, if storms in an area are frequent, the first flush may not be significant and further monitoring may be needed.

Volume control. Infiltration basins can reduce the runoff volumes of smaller storms by diverting much of the runoff back into the soil.

Groundwater replenishment. Infiltration basins provide an excellent way to replenish groundwater lost because of development; however, this benefit must be weighed against the potential for groundwater contamination.

Streambank erosion control. While some nonpoint source pollution methods control streambank erosion to some extent during a two-year storm if properly designed, installed, and maintained, more severe storms require large extended detention ponds and infiltration controls to prevent downstream erosion.

■ **Pollutant removal.** The third step is to determine which control method will remove the greatest volume of pollutants. Important interrelated factors are the removal mechanisms, types and percentage of runoff to be treated (first flush versus total runoff), and the type of pollutant being removed.

The nature of the pollutant is the most important factor in a control method's effectiveness. For example, most control methods are extremely effective in removing sediment and trace metals, which are usually adsorbed into sediment surfaces. However, vegetative systems are more effective in removing soluble pollutants such as phosphorus, nitrogen, and chloride. Systems that combine nonvegetative and vegetative features are generally highly effective.

■ **Cost.** A final step in selecting a control method is estimating the cost by taking into account all factors associated with the method. Construction and both short- and long-term maintenance are, of course, the major cost components. Costs may include

- labor,
- materials,
- land purchase,
- loss of tax revenue on acquired lands, and
- downstream mitigation.

Flood Control and Retrofitting

In the past, flood control efforts have focused primarily on decreasing the volume of water that abruptly enters waterbodies. Traditional methods to reduce flooding include using dry detention basins that temporarily store excess runoff, constructing channels, streambank hardening, and floodplain restrictions that limit development along or in flood-prone stream areas.

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These flood control measures were not originally designed to control pollution caused by increased urbanization. The historical focus was on quantity control — not quality control. Urban planners and water quality professionals now recognize that these issues must be incorporated into an overall strategy that assesses both flooding and pollutant removal. Existing flood control BMPs are now being redesigned or retrofitted to protect water quality. New flood control BMPs are almost universally being built with this dual focus.

A comprehensive watershed protection strategy, which uses nonstructural and structural BMPs, will reduce the long-term costs of both controlling floods and protecting water quality.

Identifying and preserving buffers and natural systems is an important component of a watershed management plan. These areas serve as nonstructural controls, filtering out many pollutants in urban runoff that might reach the waterbodies. However, in existing developments, they have often been altered. When nonstructural controls are impossible or impractical because of existing development, a community may turn to structural practices — constructing new runoff treatment structures or retrofitting existing runoff management systems.

Retrofitting requires modifying runoff control structures or conveyance systems, originally designed to control flooding, to also control water quality. Modifications might include enlarging structures, changing the inflow and outflow patterns, and increasing detention times.

Retrofitting costs are a major hindrance in improving water quality in developed areas. Therefore, communities may need to identify the most insidious pollutants and then select the most cost-efficient and effective solutions to deal with them, thus improving water quality in urban runoff.

Urban Best Management Practices

BMPs should be selected as part of an erosion and sediment control plan during the site development process, with long-term runoff management part of the objective. The best system of practices to control nonpoint source pollution after construction is completed may be a modification of the practices used during the construction process.

Selecting the proper BMP system is critical in achieving the ultimate goal — reducing the pollutants in urban runoff. In selecting the most appropriate BMPs for a specific site, consider the following:

- the site's physical condition and development status;
- runoff control benefits provided by each BMP option;
- the pollutant removal capability of each BMP option under several design scenarios;

URBAN RUNOFF CONTROL PROGRAMS

Several states and localities have made significant advances in developing and implementing runoff controls. Two particularly noteworthy examples are in Maryland and Florida.

- *Maryland began its stormwater management program with the passage of a 1982 state law requiring each county and municipality to adopt a stormwater management ordinance based on state criteria. Criteria call for maintaining predevelopment hydrological conditions and reducing erosion and pollution.*

  The state Sediment and Stormwater Administration reviews and approves local ordinances and develops stormwater management programs for state and federal construction projects. The ordinances must include an approved stormwater management plan, criteria and procedures for stormwater management, proper implementation of the plan (including design criteria for specific proposed controls), maintenance and inspection procedures, and penalties for noncompliance. The ordinances are required for any new construction projects, with a few exceptions for single-family homes on small parcels of land.

- *Florida's stormwater management program applies to all new development. Administered through a stormwater rule that serves as a performance standard, Florida's program ensures that runoff volume, speed, timing, and pollutant loads are close to predevelopment levels.*

  The standard requires that a stormwater management system remove at least 80 to 95 percent of the annual pollutant load of sediments, nutrients, and many heavy metals. If permit applicants show that they can meet the standard, the state assumes that water quality requirements will not be violated. But if violations occur, the state can impose more stringent requirements, even if the basic performance standard has been met.

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- the environmental and human advantages of each BMP option; and
- the long-term maintenance cost of the BMP.

Table 3 compares the effectiveness of a number of currently used urban best management practices. Urban BMPs are generally grouped into four categories based on the operating principle or physical mechanism used to reduce the amount of runoff pollutants — detention basins, retention/infiltration devices, vegetative controls, and source controls.

■ **Detention basins.** Detention basins are most popular and effective in reducing suspended solids and particles by temporarily holding the runoff and allowing the sediment to settle.

In addition to reducing the pollution in runoff, detention basins also delay the amount of runoff released into receiving waters, thus reducing flooding and streambank erosion and lessening the stress on the physical habitat. The slow release also dilutes the runoff, thereby reducing the concentration of pollutants entering the stream.

With proven success in controlling runoff, detention basins can reduce suspended solid concentrations by 50 to 95 percent. These basins can be used for large drainage areas, be incorporated into new development site plans, and enhance the value of the surrounding property.

Often, however, finding suitable land for a detention basin is difficult and constructing basins in developed areas may not be possible. One solution may be to convert dry ponds previously installed for flow control; they can usually be economically retrofitted to detention basins.

Routine maintenance is required for detention basins. Solids should be removed regularly, because removing accumulated solids after 10 to 20 years can be expensive.

Detention basins are generally of three types:

Dry ponds. Used for flood and erosion control, dry ponds remain dry and available to catch water following large storms. While intended to control water quantity, they can be retrofitted to improve water quality.

Wet ponds. Designed to hold water permanently, wet ponds can be highly efficient in removing sediment and in reducing nutrients through biological activity such as algal growth if properly constructed.

Extended detention dry ponds. These ponds catch stormwater and retain it for 24 to 40 hours, remaining dry at other times. They remove pollutants by trapping sediment particles and allowing them to settle.

■ **Retention/infiltration devices.** Retention or infiltration devices allow runoff to percolate into the ground, reducing the amount of pollutants released into the receiving water. The filtration and adsorption mechanism traps many pollutants — particularly suspended solids, bacteria, heavy metals, and phosphorus — in the upper soil layers and prevents them from reaching the groundwater.

Infiltration devices can remove up to 99 percent of runoff pollutants, depending on the percolation rate and area, soil type, pollutants present, and available storage volume. Success also depends on the rainfall. Not only do infiltration devices have high pollution removal rates, but they can also be built in developed areas and effectively reduce the volume of runoff.

However, poor site conditions such as impermeable soils, a high water table, and bedrock can lessen the effectiveness or cause failure of retention/infiltration devices. These devices must also be installed carefully to prevent soil compaction from heavy machinery, and they require such pretreatment devices as grass filter strips to remove coarse sediment from the infiltration surface. Operation and maintenance are also critical. Many infiltration BMPs have failed from lack of maintenance. Devices must be designed for ease of access, maintenance, and operation.

Retention devices fall into the following categories:

Infiltration basins. An infiltration basin is a natural or excavated large open depression. It temporarily stores runoff until the water percolates through the bottom or sides. Excess runoff can overflow through elevated outlets to maximize the storage volume. Because runoff usually percolates in a day or two, these basins can be dry.

Infiltration trenches and dry wells. Similar in design, infiltration trenches and dry wells are excavated holes filled with coarse stones and then covered. Dry wells are used primarily for roof drainage; trenches are used on larger areas such as streets and commercial parking lots. In both designs, runoff infiltrates the surrounding soil or is collected by perforated underdrain pipes and routed to an outflow. Infiltration trenches preserve the natural hydrology of an area and can fit on small sites. However, they require considerable maintenance and can contaminate groundwater under certain conditions.

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URBAN BMP OPTIONS*	RELIABILITY FOR POLLUTANT REMOVAL	LONGEVITY*	APPLICABLE TO MOST DEVELOPMENTS	WILDLIFE HABITAT POTENTIAL	ENVIRONMENTAL CONCERNS	COMPARATIVE COST	SPECIAL CONSIDERATIONS
STORMWATER WETLANDS	Moderate to high, depending on design	20+ years	Applicable to most sites if land is available	High	Stream warming, natural wetland alteration	Marginally higher than wet ponds	Recommended with design improvements and the use of micropools and wetlands
EXTENDED DETENTION PONDS	Moderate, but not always reliable	20+ years, but frequent clogging and short detention common	Widely applicable, but requires at least 10 acres of drainage area	Moderate	Possible stream warming and habitat destruction	Lowest cost alternative in size range	Recommended with design improvements and the use of micropools and wetlands
WET PONDS	Moderate to high	20+ years	Widely applicable, but requires drainage area of greater than 2 acres	Moderate to high	Possible stream warming, trophic shifts, habitat	Moderate to high compared to conventional	Recommended, with careful site evaluation
MULTIPLE POND SYSTEMS	Moderate to high; redundancy increases reliability	20+ years	Widely applicable	Moderate to high	Selection of appropriate pond option minimizes overall environmental impact	Most expensive pond option	Recommended
INFILTRATION TRENCHES	Presumed moderate	50% failure rate within five years	Highly restricted (soils, groundwater, slope, area, sediment input)	Low	Slight risk of groundwater contamination	Cost effective on smaller sites, rehab costs can be considerable	Recommended with pretreatment and geotechnical evaluation
INFILTRATION BASINS	Presumed moderate, if working	60 – 100% failure within 5 years	Highly restricted (see infiltration trench)	Low to moderate	Slight risk of groundwater contamination	Construction cost moderate, but rehab cost high	Not widely recommended until longevity is improved
POROUS PAVEMENT	High (if working)	75% failure within 5 years	Extremely restricted (traffic, soils, groundwater, slope, area, sediment input)	Low	Possible groundwater contamination	Cost-effective compared to conventional asphalt when working properly	Recommended in highly restricted applications with careful construction and effective maintenance
SAND FILTERS	Moderate to high	20+ years	Applicable for smaller developments	Low	Minor	Comparatively high construction costs and frequent maintenance	Recommended, with local demonstration
GRASSED SWALES	Low to moderate, but unreliable	20+ years	Low-density development and roads	Low	Minor	Low compared to curb and gutter	Recommended, with checkdams as one element of a BMP system
FILTER STRIPS	Unreliable in urban settings	Unknown, but may be limited	Restricted to low-density areas	Moderate if forested	Minor	Low	Recommended as one element of a BMP system
WATER QUALITY INLETS	Presumed low	20+ years	Small, highly impervious catchments (<2 acres)	Low	Resuspension of hydrocarbon loadings; disposal of hydrocarbon and toxic residuals	High, compared to trenches and sand filters	Not currently recommended as a primary BMP option

* Based on current designs and prevailing maintenance practices. *Source: Metropolitan Washington Council of Governments, 1992.*

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Sand filter. Sand filters, used to pretreat runoff before it enters another stormwater structure, are suitable for small sites in highly impervious areas and can be retrofitted into existing urban areas. To use sand filters, drainage areas must be stabilized against erosion. Designed mainly to enhance water quality, sand filters are also used to control first-flush water quantity in smaller drainage areas.

Porous pavement. Most practically used for parking lots, porous pavements increase infiltration of water into the soil, maintaining the water balance at nearly the same level as before the land was paved. Runoff rapidly permeates the pores of several layers of different permeable materials and filters the pollutants into the underlying subsoil or perforated drain pipes. The rate of pollutant removal depends on the amount of filtered runoff and underlying soil type.

A study by the Metropolitan Washington Council of Governments found that porous pavement removes as much or more suspended sediment and other pollutants — phosphorus, nitrogen, bacteria, lead, and zinc — as detention/retention basins. Porous pavements can also moderate runoff rate and volume so that drainage patterns and surrounding vegetation remain normal, improving erosion control and enhancing water quality.

Operation and maintenance must be considered in the use of porous pavements, however. They do eventually clog and should be routinely vacuumed.

Oil/grit separators. Also known as water quality inlets, oil/grit separators are designed to remove sediment and hydrocarbons from runoff before it is released to the storm drain network or infiltration system. Runoff passes through long, rectangular concrete chambers — modified to remove sediment, grit, and oil — before exiting through a storm drain pipe.

Oil/grit separators are used infrequently because of their limited ability to remove pollutants caused by low average detention times and the possibility that pollutants removed during one storm could reenter runoff from later storms. However, oil/grit separators can remove coarse-grained sediments from urban runoff and treat runoff before it enters underground filtration systems. They are unobtrusive, compatible with storm drain networks, and easily accessed.

OPERATION AND MAINTENANCE OF URBAN BMPS

Proper operation and maintenance of urban BMPs are critical to their success. A 1990 study of four Maryland counties showed that in 434 wet and dry detention ponds, 70 percent were not operating properly. Poor maintenance was the most frequently cited reason.

To ensure that stormwater management facilities are an asset to the community, not a liability, maintenance must include

- *periodic inspections;*
- *debris and sediment removal from basins and channels;*
- *pipes, pumps, and structure maintenance;*
- *general housekeeping, such as grass cutting and repairs;*
- *mosquito control;*
- *fish stocking; and*
- *vegetation control.*

Before adopting a nonpoint source program using urban BMPs, include sufficient funding for regular maintenance to ensure proper functioning.

Maintenance can be performed by private corporations, individuals, or local government staff. While homeowners' associations and individual property owners can do some maintenance, depending on private citizens to maintain urban BMPs is risky. Legal maintenance and monitoring agreements can be negotiated between a developer and the local public works department. When maintenance is clearly its responsibility, local government may choose to contract with a private company.

A realistic cost estimate is vital to making the community aware of its responsibility for nonpoint source pollution. Maintenance requires staff time to record and assess routine maintenance checks and on-site visits to perform the routine checks.

■ **Vegetative controls.** Vegetative BMPs decrease the velocity of stormwater runoff, promoting infiltration and settling of suspended solids and preventing erosion (see Fig. 13). For maximum effectiveness,

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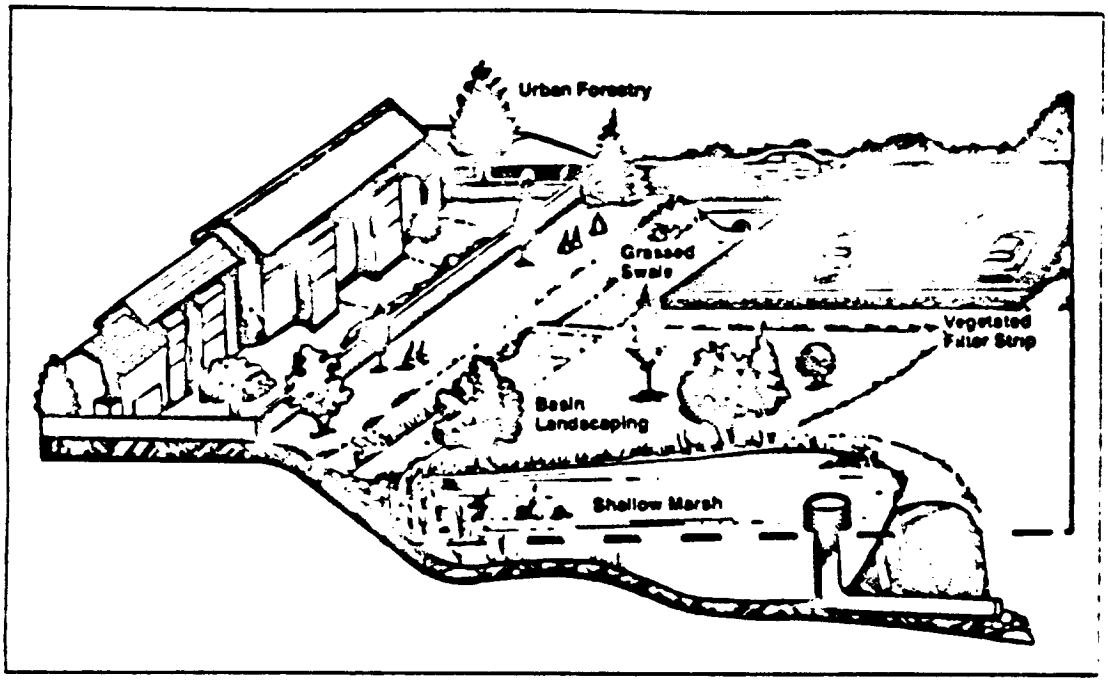

Figure 13.—Vegetative BMPs take many forms and are used for various purposes. *Adapted from Schueler, 1987.*

vegetative controls must be used in combination with other BMPs as a first line of defense in removing suspended solids before more intensive treatments take over. Vegetative BMPs also remove organic material, nutrients, and trace metals.

Less costly than other control practices, vegetative controls enhance the attractiveness and value of sites. Using vegetative controls to pretreat runoff improves the operation and maintenance of other BMPs.

The ultimate performance and practicality of vegetative controls depend on the site's physical features. Plant material must be selected carefully and regularly maintained. Because they have limited ability to control runoff, and effectiveness varies according to the season, vegetative controls should not be a site's only control practice.

Several types of vegetative controls are as follows:

Basin landscaping. Landscaping can improve a stormwater basin's effectiveness in removing pollutants. Landscaping around a basin reduces the amount of impervious surface area, provides an attractive, green buffer along streambanks, and protects and enhances the use of existing wetlands. Proper landscaping can route stormwater runoff through green areas and away from erosion-prone steep slopes and other areas.

Grassed swales. Grassed swales are depressions, such as gullies, that infiltrate and transport runoff water. They are often used in residential developments and on highway medians as an alternative to curb and gutter drainage systems.

Swales control peak discharges by reducing runoff velocity. The swale allows some runoff to infiltrate the soil, thus diminishing the volume of water passing downstream. Swales are easy to construct, attractive, and a potential habitat for wildlife. However, effectiveness varies considerably from site to site; swales may encourage mosquitos, ragweed, dumping, and erosion.

Filter strips. While similar to grass swales, filter strips are shallower and distribute runoff across a wider area. Their efficiency depends on strip length, slope, and size; soil porosity; normal runoff velocity; and vegetation type. Grassy strips supplemented with shrubs and small trees increase the ability to absorb and retain nutrients.

Riparian reforestation. Trees planted near streambanks can stabilize soil, cool water, and benefit many forms of aquatic life.

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■ **Pollution prevention.** Local governments should establish ongoing programs to reduce the generation and exposure of pollutants that accumulate on streets and other surfaces, and eventually wash into lakes and streams. These source reduction programs are usually called pollution prevention programs.

In most cases, pollution prevention is more cost effective than structural BMPs in reducing pollutant loadings. However, a combination of source reduction efforts and structural BMPs is generally needed to fully control the effects of urbanization.

Pollution prevention controls — also known as nonstructural controls — include land use planning and zoning strategies, as well as public education efforts. Storm drain painting, recycling, and household hazardous waste collection offer high value for the initial investment. Incentives to use public transportation or otherwise lower emissions that generate pollutants are also considered source controls. (See *Clean Water in Your Watershed: A Citizens Guide to Watershed Protection* for more information on source reduction controls and areas to target for community participation.)

Pollution prevention controls can generate a sense of community; in addition, they have aesthetic or economic benefits. To be effective, source reduction practices require a combination of education, regulation, and guidance. Chapter 5 more fully discusses these issues relating to citizen involvement and education.

Listed below are common pollution prevention controls communities can consider. Local governments can

- collect and recycle crankcase oil;
- begin leaf and other yard waste collection programs;
- establish catch basin drainage programs;
- redesign road salting programs to minimize the salt quantity and, where feasible, use an alternative deicer;
- educate the public about the hazards of fertilizers and pesticides used in commercial lawn care and grounds maintenance operations and the alternative organic treatments;
- start remedial erosion control programs;
- educate the public on how to reduce litter and properly dispose of pet wastes and household pollutants;
- remove illegal and improper industrial and commercial connections to storm drains that discharge directly into receiving waters without prior treatment; and
- plug or seal abandoned wells and cisterns that are conduits for nonpoint source groundwater pollution.

Other administrative strategies may include hazardous waste restrictions or contingency plans. Source prohibitions — barring storage or use of dangerous materials in a defined area — are common ways to protect health and the environment. Many jurisdictions, for example, now prohibit handling or storing toxic chemicals where a spill could threaten groundwater supplies. Jurisdictions also offer hazardous waste amnesty days, which provide residents the opportunity to properly dispose of hazardous waste.

Many commercial and industrial users produce hazardous wastes that threaten water quality. They include dry cleaners, auto service stations, industrial plants, trucking and railroad facilities, and airports. Other activities — such as agriculture, junk yards, machine shops, landfills, and septic systems — also use hazardous materials.

Most of these activities are controlled by NPDES industrial or municipal stormwater permits, but local governments should check with their permitting authorities to determine the degree to which permit requirements are being met and controls inspected.

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Chapter 5

Community Education and Citizen Involvement

Even the best planned nonpoint source pollution program cannot succeed without community participation and cooperation. Citizen monitoring groups and solid public information and education programs are invaluable tools to be planned for and nurtured.

Because nonpoint source pollution is a continuing issue related to development and individual life styles, a water quality program must be established and embraced to succeed. Organization and ordinances mean nothing without community support. The community must buy in and accept the program, just as it does a sewage treatment system.

To gain support, you must understand your community. Is your community small or large? Are residents primarily retired or parents with young children? Are residents commuters or do they earn their living in the community? Do most residents stay in the community all year or seasonally? How much do residents know about nonpoint source pollution? How will they be affected by a nonpoint source management plan? How can they be expected to react to the proposed plan?

A public opinion survey or series of well-publicized public hearings throughout the watershed and in your immediate community will help you get to know the community and give you a basis for measuring public opinion.

■ **Public awareness.** Public information and education are important ways to curb nonpoint source pollution, since the solution lies largely in changing individual behaviors and lifestyles. An informational program must educate citizens about the problem and make citizen involvement part of the solution.

■ **Framing the message.** An initial step in developing a public awareness program is to frame your message. Determine what information about nonpoint source pollution you wish to convey, and stress this message at every opportunity. The tone and level of complexity of your message depend on the community's composition and sophistication. The program should include concrete information about using and disposing of toxic substances in homes, yards, farms, and work places.

■ **Targeting the audience.** Nonpoint source pollution affects everyone in the community. On the issue of control, business people, developers, and home-

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owners each have an individual agenda. Make sure your public awareness program considers these individual needs and interest.

Tailor your messages and presentations to specific groups — for example, college faculty, city employees, developers, civic organizations, or youth groups. Involve environmental groups such as the Izaak Walton League, state associations of conservation districts, and other public or private organizations.

■ **Reaching your audience.** A targeted public awareness campaign uses a variety of tools to convey your message and attain your goals. Some of the tools include

- *Media*. Techniques include press releases, articles, photos with captions, talk shows, news programs, public service announcements, newsletters, and public notices to publicize your message.
- *Community events*. River/lake festivals, county/city fairs, and other special events are educational and public awareness opportunities to make your message known to a variety of audiences.
- *Awards*. Broaden your visibility, recognize good work, and gain a variety of advocates for your program through conservation awards for young people, public service awards, and participation and sponsorship awards.
- *Meetings*. Use public gatherings, club meetings, special conferences, and workshops to explain your program; customize your message to the needs and interests of your audience.
- *Speakers' bureau*. Face-to-face communication to a specialized audience provides a powerful opportunity to deliver your message, answer questions, and clarify ambiguities.
- *Educational materials*. Brochures and posters obtained from EPA, the state water authority, or other groups can be distributed to schools, civic groups, and businesses to further support your message.

■ **Using a variety of information/education tools.** The numerous techniques available to make your community aware of the nonpoint source problem and its solutions are limited only by your imagination and budget. See the following list and Table 4 for ideas to ensure support from your community:

- Publicize your program in all possible ways — use fact sheets inserted into utility statements, flyers, radio, TV, newspapers, public hearings, group meetings; develop personal contacts with reporters — offer story and photo opportunities.
- Tailor your message to various levels of knowledge — from those who understand the concept of nonpoint source pollution to those who have never heard of it.
- Form committees to work on specific aspects of the program; include representatives from all interest groups.
- Offer field trips to groups. Seeing the watershed's problem has much more impact than reading about it.
- Distribute drafts of the plan to interested groups for review.
- Set up meetings using existing organizations such as 4-H or Extension Service and organize community informational watershed workshops.
- Involve schools — make presentations to classes or conduct field trips.
- Set up nonpoint source pollution displays at every opportunity — county fairs, local Earth Day events, conferences, school events.

■ **Citizen monitoring.** Environmentally conscious citizens have made great contributions to local programs nationwide. Groups such as the Chesapeake Bay Watch and the Streamwalk Committee in Seattle, Washington, have become integral parts of the water quality program. Citizen groups can collect valuable information on basic parameters — they can monitor and identify problems, collect surface water samples, and measure turbidity.

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Table 4.—Community education and citizen involvement methods.

METHOD	MOST EFFECTIVE USE	RESULTS
Newsletters	Announce meeting time and dates, update information on actions already taken, list issues to be discussed at upcoming meeting	Public awareness
Newspaper articles	Same as newsletter — provide additional detail about local success stories, photos of citizen activities, feature articles provide information about problems and solutions	Public awareness
Demonstration sites	Exhibit innovative technology — should be accompanied by signs, brochures, or permanent on-site interpretive staff	Public awareness, knowledge, understanding
Printed and taped material (e.g., factsheets, videos)	Explain new technology, describe case studies, provide training information for new employees, outline facts to stakeholders	Public awareness, knowledge, understanding
Signs	Mark watershed boundaries, identify critical areas, promote specific behaviors in specific places, identify cooperators in project, explain adjacent project and its BMPs, provide interpretive natural resources information	Public awareness, knowledge, understanding
Meetings	Share information, plan actions, evaluate progress	Public awareness, knowledge, understanding, desire/ability to act
Field trips	Observe resources to be protected, view installed BMPs, learn how BMPs operate, monitor (assessment or compliance type) BMPs	Public awareness, knowledge, understanding, desire/ability to act
On-site inspections	Identify problems, recommend corrective actions, evaluate effectiveness of pollution controls, identify noncompliant stakeholders, educate individuals	Action
Training	Provide new skills to stakeholders	Action
Technical assistance	Identify problems, recommend solutions, assist with installation of BMPs, educate individuals, evaluate effectiveness of solutions	Understanding, desire/ability to act, action

Source: Terrene Institute, Clean Water in Your Watershed: A Citizens Guide to Watershed Protection, 1993.

Local officials see two advantages to citizen monitoring. First, these activities are an economical way to gather high quality data. Second, citizen monitoring is a valuable tool to build grassroots interest in water quality issues. In addition to helping officials identify and avert potential water problems, citizen groups build public support for nonpoint source programs and remedial actions, when necessary.

Despite these benefits, a volunteer program needs careful handling. Everyone is not suited to be a volunteer monitor. Groups and individuals may have difficulty staying motivated throughout an entire sampling project. Inappropriate training or procedures can result in useless data. Sampling also involves a slight risk of injury; local governments must have sufficient liability insurance to cover such situations.

Consider the following recommendations concerning volunteer monitoring programs:

- Citizen monitoring projects should not stand alone but should be integrated into a total water quality management program.
- A qualified water quality specialist should develop the sampling design, analyze the data, and prepare the final report.
- A qualified water quality specialist should train and supervise volunteers in the field, review data frequently, and work closely with the state water quality agency.

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TVA RESERVOIR LANDS PLANNING PROGRAM*

The Tennessee Valley Authority manages some 300,000 acres of public reservoir lands, spanning seven states and including 23 multipurpose reservoirs with more than 11,000 miles of shoreline.

When he established TVA in 1933, President Franklin D. Roosevelt charged it with "the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin."

TVA uses the land for activities ranging from generating electrical power to managing recreation, forestry, and wildlife areas. Communities and the public use TVA's reservoir lands for industrial and navigation facilities, agriculture, community parks, and recreation.

Since it receives more than 1,500 requests for land use each year, TVA considers planning a land management priority. To accommodate the growing demand for development on its lands, TVA initiated a planning process to balance competing demands for public and private uses with environmental needs and national, regional, and local values.

TVA uses planning teams to determine how the land should be used. The team considers public comment, compatibility with existing and adjacent land uses, and legal requirements in making its decision. Plans approved by the TVA Board are continually revised to keep up with growth pressures, economic trends, public needs, environmental conditions, and changing laws. A Geographic Information System (GIS) keeps track of an endless amount of resource data on which the team bases and updates its recommendations.

As part of its planning process, TVA developed a three-step public participation plan. First, TVA identified why and how the public should be involved; next, it identified its audience; and finally, it planned how to involve the public. During public meetings, for example, private citizens and local, state and federal agencies identify regional concerns and local land use issues. This information is incorporated into the GIS data and used to make social, cultural, and environmental planning decisions.

TVA's land planning process provides a continuing opportunity for local governments and citizens to offer their views on how public reservoir lands should be used, with public acceptance an added benefit. This objective assessment of regional needs guides TVA in handling a multitude of land use request.

Constant public involvement and reevaluation give TVA an insight into early problems, avoiding later crisis management. In addition, local governments and interest groups have a clear understanding of TVA's land use and development intentions. Finally, this process provides warnings of potential detrimental impacts to water quality from proposed uses.

**Adapted from TVA Reservoir Lands Planning and Land Management Planning Applications of a Geographic Information System fact sheets.*

- The sample design should be relatively simple and not dependent on precise measurement.
- Volunteers should be carefully recruited and trained; periodic training may be necessary to replace drop-outs and refresh monitoring skills of current volunteers.
- The water quality specialist should encourage frequent reports, personal presentations at group meetings, and media coverage to keep the group motivated.

The Missing Link — Community Partnership

The optimum situation — informed watershed planning to identify and correct existing problems and prevent future problems — will achieve the best environment possible. But all planning, no matter how complete, must be done *with* your community, not *for* it.

The advantages of the prevention/restoration ethic are impressive and would tempt any community — clean, usable waterbodies attract business and recreational dollars and measurably improve the economic health of the community. Remedial measures, designed to address current environmental conditions, can return water resources to an acceptable purity level.

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However, billions of dollars are lost on public works projects, declining property values, and missed revenues from tourism, recreation, and other uses because of the missing link — community partnerships. Without community buy-ins by educated citizens who understand their individual responsibility and the community's needs, remediation will need to be repeated in each generation, if not more often.

Planning and prevention within the total community and watershed area comprise a vital permanent solution to water quality issues. In some cases, eliminating the cause of pollution may not be enough — the waterbody will still need rehabilitation. In other cases, communities must restore the quality of a waterbody even as they prevent further harm.

So plan for the optimum, seeking guidance and cooperation from your community along the way. When the community agrees to implement the plan you know will work, you will have served them — and the environment — well.

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Appendix A

Federal Water Quality Program Summary

Coastal Zone Management Act of 1972 (CZMA)

This act established a program to encourage states and territories to develop comprehensive programs to protect and manage coastal resources, including the Great Lakes. To receive federal approval and implementation funding, states and territories had to demonstrate programs and enforceable policies sufficiently comprehensive and specific to regulate land and water uses and coastal development and to resolve conflicts between competing uses. They also needed authority to implement the enforceable policies.

Under federally approved state and territorial programs, the program must protect and manage important coastal resources, including wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitats. Resource management and protection are accomplished through state laws, regulations, permits, and local plans and zoning ordinances.

Water quality protection was not specifically cited as a purpose or policy of the original statutes. The Coastal Zone Act Reauthorization Amendments of 1990 specifically charged state coastal programs, and state nonpoint source programs, to address nonpoint source pollution affecting coastal water quality.

Coastal Zone Act Reauthorization Amendments of 1990 (CZARA)

In these amendments, Congress recognized that nonpoint pollution is a key factor in the continuing degradation of many coastal waters and established a new program to address this pollution. Congress further recognized that the solution to nonpoint pollution lies in state and local action. In enacting CZARA, Congress called upon states to develop and implement state coastal nonpoint pollution control programs.

EPA developed the technical guidance to help states develop control programs. The guidance specifies management measures for sources of nonpoint pollution in coastal waters — agriculture, silviculture, urban, marinas, and hydromodification. Management measures are economically achievable measures to control the addition of pollutants to coastal waters; that is, they reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

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National Pollutant Discharge Elimination System (NPDES)

Traditional point sources of water pollution are regulated by EPA and the individual states under the NPDES permit program established by section 402 of the Clean Water Act, which establishes permit requirements for certain municipal and industrial stormwater discharges.

Under Phase I, NPDES permits are required for municipal separate storm sewers serving large or medium-sized populations (greater than 250,000 or 100,000 people, respectively) and for stormwater discharges associated with industrial activity. Permits are also issued, case by case, if EPA or a state determines that a stormwater discharge contributes to a violation of a water quality standard or significantly contributes pollutants to U. S. waters.

Under Phase II, EPA is to prepare two reports to Congress that (1) assess the remaining stormwater discharges, (2) determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges, and (3) establish procedures and methods to control stormwater discharges to the extent necessary to mitigate impacts on water quality. Then EPA is to designate stormwater discharges in addition to those addressed in Phase I that must be regulated to protect water quality and establish a comprehensive program to regulate those designated sources.

Section 319 of the Clean Water Act

This statute establishes a national program to control nonpoint sources of water pollution and to protect groundwater. Under section 319, states address nonpoint pollution by assessing the problems and causes within the state, adopting management programs to control the pollution, and implementing the management programs.

States are required to submit an assessment of state waters not expected to meet water quality standards because of nonpoint source pollution and a management program for controlling nonpoint source pollution. Section 319 authorizes EPA to issue grants to states to assist them in implementing management programs or portions of management programs that have been approved by EPA.

National Estuary Program

Administered by EPA under section 320 of the Clean Water Act, this program focuses on point and nonpoint pollution in geographically targeted, high-priority estuarine waters. In this program, EPA assists state, regional, and local governments in developing comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters.

Section 320 authorizes EPA, on its own or at the request of a state, to convene a management conference to address water pollution problems in estuaries. This conference must identify the causes of environmental problems within the estuarine zone and develop a comprehensive conservation and management plan for the estuary that recommends corrective actions and compliance schedules for controlling point and nonpoint sources of pollution.

Pesticides Program

Administered by EPA, this program controls some forms of nonpoint pollution under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). It authorizes EPA to control pesticides that may threaten groundwater and surface water. FIFRA provides for the registration of pesticides and enforceable label requirements, which may include maximum rates of application, restrictions on use practices, and classification of pesticides as "restricted use" pesticides, which would limit their use to certified applicators trained to handle toxic chemicals.

Source: Adapted from U.S. Environmental Protection Agency, Guidance Specifying Management Measures from Sources of Nonpoint Pollution in Coastal Waters, 1993.

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Appendix B

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Appendix D

Watershed Restoration and Pollution Control Programs

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Environmental Protection Agency (EPA)	Administers educational and regulatory programs designed to protect the environment (prevent and control pollution). Provides environmental assessments, water quality monitoring, regulations and regulatory oversight, education, planning, technical assistance, grants, and loans for pollution control. Works mainly with state, federal, regional, and local agencies on pollution control efforts.	Staff, information and data, laboratories and research facilities, grants and loans for pollution control, educational materials, monitoring equipment. Offices located in 10 regional centers and Washington, DC.
EPA Water Quality	Overall water quality planning and management. • Nonpoint Source Control program oversees and approves state development of water quality assessments and implementation of management programs designed to control nonpoint source pollution, directs funds to high priority watersheds or projects. • Clean Lakes program provides funds to restore or enhance publicly owned lakes. • Water Quality Standards Program provides technical assistance in developing numeric, narrative, and biological limits (standards) to protect water quality and its use. • Coastal programs oversee a number of different programs and initiatives designed to assess coastal resources and study ways to protect coastal waters. Includes the National Estuary program; administers new CZARA.	Staff for technical assistance to state and local agencies, review and approval of state programs, research, and special studies. Provides grants to states for most water quality protection activities, educational materials, and programs; funds for special studies or projects.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Environmental Protection Agency (continued)		
EPA Permits	NPDES permits for industries, cities, and confined animal feeding operations; provides enforcement for noncompliance.	Staff for technical assistance with modeling and permit drafting, site inspections, and compliance monitoring, funds for special studies or projects.
EPA Pesticides	Regulates pesticide labeling and registration, including application rates, allowable crops and pests, environmental and human health cautions, disposal procedures, licenses restricted-use pesticide applicators.	Staff to review research results, assist with strategic planning, education and training, oversee enforcement procedures of states, funds for special projects and studies.
EPA Groundwater	Administers the Sole Source Aquifer Protection Program; provides technical and programmatic assistance to state wellhead protection programs.	Staff for technical assistance, funds for special studies.
EPA Wetlands	Cooperatively administers wetlands dredge and fill permits with the Corps of Engineers, enforces actions for illegal wetlands filling; technical support for wetlands delineations, research and education about wetland values and function.	Staff to oversee and enforce activities, monitoring wetland status, health, and trends, funds for special studies, educational materials, and programs, data
EPA Monitoring and Surveillance	Provides environmental assessment, data analysis, oversight of state monitoring programs, special studies and agency research, EPA lab and Office of Research and Development coordination.	Staff for technical assistance to states and citizens on monitoring programs and projects, special studies and data analysis upon request, water quality monitoring at select locations.
EPA Drinking Water	Regulates public drinking water supplies and suppliers, special studies on human health and risk, develops drinking water criteria and maximum contaminant levels (MCLs). Administers special program for watershed treatment to decrease pollution loads to drinking water supplies if installation of BMPs is cheaper than the water treatment method needed.	Staff for technical assistance to set drinking water standards. Special studies, oversight, and compliance monitoring of public water supplies and suppliers.
EPA National Environmental Policy Act (NEPA)	Reviews and comments on other federal agencies' environmental impact statements (EISs), prepares EISs for EPA-sponsored projects.	Staff for technical assistance to prepare NEPA documents and review pollution control techniques required as part of federal action.
EPA Office of Research and Development (ORD)	Conducts basic and applied research to support EPA's mission, including biological and physical studies on fate and transport of environmental contaminants, studies ecosystems at large.	Provides reports, data, maps, monitoring equipment, study, and demonstration sites, staff for technical assistance in interpreting research results. Laboratories and research stations located throughout the country.
U.S. Department of Agriculture (USDA)	Stabilizes and supports efficient production, marketing, and distribution of food and fiber. In addition to commodity and public welfare programs, administers a number of conservation programs to assist private and federal land owners or managers in natural resource conservation and multiple-use management. Works mainly with private individuals on improving resource management.	Staff, technical assistance, information and data, educational materials, cost-share funds, engineering equipment. Field offices located in nearly every county, state, and Washington, DC.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA — Multiple agency administration of the 1985 and 1990 Farm Bill programs:		
Conservation Reserve Program	Conserves and protects highly erodible or other environmentally sensitive land from production with permanent vegetative cover through 10-year easements and annual rental payments.	In most cases, responsibilities within programs are divided between various USDA departments: **SCS** — Technical assistance in planning, designing, and implementing BMPs. **ASCS** — Administrative oversight of program and cost-share funding disbursement. **CES** — Education and information about the variety of conservation and economic choices available **CSRS** — Research, data, and the results of demonstration field trials of new technologies.
Wetlands Reserve Program	Available only in pilot states to return drained wetlands to wetland status and protect existing wetlands. Uses same easement/payment method as CRP.	
Sustainable Agricultural Research and Education Program	A practical research and education and grant program to promote lower input methods of farming	
Conservation Cross Compliance (Sodbuster and Swampbuster)	A quasi-regulatory program that denies subsidy payments to farmers who plow highly erodible land or drain wetlands	
Water Quality Incentives Program	A watershed treatment program designed to improve or protect soil and water resources in watersheds impacted or threatened by NPS pollution	
USDA Soil Conservation Service (SCS)	Technical assistance on planning, site-specific design, and installation and management of soil and range conservation, animal waste, and water quality management systems, special land and water resource assessments and inventories. Cost-share funds to install BMPs on private lands available from some programs	Staff and equipment in field offices for technical assistance including engineering designs, survey work, and planning for water resource protection.
USDA SCS — Small Watershed Program (PL-566)	Evaluates and treats small agricultural watersheds with multiple resources to protect. Targets resources for both technical and financial assistance and educational programs.	Staff for technical assistance to landowners and decisionmakers in the watershed; funds for demonstration projects.
USDA SCS — Great Plains Conservation Program (GPCP)	Intensive conservation treatment for individual farms located within the Great Plains ecoregion through long-term agreements (3 to 10-year contracts) with farmers	Technical assistance and cost-share funds up to 75 percent of the average cost of selected high priority conservation practices
USDA SCS — Resource Conservation & Development Program (RC&D)	Helps local governments in authorized areas plan and use natural resources and solve local problems.	Planning assistance for small communities for resource protection; financial assistance up to 25 percent of a project — not to exceed $50,000.
USDA SCS — River Basin Program	Assists state and local governments identify water and related land resource problems, evaluate alternative solutions, and develop their implementation program.	Staff for technical assistance to decisionmakers for inventory and planning activities.
USDA SCS — Natural Resource Assessment Programs: Soil Survey, Natural Resources Inventory	Various programs to map and assess the condition of natural resources (soil, water, vegetation, and wildlife) and conservation treatments.	Maps, reports, data information, statistical analysis.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA Agricultural Stabilization and Conservation Service (ASCS)	Provides administrative oversight and cost-sharing programs for approved conservation practices from ASCS and other USDA administered programs, tracks crop production and other statistics, distributes crop subsidy and deficiency payments.	Financial assistance (i.e., cost sharing); map and conservation practice information.
USDA ASCS — Agricultural Conservation Program (ACP)	Annual cost-sharing for a number of soil conserving, production improving, and water quality practices.	Funding for cost-share programs generally limited to $3,500 per farm per year.
USDA ASCS — Emergency Conservation Program (ECP)	Annual cost-sharing to replace conservation treatments (mainly structural) destroyed in areas designated as natural disaster areas.	Cost-share funds for high priority conservation practices.
USDA ASCS — Water Bank Program	Designed to improve and restore wetland areas through financial compensation for 10-year easements on private property	Funding for easement compensation on eligible lands in participating states.
USDA ASCS — Colorado River Salinity Control Program (CRSCP)	Financial assistance on farm projects that seek to control salinity levels delivered to the basin, primarily irrigation water management.	Funds, reports, data on level of conservation treatment and demonstration sites; cost-sharing, monitoring, and education.
USDA ASCS — Forestry Incentives Program (FIP)	Cost-share to revegetate and improve timber stands on private lands	Cost-share funds.
USDA Cooperative Extension Service (CES)	Educational programs and information to aid individuals in selecting, operating, and maintaining the most beneficial conservation treatments. Economic analysis and data for each farm or ranch, technical assistance in integrated pest management and landscape issues. Programs generally carried out in cooperation with state land-grant universities.	Staff to offer educational programs and technical assistance and personalized economic analysis; coordinates small-scale demonstrations on local farms; educational materials.
USDA Cooperative State Research Service (CSRS)	Applied research, usually at state experiment stations, on agricultural production and soil and water conservation, generally using demonstration plots. Conducts the Sustainable Agriculture Research and Education (SARE) program. Many projects in cooperation with state land grant universities.	Provides reports, data, equipment; occasionally has funds for joint or special projects outside the normal research agenda, grants for Agriculture in Concert with the Environment (ACE) program.
USDA Forest Service (FS) — National Forest System (NFS)	Manages national forests and grasslands for sustained production and multiple use. Works with individuals, industries, and other agencies.	Staff, maps, reports, equipment for construction and monitoring, educational materials; occasionally funds for special projects. Field offices located in each national forest; regional offices located in 9 areas and Washington, DC.
USDA NFS — Permit Program	Oversees timber sales and harvest contracts, grazing leases, and minerals developed on FS property; provides technical assistance to permittee in proper resource use.	Staff for technical assistance and compliance monitoring.
USDA NFS Air and Watershed Programs	Overall environmental planning and technical support for forest management decisions, special studies and watershed demonstration projects in certain areas.	Funds for special studies and watershed demonstration projects; natural resource inventories and reports, water quality or habitat monitoring, environmental analysis of resource trends and conditions.
USDA NFS — Research	Basic and applied research on range and forest lands.	Technical papers on effects of management on water quality.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA NFS — State and Private Forestry —Forest Stewardship Initiative	Technical assistance and cost share to inholding or privately owned lands adjacent to national forest lands for installing BMPs.	Funds for and technical assistance to individuals.
USDA Farmers Home Administration (FmHA)	Loans and loan guarantees to eligible producers for operating expenses, land purchase, and conservation measures.	Funds and loans for property improvement and conservation, treatment installation, and water conservation practices. Located in counties, states, and national offices.
USDA Agricultural Research Service (ARS)	Basic and applied research on agricultural production and conservation measures, including fertilizers, pesticides, and BMP effectiveness.	Reports on BMP effectiveness and environmental fate and transport data, demonstration sites, occasionally provides funds for joint sponsored projects. Research stations, located throughout each state, specialize in particular types of investigations.
U.S. Department of Commerce — National Oceanic and Atmospheric Administration (NOAA)	Administers programs in cooperation with states to inventory and manage coastal resources, funds and performs basic research and assessments relating to coastal eutrophication, maintains database for agricultural pesticides and nutrient loadings.	Funds to state coastal programs, staff for technical assistance, data, reports, and educational materials, occasionally administers funds for special demonstration projects.
NOAA — Coastal Zone Management Act Programs (CZMA)	Administers a quasi-regulatory coastal protection program, in cooperation with EPA, that sets performance-based management measures for control and prevention of nonpoint source pollution in coastal areas for all land use activities.	Staff for technical assistance, funds for plan development.
U.S. Department of Defense (DOD) Army Corps of Engineers (COE)	Oversees construction and operation of large flood control and public water supply reservoirs, conducts water quality monitoring on lakes within its jurisdiction, regulates in-lake activities and shoreline development. Cooperatively administers wetlands dredge and fill permit program with EPA and Fish and Wildlife Services, can enforce permit requirements for wetland BMPs or other mitigation measures.	Maps, special studies, water quality monitoring data, staff and funds for improvement of existing projects, staff to review and oversee 404 (wetlands) permits. Field offices located in various districts throughout states and Washington, DC.
U.S. Department of the Interior (DOI)	Oversees, manages, or monitors national natural resources, including land, water, and wildlife.	Staff, maps, reports, demonstration sites, educational materials, monitoring equipment. Offices located in regional centers, management areas, and Washington, DC.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of the Interior (continued)		
DOI Fish and Wildlife Service	Oversees and regulates the nation's wildlife resources; manages national wildlife reserves; enforces federal game and fish laws, cooperatively administers national wetlands program with the Corps of Engineers and EPA. Cooperative projects to enhance wildlife habitat, special studies, especially fisheries investigations.	Staff to enforce Endangered Species Act and other laws on public and private land, research reports and data on habitat, populations, and management of wildlife. Funds for cooperative projects. Educational materials, teacher training, curricula, and maps.
DOI Bureau of Land Management (BLM)	Administers and manages federal lands, oversees grazing leases, mineral exploration, and extraction bids and leases on BLM lands; technical assistance to permittees on BLM land in proper resource use; oversees recreational users of BLM land.	Staff for environmental analysis and trend evaluation on BLM land, technical assistance, and oversight. Funds for special studies and cost-share for permittees for certain conservation practices (generally grazing/range management); funds for range improvement, riparian area management, and recreational area development projects. Maps
DOI Bureau of Indian Affairs (BIA)	Technical assistance to tribes on tribal lands mainly for social services, some assistance for conservation work and educational programs, natural resource inventories and monitoring surface and groundwater.	Maps; natural resource inventories of Indian and tribal lands; funds for special projects; staff for technical assistance to tribes.
DOI Bureau of Reclamation	Administers, constructs, and oversees water supply facilities in western states; regulates discharges from these facilities; jointly administers the Colorado River Salinity Control Program with many agencies to set consistent salinity standards and manage public and private lands within the basin, new initiative to reclaim lands damaged by federal irrigation projects.	Staff to oversee projects and manage federal property and facilities, assesses water quality around reservoirs as part of the national irrigation water quality program; maps, reports, and some data.
DOI National Park Service	Administers and manages national parks for preservation of natural resources.	Staff to oversee and administer; funds for special studies and occasional cooperative projects on land adjoining park boundaries
DOI Office of Surface Mines (OSM)	Regulates the removal and reclamation of surface mined minerals, mostly coal on private lands.	Staff to oversee and provide technical assistance in mining operations, reclamation efforts, and engineering studies; vegetative site inspections and monitoring resources; educational materials, data, and reports.
DOI U.S. Geological Survey (USGS)	Long-term baseline monitoring of water resources (quantity, flow, and quality), hydrologic and geologic investigations and data, special intensive short-term studies.	Maps, data, and information on hydrology and water quality status and trends; staff for technical assistance in designing a monitoring plan.
State Water Quality Agencies	Administer many programs (similar to EPA) to protect water quality in surface and groundwaters, including the NPDES permit program, water quality standards regulations, the nonpoint source program, and ambient statewide monitoring programs.	Staff for technical assistance to local governments and individuals implementing BMPs; water quality monitoring, data, and reports; funds for pollution control projects, educational materials, and programs.

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State Agencies (continued)		
State Natural Resource Agencies	Administer programs for wetlands and coastal protection	Staff for technical assistance to local governments, monitor natural resource trends, reports, and data educational materials and programs
State Departments of Agriculture	Regulate pesticide registration and use and administer marketing and rural development programs, sometimes issue permits for fertilizer or feedlots	Staff to oversee pesticide applicators and other regulatory functions
State Forestry Commissions or Departments	Oversee activities on state forest lands, administer forest practice laws or BMP regulations	Staff for site inspections, technical assistance, and education for private landowners and state forests; information on forest resources
State Cooperative Extension Services	Natural resource, family health, and agricultural production education and training programs for citizens	Staff, reports, educational materials, technical assistance Field offices located in each county or state office connected with land-grant universities
State Parks and Tourism Departments or Bureaus	Administer programs to promote tourism and the use of state parks for recreation	Maps, signs, educational materials, occasional small grants for historic preservation or local development
State Natural Heritage Commissions or Boards	Administer programs to educate people and preserve historic and cultural resources	Maps, signs, educational materials
State Highway or Transportation Departments	Oversee design, construction, and maintenance of state and federal highways, provide assistance to local governments on road-related issues, responsible for erosion and pollution control along highway right-of-ways and during construction and maintenance activities.	Maps, signs, educational materials, maintenance equipment, and flower and grass seeds, technical assistance for local governments, sometimes provide funds for special studies or beautification projects
State Public Lands Commissions or Boards	Oversee administration of state lands, generate revenues for state treasury.	Natural resource information and maps.
State Natural and Scenic Rivers Commissions	Oversee use and protection of state designated scenic rivers, may levy taxes and take enforcement actions to protect the river.	Staff for river protection and (sometimes) assessments; occasionally provide funds for special protection or improvement projects.
State Livestock and Poultry Boards or Commissions	Regulate health, welfare, and safety of livestock, poultry production, and products.	Staff for site inspections, technical assistance, and enforcement actions; sometimes special studies and reports.
State Water Well Boards	Regulate the drilling of new wells and the sealing of old ones.	Staff for site inspections, technical assistance, and enforcement; educational materials and training for drillers.
State Oil, Gas, and Minerals Departments or Commissions	Oversee the leasing, production, and administration of state and privately owned natural resources; responsible for spills and environmental programs related to petroleum.	Staff for oversight and inspection including site-specific environmental audits and spill prevention and clean-up.

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State Agencies (continued)		
State Plant Boards	Administer programs that evaluate mainly agricultural plants and conservation plantings	Staff for technical assistance; special studies and reports.
State Health Departments	Administer septic tank and public drinking water regulatory programs, monitor water supplies; provide technical assistance to local governments.	Staff for technical assistance to local governments, monitoring, and educational programs; data, reports, and educational materials.
State Soil and Water Conservation Commissions	Administer cooperative programs with the USDA/SCS to conserve soil and water resources on private lands; provide technical assistance to individuals.	Staff for technical assistance to individuals; engineering or construction equipment, services, and supplies that support BMP implementation. Some states have cost-share funds for BMPs.
State Fish and Game Agencies	Regulate the harvest of fish and wildlife resources by individuals and commercial operations, responsible for state cost recovery of lost fish and wildlife affected by environmental contamination.	Staff for enforcement of state fish and game laws and for technical assistance in wildlife and fisheries management for private individuals, educational materials; natural resource inventory data.
State Water Rights Agencies	Allocate water rights (mostly in western states); regulate consumptive use of water resources.	Staff for permit writing and oversight; data and reports on water flow.
Local Planning and Zoning Boards, City Planning Commissions, County Planning Boards	Specify land use zoning and boundary determinations, general community planning, oversee program operation.	Maps, long-range plans, inventory of local resources, special reports, budget information, staff for technical assistance.
Local County Judges, Commissioners Court, or Parish Police Jury	Manage, construct, and maintain county roads and bridges; oversee and approve county budgets for all county programs. Taxing authority.	Information on county conditions; equipment for construction and maintenance, budget reports; occasional funds for special projects.
Local SWCDs	Local field office of state agency.	See State Soil and Water Conservation Commission.
Local Erosion and Sediment Control Districts	Oversee activities that could cause erosion and sedimentation.	Staff for on-site inspections, technical assistance, and sometimes enforcement actions.
Local Irrigation or Acequia Districts	Regulate local water use and maintain public or jointly owned irrigation projects; responsible for controlling pollution and erosion from projects.	Maintenance workers.
Local Flood Control, Water Management, or Subsidence Districts	Regulate water and land use and management to prevent subsidence or flooding.	Staff for on-site assessments and inspections; maps, reports, land use data, zoning information.
Local School Boards and School Administrations	Oversee public education within jurisdictional boundaries; can set local curricula requirements and priorities. Taxing and bond issuing authority.	Information on status of current educational programs; assistance in developing new initiatives.
Local Municipal Utilities Districts	Oversee construction and maintenance of public works projects for water, sewer, and occasionally energy. Taxing and bond issuing authority.	Information and special reports on water issues, funds for special projects to enhance system operation and reduce costs.

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AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
Regional River Authorities	Manage and coordinate activities within their basin for flood control, water quality protection, energy development. Taxing authority	Data, reports, maps, water quality monitoring, staff for technical assistance to local government and other agencies or groups. Funds for special projects
Regional Planning Commissions and Councils of Government	Assist in coordinating activities of all governments within the area, provide technical assistance and information, promote special projects of benefit to all	Staff for technical assistance to local governments, occasional water quality monitoring, reports, and data about local conditions, funds for special projects
Others — Commodity Groups	Various groups usually formed to improve marketing and lobbying capabilities for specific crops or livestock interests. Nearly every major crop has at least one such group.	Staff for data gathering and analysis, public education campaigns, technical support to growers, legislative and market analysis, funds from members for special projects
Environmental Organizations	Various groups formed to protect, conserve, or preserve the environment in general or to address a specific issue, lobby for environmental laws and programs as well as funding. Many perform volunteer services such as water quality monitoring, natural resource rehabilitation work, cost-share, or provide other funds for special projects	Staff and volunteers assist with local projects, educational materials and programs, reports and data on environmental conditions and trends, occasional funding for cooperative work
Social and Service Clubs	Formed for reasons other than resource protection, most have local projects that enhance or beautify community. Provide labor, supplies, and equipment on mutually beneficial projects as well as insight into the community.	Volunteers for special projects

Source: Adapted from Terrene Institute, Clean Water in Your Watershed: A Citizens Guide to Watershed Protection, 1993.

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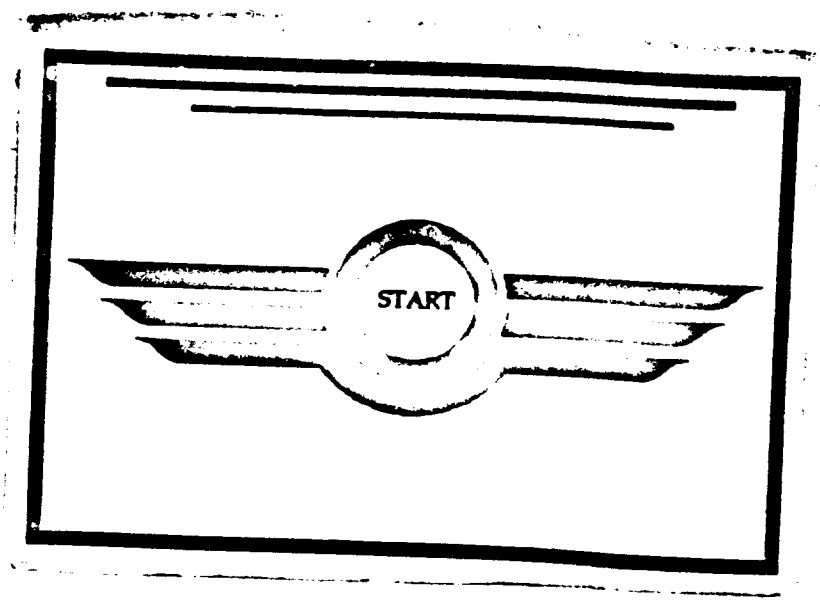

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From The Library Of
Carlos Miguel Ucumaya

Urban Runoff Management Information/ Education Products

Developed by

USEPA, Region 5
Water Division, Wetlands and
Watershed Section
Watershed Management Unit

and

USEPA
Office of Wastewater Enforcement
and Compliance
Permits Division
NPDES Program Branch
Stormwater Section

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This catalog contains information and education material related to urban runoff, stormwater and construction activities. The material has been categorized by information media. The purpose of this catalog is to showcase existing efforts, transfer information, attempt to avoid duplication and to provide a resource list for future activity. Also, it can be used as a educational guide for school systems. Special thanks goes out to the individuals who provided the urban runoff information and education materials.

This catalog was developed by the U.S. Environmental Protection Agency (USEPA), Region 5, Water Division, Wetlands and Watershed Section, Watershed Management Unit, and USEPA, Office of Wastewater Enforcement and Compliance, Permits Division, NPDES Program Branch, Stormwater Section. This agency is committed to updating this catalog on a periodic basis. We will be expanding this catalog with additional stormwater or urban runoff management information to include technical, institutional, program, policy, and other appropriate information. If you have any stormwater or urban runoff information and education products that you wish to add to this catalog, please send to the following address:

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BOOKLETS

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All Riled Up — Nonpoint Source Pollution: The Point of No Return

Intended Audience General Public

Description 32-page magazine devoted to the many aspects of nonpoint pollution in Wisconsin and the management of nonpoint source pollution.

Order From Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

The All Seeing All Knowing Desert Lawn Care Manual (Northern Version)

Intended Audience General Public

Description 19-page booklet with evaluation card providing "Turf Tips" on lawn watering using the "ET" (evapotranspiration) method to conserve water and improve water quality by avoiding runoff from overwatering, reducing nonpoint source pollution.

Order From University of Nevada
Cooperative Extension
P.O. Box 11130
Reno, NV 89520-0027

The All Seeing All Knowing Desert Lawn Care Manual (Southern Version)

Intended Audience General Public

Description 19-page booklet with evaluation card providing "Turf Tips" on lawn watering using the "ET" (evapotranspiration) method to conserve water and improve water quality by avoiding runoff from overwatering, reducing nonpoint source pollution.

Order From University of Nevada
Cooperative Extension
S.T.& P. Bldg., Suite 207
953 E. Sahara
Las Vegas, NV 89104

Alternative Lawn Care Practices Guide

Intended Audience Homeowners, Lawn Care Companies

Description A guidebook of lawn care practices that prevent contamination of runoff. It was compiled from an alternative lawn care demonstration project and is Louisiana-specific.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

American Wetlands

Intended Audience General Public

Description A colorful brochure describing the values and functions of wetlands.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317

An Elusive Compromise: Rhode Island Coastal Ponds and Their People

Intended Audience General Public

Description 82-page booklet discussing characteristics and history of Rhode Island's coastal ponds, which have experienced rapid development in the last two decades. Their fragile nature makes them particularly vulnerable to stresses brought about by humans.

Order From University of Rhode Island
Rhode Island Sea Grant College Program
Graduate School of Oceanography
Narragansett, RI 02882-1197
(401) 792-6800

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An Introduction to Michigan's Water Resources

Intended Audience Students, General Public

Description Comprehensive document describing the availability, distribution, quality, and uses of Michigan's water resources. Provides a foundation for understanding the hydrologic cycle and human influences. Maps and text give an overview of inland surface water, groundwater, and the Great Lakes.

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824
(517) 353-3742

An Introduction to the Ecology of the San Francisco Estuary

Intended Audience General Public

Description A 29-page booklet with comprehensive information about the estuary and the concerns surrounding it.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Answers to Common Lake Questions

Intended Audience General Public

Description 29-page booklet on lake environmental issues. Addresses nonpoint source pollution in general.

Order From New Hampshire Department of Environmental Services
Water Supply and Pollution Control Division
P.O. Box 95, Hazen Drive
Concord, NH 03301

Bay Repair Kit

Intended Audience General Public

Description 16-page, award-winning publication containing practical tips for bay-friendly living. Topics include lawn care, pets, boats, pools, cars, septic tanks, and hazardous materials.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Baybook for Green Bay, Wisconsin

Intended Audience General Public

Description 25-page guide to reducing water pollution at home. Addresses effects on the Bay of urban runoff nonpoint source pollution. Provides educational information for homeowners.

Order From Wisconsin Department of Natural Resources
P.O. Box 10448
Green Bay, WI 54307-0448
(414) 492-5904

Baybook: A Guide to Reducing Water Pollution at Home

Intended Audience General Public

Description 32-page booklet including 14 individual sections on things the homeowner/individual can do to reduce water pollution. Topics covered include erosion control, drainage, septic systems, paving, landscaping, gardening, pesticides, household chemicals, water conservation, and boats.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

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Best Management Practices for Automotive-Related Industries

Intended Audience Automotive Businesses

Description Illustrated guide for auto industries on keeping stormwater from coming into contact with potential pollutants. Contains some guidance on local permits.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Best Management Practices for Industrial Stormwater Pollution Control

Intended Audience Business Owners, Industrial Managers

Description Illustrated guide for industry on keeping stormwater from coming into contact with potential pollutants. Also contains guidance on complying with the county's General Permit for Industry.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Better Homes and Groundwater

Intended Audience General Public, Businesses

Description A guide to better groundwater including proper dispocal of household chemicals, fertilizer application, underground tanks, etc.

Order From Stevens Point-Whiting-Plover Wellhead Protection Project
Soil Conservation Service
1516 Church Street
Stevens Point, WI 54481
(715) 345-5979

Blueprint For a Clean Bay

Intended Audience Builders, Contractors

Description Illustrated guide for construction industries on keeping stormwater from coming into contact with potential pollutants. Contains some information on complying with the state's NPDES permit requirements.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Certification Program for Erosion and Sediment/Stormwater Management Program — Administrators, Inspectors, and Plan Reviewers

Intended Audience Planners, Inspectors

Description This booklet covers requirements for erosion and sediment/stormwater management certification for program administrators, inspectors, and plan reviewers.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Chesapeake Bay: Introduction to an Ecosystem

Intended Audience General Public

Description 34-page guide to what an estuary is; how it works; and how geology, biology, and chemistry are interrelated. Specific to the Chesapeake, but many sections are universally applicable, for example the section on nutrient cycling and food chains. Excellent reproducible diagrams. Relatively nontechnical.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

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Citizen's Guide to Groundwater Protection

Intended Audience General Public

Description 34-page booklet on groundwater protection, including a general discussion of nonpoint source pollution.

Order From U.S. Environmental Protection Agency
Office of Water
401 M Street, SW (WH-550G)
Washington, DC 20460

Clean Coastal Water

Intended Audience General Public

Description Three booklets on sewage treatment for coastal communities explaining in nontechnical terms the effects of sewage pollution on the marine environment, alternative solutions, and the benefits and costs of centralized and on-site sewage treatment.

Order From Massachusetts Audubon Society
Educational Resources Office
South Great Road
Lincoln, MA 01773
(617) 259-9500

A Clean Lake for Tomorrow: Action Plan

Intended Audience Government Officials, General Public

Description An action plan addressing the critical steps necessary for phosphorus reduction. The Action Plan is an outgrowth of the November 30, 1990, Lake Champlain Committee Conference, A Clean Lake for Tomorrow, held at Marble Island Resort in Colchester, Vermont.

Order From Lake Champlain Committee
14 South Williams Street
Burlington, VT 05401
(802) 658-1414

Clean Water Begins With Me

Intended Audience Children

Description 10-page coloring book promoting a clean environment. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

The Clean Water Book

Intended Audience Homeowners

Description A 25-page adaptation of the *Baybook* produced for the Chesapeake Bay area. It describes nonpoint source pollution, how it affects our water systems, and what homeowners can do to prevent nonpoint and other kinds of pollution.

Order From NJ Dept. of Environmental Protection
Division of Water Resources
CN 029
Trenton, NJ 08625-0029
(609) 633-7021

Coast-Links: A Resource Guide to Maine's Coastal Organizations

Intended Audience General Public

Description This 76-page booklet lists all Maine organizations with coastal connections including educational, recreational, and natural resource organizations. Museums, aquariums, and state and federal agencies are also listed.

Order From Maine Coastal Program
State House Station 38
Augusta, ME 04333

VOL 12
3246
R0036554

Comprehensive Planning for Lake Watersheds

Intended Audience Planners, Engineers, Designers

Description This 54-page booklet, written by the Maine Dept. of Environmental Protection and the Androscoggin Valley Council of Governments, outlines the comprehensive planning process for lake protection. Evaluation of phosphorus sources, watershed data collection, planning, and analysis are discussed.

Order From Maine Dept. of Environmental Protection
Water Bureau, Lakes Section
State House Section 17
Augusta, ME 04333

Directory of Local Erosion and Sediment Control Programs

Intended Audience Planners, Engineers, Designers, Developers

Description This booklet contains information on Virginia's locally administered soil erosion and sediment control programs.

Order From Virginia Dept. of Conservation and Regulation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Eastman and Laird's Teenage Mutant Ninja Turtles: Storm Drain Savers

Intended Audience Children

Description 8-page mini-coloring book. The turtles despair at the volume of litter pollution entering their storm drains and subsequently the marine environment and make an appeal for readers to think globally and act locally.

Order From Santa Monica Bay Restoration Project
Public Outreach Campaign
101 Centre Plaza Drive
Monterey Park, CA 91754

Erosion and Sediment Pollution Control Plan Development Checklist and Worksheets (Pennsylvania)

Intended Audience Builders, Contractors, Planners, Inspectors

Description A guide developed to assist in preparing Erosion and Sediment Control Plans.

Order From PA Department of Environmental Resources
Bureau of Land and Water Conservation
P.O. Box 8555
Harrisburg, PA 17105-8555

Erosion, Sediment and Stormwater — 1989 Update

Intended Audience Government Officials, Resource Managers

Description 100-page update of report on state progress in erosion, sediment, and stormwater programs. Addresses nonpoint source pollution in agriculture, construction, and urban stormwater runoff. Provides general educational information for state and local government officials.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

Erosion, Sediment and Stormwater: Problems, Progress and Needs

Intended Audience General Public

Description 127-page booklet discussing erosion, sediment, and storm water issues and detailing the status of erosion, sediment, and stormwater programs. Addresses nonpoint source pollution in agriculture, silviculture, construction, and urban stormwater runoff.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

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The Estuary Book

Intended Audience General Public

Description 48-page booklet that describes estuarine resources and values, communities, pollution, and the need for regional management of estuaries. Includes methods for citizen involvement in estuarine management.

Order From Maine Coastal Program
State Planning Office
State House Station 38
Augusta, ME 04333

Estuarywise

Intended Audience General Public

Description 24-page handbook containing 100 tips on how people can prevent pollution to the bay and delta. Lists contacts and information centers.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Florida Lakes

Intended Audience General Public

Description 32-page booklet describing Florida lakes, their processes, and means for their protection.

Order From Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Florida State of the Environment: Groundwater

Intended Audience General Public

Description 20-page booklet on groundwater problems in Florida. Addresses nonpoint source pollution in general.

Order From Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Florida State of the Environment: Solid Waste Management

Intended Audience General Public

Description 25-page booklet on solid waste management. Addresses nonpoint source pollution effects of land disposal of waste.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Freshwater Wetlands

Intended Audience General Public

Description 27-page booklet describing in "everyday" language the general characteristics and value of wetlands, including how their needless destruction is detrimental to man and the necessity of their protection. Includes an explanation of the New York State Freshwater Wetlands Act.

Order From The Catskill Center
Route 28
Arkville, NY 12406
(914) 586-2611

VOL 12
3248
R0036556

Get to Know Your Septic Tank

Intended Audience Homeowners Using Septic Systems

Description Narrative brochure summarizing acceptable types of soil treatment systems, the how-to of caring for and feeding a septic system, and what to look for when buying a new lot.

Order From Dist. Ctr MN Ext. Svc.
3 Coffey Hall, 1420 Eckles
University of Minnesota
St. Paul, MN 55108
(Small fee)

The Great Lakes Primer

Intended Audience General Public

Description 58-page booklet describing the Great Lakes' problems of toxics, water quality, fish contamination, toxic rain, and effects on wildlife.

Order From Pollution Probe
12 Madison Avenue
Toronto, Ontario
Canada, M5R

The Groundwater Cycle

Intended Audience General Public

Description Booklet discussing groundwater availability, depletion, quality, contamination, public health concerns, and contaminant detection and monitoring.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

Ground Water Resource Protection

Intended Audience Local Government Officials, Planners, General Public

Description Provides basic tools for guiding local groundwater protection efforts. Describes tools useful to local government officials and planners as well as the general public.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

Groundwater

Intended Audience General Public

Description 20-page booklet in full color explaining groundwater. Includes a two-page diagram of water cycle, contacts, glossary, and tips on how people can help. Addresses nonpoint source pollution in general.

Order From Ohio EPA
1800 Watermark
P.O. Box 1049
Columbus, OH 43266-0149
(614) 481-2160

Groundwater Contamination: No "Quick Fix" in Sight

Intended Audience General Public

Description 11-page booklet describing work being done by the U.S. Geological Survey concerning groundwater contamination. Briefly describes some legislation dealing with this problem.

Order From U.S. Geological Survey
Books and Open-File Services
Box 25425, Federal Center
Denver, CO 80225

VOL 12
3249
R0036557

Groundwater in Southwest Michigan

Intended Audience Local Officials, Planners

Description 42-page guidebook for citizens and public officials concerned with protecting drinking water supplies.

Order From Science for Citizens Center
Western Michigan University
Kalamazoo, MI 49008
(616) 387-2715

Groundwater Information Flyers

Intended Audience Local Officials, General Public

Description Series of nine booklets published by the Massachusetts Audubon Society's Community Groundwater Protection Project. The flyers provide information to help Massachusetts citizens and local officials protect groundwater resources in their communities.

Order From Massachusetts Audubon Society
South Great Road
Lincoln, MA 01773
(617) 259-9500

Groundwater Issues and Answers

Intended Audience General Public

Description 24-page color booklet.

Order From American Institute of Professional Geologists
7828 Vance Dr., Suite 103
Arvada, CO 80003
(303) 431-0831

Groundwater Quality and the Use of Lawn and Garden Chemicals by Homeowners

Intended Audience Homeowners

Description Information from Extension Specialists on best management practices and the use of fertilizers and pesticides around the home. 20 pages.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

Groundwater: Out of Sight - Not Out of Danger

Intended Audience General Public

Description Defines and describes groundwater, aquifers, and recharge areas. Discusses costs of groundwater contamination, groundwater protection, and techniques for groundwater management.

Order From N. Eng. Interstate Water Poll. Control Comm.
85 Merrimac Street
Boston, MA 02114
(617) 367-8522

Groundwater: Understanding and Protecting a Vital Resource

Intended Audience General Public

Description 14-page color booklet concerning groundwater protection.

Order From Dow Chemical Company
2020 Willard H Dow Center
Midland, MI 48674
(800) 258-2436

VOL 12
32500
R0036558

The Guidebook for Proper Management of Household Hazardous Waste

Intended Audience Local Officials, Municipal Workers

Description Tabbed booklet for municipal receptionists or others who are first contacts for inquiries concerning hazardous products, waste disposal, recycling, emergency phone numbers, and governmental agencies.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Guidelines for Liming Acidified Lakes and Ponds

Intended Audience Lake Managers

Description This 32-page booklet provides guidelines for treating lakes and ponds with acidic waters by using lime.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost - $4)

A Guide to Designing a Community Water Conservation Program

Pub. EC378

Intended Audience Community Leaders, Environmental Groups

Description Discusses water conservation strategies, gives sources of water conservation information, and relates practical advice on beginning a conservation program. 15 pages.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762
(Cost: $2, payable to Rutgers)

A Guide to Household Hazardous Waste

Intended Audience General Public

Description 8-page booklet on use of, alternatives to, and disposal of hazardous household products. Addresses nonpoint source pollution in general.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

A Guide to Illinois Lake Management

Intended Audience Local Officials, Lake Managers, General Public

Description This guidebook provides a nontechnical overview of the common problems and management challenges confronting our lakes. The intended audience includes government decision-makers, natural resource and recreation department staff, lake users and homeowners, and others interested in lake management.

Order From Northeastern Illinois Planning Commission
400 West Madison Street, Room 200
Chicago, IL 60606
(312) 454-0400

A Guide to Protecting Our Surface Waters

Intended Audience General Public

Description 20-page booklet on protecting surface waters. Addresses nonpoint source pollution in Northwest Florida.

Order From Northwest Florida Water Management District
Route 1, Box 3100
Havana, FL 32333
(904) 539-5999

VOL 12
3251
R0036559

A Guide to Septic Systems and Alternatives

Intended Audience Homeowners

Description This 44-page booklet contains information to help homeowners maintain their on-site disposal systems.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $8)

A Guide to Wisconsin's Lake Management Law

Intended Audience Citizen Groups, Resource Managers

Description Provides information on Chapter 33, a statute that establishes methods for the formation of lake management districts and gives the districts the power to carry out lake management practices as special purpose units of government. Includes information on available grants, district boundaries, and bylaws.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

Gulf-Links: A Resource Guide to Organizations in the Gulf of Maine Region

Intended Audience General Public

Description This 84-page booklet lists all organizations with coastal connections in the Gulf of Maine region including educational, recreational, and natural resource groups. Museums, aquariums, and state and federal agencies in the Gulf of Maine region are also listed.

Order From Maine Coastal Program
State House Station 38
Augusta, ME 04333

Homebuyers . . . Soil Surveys Can Help You

SCS Program Aid No. 1050

Intended Audience Potential Home Buyers

Description 8-page booklet describing the benefits of consulting soil surveys to determine the suitability of home sites, including flooding, septic tank suitability, and erosion hazards.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Homeowner's Guide to Domestic Wells

Intended Audience Homeowners

Description 32-page illustrated guide to locating, constructing, and maintaining a domestic well.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $3.20)

Homeowner's Guide to Reducing Water Pollution

Intended Audience Homeowners

Description 26-page booklet on reducing water pollution at home. Addresses nonpoint source pollution in general.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

VOL 12
3252
R0036560

Homeowner's Manual: Household Hazardous Waste

Intended Audience General Public

Description 6-page booklet on household hazardous waste.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Household Waste: Issues and Opportunities

Intended Audience General Public

Description 30-page booklet providing citizens with information about household waste and how they can contribute to its reduction by adopting new habits, making informed choices, and becoming involved in community action.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

Implementation Strategies for Lake Water Quality Protection

Intended Audience Planners, Engineers, Designers, Developers

Description This booklet, written by the North Kennebec Regional Planning Commission, is a 42-page handbook of model ordinances and nonregulatory techniques designed to control the impact of phosphorus from development on water quality. Techniques designed for new development as well as existing land use patterns are included.

Order From Maine Dept. of Environmental Protection
Water Bureau, Lakes Section
State House Section 17
Augusta, ME 04333

Industrial Nonpoint Runoff — A Summary of Best Management Practices

Intended Audience Government Officials, Planners, Plant Managers

Description 26-page booklet on industrial nonpoint source runoff pollution. Provides educational information for developers.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

The Lake in Your Community

Intended Audience General Public, Citizen Groups, Resource Managers

Description Provides information on the physical properties of lakes. Describes potential problems and outlines management practices for correction and long-term well-being of the lake.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

Lake Protection Through Town Planning

Intended Audience Local Government Officials, Planners

Description 10-page booklet that provides an overview of the lake and watershed issues relevant to water quality that a town may want to address during its planning process.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-5638

VOL 12
32553
R0036561

Lake Superior Water Quality Issues: Recommendations for Action — 1988 Update

Intended Audience Government Officials, Planners, General Public

Description 18-page booklet recommending policy changes needed to prevent further toxic contamination of Lake Superior. Represents a consensus of over 50 citizens' organizations around Lake Superior.

Order From Great Lakes United State University
State University College at Buffalo
1300 Elmwood Avenue
Buffalo, NY 14222
(716) 886-0142

Land Trusts: A Primer

Intended Audience General Public, Land Owners

Description 10-page informational booklet, written in layperson's terms, explaining the purposes and benefits of land trusts as well as land trust resources.

Order From Lake County Soil and Water Conservation District
125 East Erie Street
Painesville, OH 44077
(226) 357-2730

Landscaping for Water Conservation — A Guide for New Jersey

Pub. E080

Intended Audience Homeowners, Landscapers

Description The purpose of this 24-page publication is to help in the planning of unique and pleasing landscapes that use less water. By using the correct combination of design, plants, mulches, and watering techniques, landscapes can be created that are environmentally safe to the locale, but also conserve water.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762
(Cost: $2, payable to Rutgers, The State University)

Layperson's Guide to Groundwater and Toxics

Intended Audience General Public

Description 16-page booklet introducing readers to groundwater resources. Gives background for better understanding of the problems behind the frightening headlines about toxics, contamination, and possible health effects.

Order From Water Education Foundation
717 K Street, Suite 517
Sacramento, CA 95814
(916) 444-6240

VOL 12
3254
R0036562

Make Room for Monsters . . . and Wildlife on the Land

Intended Audience Children

Description Helps children to examine the basics of ecology, explore local and exotic ecotypes, and learn ways to attract wildlife to yards and apartments.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL

Management Guidelines for Forested Wetlands in Florida

Intended Audience Land Users

Description 46-page booklet concerning forestry practices in wetlands. Companion to the *Florida Silviculture Best Management Practices Manual*. Addresses effects of silviculture as a source of nonpoint source pollution. Provides low-technology best management practices for land users.

Order From Florida Division of Forestry
3125 Conner Blvd.
Tallahassee, FL 32301
(904) 488-7493

Managing Private Groundwater Through Underground Water Conservation Districts

Intended Audience Local Officials, Planners

Description 10-page booklet on groundwater management. Addresses governmental aspects. Provides educational information for local government officials and planners.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

Maryland PLANT Community

Intended Audience General Public

Description Colorful six-panel booklet describing Maryland's award program for recognizing communities that are actively involved in community tree planting and care. This booklet also lists the Standards and Accomplishments associated with the achievement of this award.

Order From Maryland PLANT Community
DNR-Forestry Programs
Tawes State Office Building
Annapolis, MD 21401

Municipal Official's Guide to Water Conservation

Intended Audience Local Government Officials

Description 16-page booklet describing why water conservation is important and providing information on how water conservation can be achieved at residential and institutional facilities.

Order From N. Eng. Interstate Water Poll. Control Comm.
85 Merrimac Street
Boston, MA 02114
(617) 367-8522

The Nebraska Association of Resource Districts

Intended Audience General Public

Description 16-page color booklet describing the history and functions of Nebraska's Natural Resource Districts. Describes the NRDs' involvement with water, soil, wildlife habitat, urban conservation, education, and recreation.

Order From The Nebraska Assoc. of Resource Districts
1327 H Street, Suite 102
Lincoln, NE 68508

VOL 12
32555
R0036563

Nonpoint Source Education/Demonstration Project Evaluation Report

Intended Audience Public Officials, General Public

Description 67-page report that summarizes low-cost NPS pollution abatement education/demonstration projects implemented in Ohio from 1981 to 1987. Also presents the results of the projects and the lessons learned.

Order From Ohio EPA
1800 Watermark Drive
Columbus, OH 43215
Contact: Rich McClay

Nutrient Management for Lawn Service Companies

Pub. ETT 03

Intended Audience Lawn Care Professionals

Description Presents information on nutrient management in turf to reduce water quality pollution.

Order From Dr. Jack Hall
Extension Specialist - CSES Dept.
Smyth Hall
Virginia Tech.
Blacksburg, VA 24061

Oil Recycling and the Bay

Intended Audience General Public, Car Owners

Description 4-page booklet on motor oil recycling. Addresses storm sewer nonpoint source pollution with respect to the Chesapeake Bay. Provides educational information for car owners and the public.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

Our Water . . . It's Too Valuable to Waste

Intended Audience General Public

Description 29-page booklet explaining why water conservation is important and how to conserve water and reduce water waste at home.

Order From South Carolina Water Resources Commission
AT&T Building
1201 S. Main St., Suite 1100
Columbia, SC 29201
(803) 737-0800

Outlook on Groundwater

Intended Audience Students

Description Booklets on groundwater that address nonpoint source pollution in general. Provide educational information for elementary, junior high, and senior high students.

Order From U.S. EPA Region 7
726 Minnesota
Kansas City, KS 66101
(913) 236-2817

The Pesticides Guide

Intended Audience General Public

Description Booklet discussing pesticides and health, agricultural pesticides, and pesticides in forests, cities, and towns.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

VOL 12
32556
R0036564

Pesticides in Your Environment

Intended Audience General Public

Description Magazine-type publication describing the benefits of each segment of the specialty pesticides industry.

Order From Responsible Industry for a Sound Environment
1155 15th Street, NW
Suite 900
Washington, DC 20005

Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development

Intended Audience Engineers, Developers, Planners

Description This 111-page technical guide defines and explains the impact of development on water quality. Uses quantitative terms to evaluate the impact and apply it equitably over the watershed.

Order From Maine Dept. of Environmental Protection
Water Bureau, Lakes Section
State House Station 17
Augusta, ME 04333

A Primer on Groundwater

Intended Audience General Public

Description 26-page booklet describing groundwater, groundwater quality, and the management of groundwater resources.

Order From U.S. Geological Survey
Books and Open-File Services
Box 25425, Federal Center
Denver, CO 80225

A Primer on Water

Intended Audience General Public

Description 50-page booklet describing basic hydrology, the hydrologic cycle, groundwater, and groundwater movement. Provides definitions of terms such as "aquifer." Also discusses streamflow and the formation of flood plains. A very basic and complete primer on water.

Order From U.S. Geological Survey
Books and Open-File Services
Box 25425, Federal Center
Denver, CO 80225

A Primer on Water Quality

Intended Audience General Public

Description 27-page booklet that defines water quality and the water cycle and explains how nature affects water quality. Discusses criteria for water quality, water quality management, and the need for research on water quality. A very basic and complete primer.

Order From U.S. Geological Survey
Books and Open-File Services
Box 25425, Federal Center
Denver, CO 80225

A Property Owner's Guide to Wetland Permits

Intended Audience Property Owners

Description A 36-page booklet providing information on the wetland permitting process.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $6)

VOL 12
32257
R0036565

Protecting Connecticut's Groundwater

Intended Audience Local Officials, Planners

Description 100-page guide to groundwater protection. Addresses nonpoint source pollution in general as it relates to groundwater. Provides low-technology BMPs for public officials and planners.

Order From Massachusetts Audubon Society
South Great Road
Lincoln, MA 01773
(617) 259-9500

Protecting Minnesota's Waters — The Land Use Connection

Intended Audience General Public

Description 30 pages of narrative, photographs, and summary tables that pull together in layperson's terms the relationships between common land use activities, NPS pollution, and the regional water quality concerns specific to Minnesota.

Order From Minnesota PCA
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
(Free)

Public Information and Education Program to Reduce Nonpoint Source Pollution in Michigan

Intended Audience Government Officials, Planners

Description 27-page booklet on Michigan's nonpoint source pollution education program. Addresses public involvement in nonpoint source pollution control. Provides general educational information for the Governor of Michigan and other governmental officials and planners.

Order From Michigan State University
Cooperative Extension Service
Director's Office Agricultural Hall
East Lansing, MI 48824-1039

Raindrops Keep Falling on Your Head

By Dawn Shank

Intended Audience Children

Description Soil and water conservation activities for children.

Order From Dawn Shank
203 Governor St., Suite 206
Richmond, VA 23219

Reducing Nonpoint Pollution from Construction Sites — What Site Designers and Erosion Control Inspectors Can Do

Intended Audience Developers, Site Designers, Local Governments

Description 16-page booklet on reducing nonpoint source pollution from construction sites. Provides low-technology BMPs for developers.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Reducing Nonpoint Source Pollution: A Decisionmaker's Guide

Intended Audience Local Government Officials, Planners

Description 20-page booklet, from the Ohio-Kentucky-Indiana Regional Council of Governments, describing nonpoint source pollution issues, practices, and resources. Includes a removable educational flyer.

Order From OKI Regional Council of Governments
801-B West Eighth Street, Suite 400
Cincinnati, OH 45203

VOL 12
32258
R0036566

Reducing Polluted Runoff From Commercial / Institutional Areas : Impacts and Best Management Practices

Intended Audience Developers, Site Designers, Local Governments

Description Urban nonpoint best management practice booklet that explains BMPs for reducing nonpoint pollution in industry and on construction sites. 30 pages.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Reducing Sediment Runoff From Construction Sites: Impacts and Best Management Practices

Intended Audience Developers, Site Designers, Local Governments

Description 10-page booklet on reducing sediment runoff from construction sites. Addresses construction runoff nonpoint source pollution. Provides educational information for developers.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Reducing Toxic Runoff From a Construction Site

Intended Audience Developers, Site Designers, Local Governments

Description 12-page booklet on toxic runoff. Addresses nonpoint source pollution. Provides educational information for developers on chemical management.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Robots of Cave Alpha: Creating a Livable Land

Intended Audience Children

Description Helps children learn that to create and sustain a quality life, people must be knowledgeable about their environment, about who makes environmental management decisions, and about how those decisions are made.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL

Sarasota BayBook, Vol. I

Intended Audience Students, Middle School

Description 43-page booklet containing reference and interdisciplinary classroom activities for grades 5-7. Focuses on subtropical estuarine ecology and related issues.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Seep, Drip, Dribble

Intended Audience General Public

Description Magazine article reprint discussing a program to combat nonpoint source pollution.

Order From New York Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

VOL 12
32559
R0036567

Septic System Care — Essentials of Using and Maintaining Your Septic Tank Sewage Disposal System

Pub. EB-10

Intended Audience Homeowners

Description Contains comprehensive information on the proper use and maintenance of a septic tank sewage disposal system. 13 pages.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762
(Cost: $1, payable to Rutgers)

Septic Systems and the Bay

Intended Audience Homeowners

Description 6-page booklet on proper use and maintenance of a septic tank. Addresses wastewater system nonpoint source pollution.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

Septic Tanks and Soil Absorption Systems — An Owner's Guide to Care and Maintenance

Intended Audience Homeowners

Description 8-page booklet describing how septic tank systems work and what owners can do to maintain the system properly.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Shoreland Zoning Options for Towns

Intended Audience Local Government Officials, Planners, Public Interest Groups

Description 32-page booklet outlining important elements in shoreland zoning and explaining how each helps to prevent water pollution. Suggests general guideline options for town zoning bylaws.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

Soil and Water Conservation Puzzles

Intended Audience Children

Description This booklet contains 6 pages of soil and water conservation puzzles for children.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Soil Conservation Around Your Home

Intended Audience Homeowners, General Public

Description 6-page booklet on reducing erosion. Addresses urban runoff nonpoint source pollution. Provides educational information for homeowners.

Order From Chesapeake Bay Foundation
214 State Street
Harrisburg, PA 17101

VOL 12
3260
R0036568

BOOKLETS

Springs of Virginia

Intended Audience General Public

Description 44-page illustrated booklet describing how springs are formed and providing a guide to spring management and protection.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $5)

Standards for Soil Erosion and Sediment Control in New Jersey

Intended Audience Developers, Engineers, Planners, Inspectors

Description Technical guidance for erosion and stormwater control in urban development projects.

Order From State Soil Conservation Committee
New Jersey Department of Agriculture
CM 330, Room 204
Trenton, NJ 08625

State of the Bay Report

Intended Audience General Public

Description 31-page booklet that provides baseline information about Casco Bay, Maine's urban coast. Studies currently funded by the Casco Bay Estuary Project are described.

Order From Casco Bay Estuary Project
312 Canco Road
Portland, ME 04103

Stormwater Management

Intended Audience General Public

Description 12-page booklet educating the public about stormwater management. Addresses urban runoff nonpoint source pollution.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Stormwater Management — Best Management Practices

Intended Audience Engineers, Designers

Description This 65-page booklet provides information on designing, selecting, and installing stormwater BMPs in the State of Maine.

Order From Joyce Noel, Water Bureau Engineer
Maine Dept. of Environmental Protection
State House Station 17
Augusta, ME 04333
OR
K.A. Wood, P.E.
York County SWCD
160 Cottage Street
Sanford, ME 03903

Stormwater Management Guidelines

Intended Audience General Public

Description 39-page guidebook that addresses effects of storm sewers on nonpoint source pollution. Provides high-technology best management practices for land users.

Order From South Carolina Coastal Council
4130 Faber Place #300
Charleston, SC 29405
(803) 744-5838

R0036569

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3261

Stormwater Management: A Guide for Floridians

By Eric H. Livingston and Ellen McCarron

Intended Audience General Public

Description A comprehensive overview of stormwater hydrology, management, and regulations. Several types of management practices are reviewed. Includes many diagrams and color photos. 72 pages.

Order From Stormwater/Nonpoint Source Management
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

The Story of Land—Its Use and Misuse Through the Centuries

Intended Audience Children

Description Helps children learn how human activities affect land and how locally directed, private land management can control land misuse. Suggestions of what young people and adults can do to encourage good land use are presented.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL

Stream Channel and Gully Grade Stabilization Structures

Intended Audience Land Owners

Description 12-page booklet on stream and gully stabilization. Describes the nonpoint source pollution effects of sediments from construction sites on waterways. Provides low-technology best management practices for the public.

Order From Mendicino County Resource Conservation District
405 Orchard Avenue
Ukiah, CA 95482
(707) 468-9223

Streams and Wetlands: A Resource Worth Preserving

Intended Audience Local Officials, General Public

Description 16-page booklet describing the benefits of natural stream and wetland systems and the difficulty of preserving these systems in the face of urbanization. Also discusses existing and alternative regulatory mechanisms for protecting streams and wetlands, as well as appropriate management techniques.

Order From Northeastern Illinois Planning Commission
400 West Madison Street, Room 200
Chicago, IL 60606
(312) 454-0400

Take Me Shopping

Intended Audience General Public

Description A comprehensive guide to safer alternatives to hazardous household products, including cleaning products, automotive products, paints, personal hygiene products, pesticides and fertilizers, pet care products, and others.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

A Tale of One City

By Maureen Mecozzi

Intended Audience General Public

Description 8-page color magazine that tells the tale of an imaginary Wisconsin town and its struggles with nonpoint source pollution threats to its lake. Describes the stages from innocence to disaster to community action in an amusing and informative way.

Order From Nonpoint Source and Land Management Section
WDNR Bureau of Water Resources Management
P.O. Box 7921
Madison, WI 53707

VOL 12
32662
R0036570

Tampa Bay Repair Kit

Intended Audience General Public

Description 18-page color guide providing tips for citizens on reducing pollution and protecting the bay. Emphasis on home practices that influence stormwater pollution.

Order From Tampa Bay National Estuary Program
c/o Tampa Bay Regional Planning Council
9455 Koger Blvd.
St. Petersburg, FL 33702-2491
(813) 577-5151

Threats to Virginia's Groundwater

Intended Audience General Public

Description A 48-page full-color booklet that describes the dangers posed to groundwater.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $4)

Turfgrass Nutrient and Pesticide Management for Public Lands

Pub. 430-398

Intended Audience Public Land Managers

Description Discusses of proper management of nutrients and pesticides in the landscape.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

Turning the Tide on Toxics in the Home: A Guide to Safer Alternatives and Proper Disposal of Home Products.

Intended Audience General Public

Description A 52-page guide on disposal of home toxics. Addresses hazardous wastes as possible nonpoint source pollutants.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711

Unfulfilled Promises

Intended Audience Government Officials, General Public

Description Citizen's review of the International Great Lakes Water Quality Agreement, by the Great Lakes Water Quality Task Force. Recommends changes in the way the treaty is being implemented in the cleaning up of the Great Lakes.

Order From Great Lakes United State University
State University College at Buffalo
1300 Elmwood Avenue
Buffalo, NY 14222
(716) 886-0142

Urban Runoff: A Pollution Abatement Program

Intended Audience Local Officials, Community Groups

Description This booklet discusses a number of different programs for solving the problem of urban runoff. Programs like Catch Basin Stenciling and Gutter Patrol are aimed at community-level education solutions to storm drain and nonpoint source pollution, while the Best Management Practices and Storm Drain Land Use Ordinance programs are aimed at policy-level solutions to the urban runoff problem.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

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32663
R0036571

Virginia Erosion and Sediment Control Law and Regulations

Intended Audience Planners, Engineers, Designers, Developers

Description This booklet is a text of Virginia erosion and sediment control laws and regulations.

Order From Virginia Dept. of Conservation and Regulation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

The Virginia Gardener's Year Round Guide to Nutrient Management

Intended Audience Gardeners

Description This booklet is a monthly guide to home and garden care.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

The Virginia Gardener's Year Round Guide to Pest Management

Pub. 426-615

Intended Audience Gardeners

Description Presents a monthly calendar for the management of pests in an environmentally sound way. 14 pages.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

Virginia Soil and Water Conservation Law

Intended Audience Planners, Engineers, Designers, Developers

Description This booklet discusses Virginia laws pertaining to soil and water conservation, flood protection and dam safety, and shoreline erosion and public beach preservation.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Virginia's Waters

Intended Audience General Public

Description This 44-page, award-winning booklet describes, with lavish color photographs, Virginia's river basins, lakes, bays, and groundwater.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $6)

Washington's Wetlands

Intended Audience General Public

Description 12-page booklet that provides general information on wetlands in Washington State, including what they are, why they are important, and how human actions have affected them.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

VOL 12
32264
R0036572

Waste Water Management Districts . . . A Starting Point

Intended Audience Local Government Officials, Planners

Description 66-page booklet on justification and implementation of wastewater management districts. Provides low-technology BMPs for local government officials and planners.

Order From Environmental Planning
Department of Administration
Rhode Island Office of Systems Planning
One Capitol Hill
Providence, RI 02908-5872

Waste: Choices for Communities

Intended Audience General Public

Description 30-page booklet providing an introduction to waste management issues—the impact of waste generation, disposal practices, and alternatives. Encourages citizens to involve themselves locally.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

Water Conservation: Wasted Water Means Wastewater

Intended Audience General Public

Description 4-page booklet with household tips on water conservation. Addresses nonpoint source pollution in general.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

Water Efficiency for Your Home

Intended Audience General Public

Description 23-page booklet that covers water efficiency products and advises which ones save water, energy, and money. Topics include greywater recycling, remaking a landscape, lawn watering, and faucet aerators.

Order From Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81645
(303) 927-3851

Water in Your Hands

Intended Audience General Public

Description An adventure spanning millions of years and covering water issues and facts around the world. Readers explore water quality and supply problems, discover the importance of a sustained supply of high-quality water, and learn how to prevent misuse and pollution of water resources. Also available in Spanish version. 15 pages.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL

Water Quality in Illinois

Intended Audience General Public

Description This booklet is a summary of the Illinois Water Quality Report (305(b) report). It describes the quality of Illinois' lakes and streams.

Order From Illinois Environmental Protection Agency
Planning Section
2200 Churchill Road
P.O. Box 19216
Springfield, IL 62794-9276

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32265
R0036573

Watering Guide for Home Gardeners

Pub. NE236

Intended Audience Home Gardeners

Description This 10-page guide is designed to help home gardeners make more efficient use of outdoor water.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762
(Cost: $1, payable to Rutgers)

The Water Sure Looks Muddy This Year — The Story of Soil Erosion Around the Chesapeake Bay

Intended Audience Junior High School Students

Description 15-page booklet concerning soil erosion. Addresses nonpoint source and other types of pollution.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

Waterways: Links to the Sea

Intended Audience Educators

Description This 36-page booklet was written as a guide on cleaning up coastal waters for teachers of grades 3-5. The booklet includes a 15-minute video to help teachers implement the activities.

Order From Shore Stewards Partnership
Maine Coastal Program
State House Station 38
Augusta, ME 04333

Wellhead Protection: A Decision Maker's Guide

Intended Audience Government Officials, Planners

Description 20-page guidebook on the wellhead protection program and how to participate.

Order From U.S. Environmental Protection Agency
Office of Ground-Water Protection
401 M Street, SW
Washington, DC 20460

Wellhead Protection Programs: Tools for Local Governments

Intended Audience Government Officials, Planners

Description 50-page guidebook on wellhead protection programs. Provides general educational information for local government officials and planners.

Order From U.S. Environmental Protection Agency
Office of Ground-Water Protection
401 M Street, SW
Washington, DC 20460

The Wetlands of Guam: "I Sesonyan Siha" — A Guidebook for Decisionmakers

Intended Audience Local Officials, Planners

Description This book is designed to help local government officials, landowners, and the general public gain a better understanding of what wetlands are and why they are an absolutely necessary part of Guam's ecosystem. It also contains suggestions on what people can do to preserve this precious resource.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

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R0036574

What Do the Standards Mean? A Citizen's Guide to Drinking Water Contaminants

Intended Audience General Public

Description 92-page illustrated booklet providing information about drinking water testing, treatment devices, drinking water contaminants, and state and federal standards.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $8)

Where the River Meets the Sea

Intended Audience General Public

Description Booklet introducing the physical and cultural aspects of the Albemarle-Pamlico region. Discusses the uses made of the system, the hydrology of the system, stresses the system is exposed to, degradation caused by some of these stresses, and some steps citizens can take to remediate the degradation.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Where to Go With The Flow

Intended Audience General Public

Description 40-page color magazine containing 1986 articles, case studies on Wisconsin's NPS program, and a fold-out on BMPs.

Order From WDNR - WR/2
P.O. Box 7921
Madison, WI 53707
Contact: Carol Holden
Phone: (608) 266-0140

Who Me? Hazardous Waste in My Home?

Intended Audience General Public

Description 8-page informational guide to hazardous wastes in the home, with phone numbers of local contacts. Addresses NPS pollution in general. Provides general educational information for householders.

Order From League of Women Voters
4447 Talmadge Road, Suite 210E
Toledo, OH 43623
(419) 475-4371

Woods and Water

Intended Audience General Public

Description 52-page booklet of urban forestry information, focusing on the connection between forests and water supplies for large metropolitan areas in New York State. Annotated bibliography.

Order From New York State Dept. of Envir. Conservation
Division of Lands and Forests
50 Wolf Road
Albany, NY 12233-4253

You Can Improve Your Natural Environment

Intended Audience General Public

Description 10-page booklet that addresses urban runoff nonpoint source pollution. Provides low-technology best management practices for the public.

Order From District of Columbia
Dept. of Consumer and Regulatory Affairs
614 H. Street, NW
Washington, DC 20001

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BOOKS

R0036576

The Great Lakes: An Environmental Atlas and Resource

Intended Audience General Public, Resource Managers, Students

Description 44-page oversize book with soft cover and wall map of the Great Lakes Area Basin tucked into the back cover flap. Covers many aspects of the Great Lakes Area including water quality, lake levels, fisheries, toxics, recreation, and shipping.

Order From EPA Great Lakes Program
230 S. Dearborn
Chicago, IL 60604

Groundwater Protection

Intended Audience Government Officials, Planners

Description 240-page book that includes the National Groundwater Policy Forum's report "Groundwater: Saving the Unseen Resource," as well as the Conservation Foundation's "A Guide to Groundwater Pollution." Defines the kind of national policy needed to protect groundwater quality and supplies.

Order From The Conservation Foundation
1250 24th Street, NW, Suite 500
Washington, DC 20037
(202) 778-9575

Pollutant Transport in Mississippi Sound

Intended Audience Resource Managers, Government Officials, Environmental Groups

Description This 124-page book is a result of a 4-year study of pollution in the Mississippi Sound. Results are reported in a format understandable to nonchemists including resource managers and the environmentally literate public. Text, charts, and illustrations.

Order From Mississippi-Alabama Sea Grant Consortium
P.O. Box 7000
Ocean Springs, MS 39564-7000
(601) 875-9341

A Riparian's Guide for Self-Help Inland Lake Water Quality Management

Intended Audience General Public

Description 67-page guidebook on the protection of the water quality of lakes. Includes Michigan laws and model lake association bylaws. Provides general educational information for householders.

Order From Michigan State University
Cooperative Extension Service
East Lansing, MI 48824
(517) 353-3742

Road Building Guide For Small Private Roads

Intended Audience Contractors, General Public

Description 74-page book explaining how to build roads properly. Describes the nonpoint source pollution effects of sediments from construction sites on waterways. Provides low-technology best management practices for the public.

Order From Mendicino County Resource Conservation District
405 Orchard Avenue
Ukiah, CA 95482
(707) 468-9223

Sarasota Bay: 1992 Framework for Action

Intended Audience Local Officials, Researchers

Description 400-page publication that contains results of the most comprehensive environmental assessment ever conducted on Sarasota Bay, Florida. Includes preliminary options for improving the Bay. Serves as a draft comprehensive plan for the Sarasota Bay National Estuary Program.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

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Sarasota Bay: Reclaiming Paradise— A Report to the People from the Sarasota Bay National Estuary Program.

Intended Audience General Public

Description 8[illegible]-page publication summarizing contents of *Sarasota Bay: 1992 Framework for Action.* Encourages citizen participation in bay restoration.

Order From Sarasota Bay National Estuary Program
1550 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

State of the Bay Report

Intended Audience General Public

Description 86-page book containing historical, sociological, and technical information on Sarasota Bay, Florida.

Order From Sarasota Bay National Estuary Program
1550 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Turfgrass Management, Third Edition

By A.J. Turgeon. ISBN 0-13-933425-4

Intended Audience Professional Turfgrass Managers

Description A comprehensive text covering the turfgrasses used around the world and all aspects of their management. Its purpose is the achievement of a desired level of turf quality at the lowest cost and with the lowest use of chemical and other inputs.

Order From Prentice-Hall, Inc.
Englewood Cliffs, NJ 07632

Vermont's Scenic Landscapes: A Guide for Growth and Protection

By Elizabeth Courtney

Intended Audience Planners

Description This 80-page book addresses Vermont's scenic landscape protection issues. It furnishes a system for identifying scenic resources and offers ways to protect them. A common language is provided for those who work with aesthetics issues related to municipal planning and zoning and Vermont's land use law, Act 250.

Order From Planning Division
Vermont Agency of Natural Resources
103 South Main Street
Waterbury, VT 05671-0301
(Cost: $15.00)

Wisconsin Self-Help Lake Monitoring Program Summary Report for 1986 - 1988

Intended Audience General Public

Description 60-page report on Wisconsin self-help lake monitoring program. Addresses what volunteers in the program do and the data collected. Provides educational information for the general public.

Order From Wisconsin Department of Natural Resources
P.O. Box 7927
Madison, WI 53707-7921

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BUMPER STICKERS

R0036579

BUMPER STICKERS

Clean Water, We All Play a Part

Intended Audience General Public

Description Bumper sticker promoting clean water. A nonpoint source logo was developed and used on the sticker.

Order From Environmental Planning Office
State Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4370
A337

Feed Me Clean Water, Louisiana

Intended Audience General Public

Description Multicolor, high-gloss sticker with an image of an alligator drinking a glass of water with a straw.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

I Helped Keep Hawaii's Waters Clean

Intended Audience General Public

Description Bumper sticker promoting clean water. A nonpoint source logo was developed and used on the bumper sticker.

Order From Environmental Planning Office
State Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4370

New Jersey Water Watch: Clean Water Begins With You

Intended Audience General Public

Description Square sticker, approximately 3" x 3".

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Protect Groundwater . . . It's Your Drinking Water

Intended Audience General Public

Description Bumper sticker promoting clean groundwater.

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824
(517) 353-3742

Protect Washington's Groundwater

Intended Audience General Public

Description Bumper sticker promoting clean groundwater.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

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VOL 12

Save the Soil and Save the Bay

Intended Audience General Public

Description Bumper sticker promoting Chesapeake Bay preservation. Promotes public awareness of Bay concerns.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

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R0036581

VOL 12

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CATALOGS

R0036582

CATALOGS

Acid Rain Foundation, Inc.

Intended Audience Librarians, Teachers, Students

Description 12-page list of educational materials, with ordering information. Addresses atmospheric pollution to waterways. Provides general information and curricula for librarians, teachers, and students.

Order From Acid Rain Foundation, Inc.
1410 Varsity Drive
Raleigh, NC 27606
(919) 828-9443

Audio Visual Aids

Intended Audience General Public

Description This brochure lists films, slide shows, and publications available from VDCR.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Bibliography: Cooperative Extension System's Water Quality Educational Materials

Intended Audience General Public

Description Lists educational materials available from Extension Services of all states, including videotapes, films, and computer software as well as publications on topics including water conservation, nutrient management, pest management, and waste management for both farm and home. Available as paper copy or free on-line through NSFnet or Bitnet.

Order From Agricultural Communication Service
Media Distribution Center
301 S. 2nd Street
Lafayette, IN 47905-1092
(219)854-2309
(Cost on paper: $10)

Books for Young People on Environmental Issues

Intended Audience General Public

Description This brochure lists books that concern a variety of environmental issues.

Order From Illinois Environmental Protection Agency
Office of Public Information
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794-9276

Catalog of Water Quality Educational Materials

Intended Audience Teachers, Environmental Educators, Organizations

Description A booklet listing and describing water quality-related educational materials available from TVA organizations. Also listed are some materials available from non-TVA sources. Includes printed materials, curricula, audiovisual presentations, posters, games, and videos.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

A Catalog of Water Quality Information and Education Materials

Intended Audience Educators

Description This 31-page catalog is a comprehensive guide featuring descriptions, authors, publishers, and sources of water quality materials available to teachers and other educators. The layout includes sections for K-6th grade, 7th-12th grade, and adults.

Order From Kathy Hope
Maine Dept. of Environmental Protection
Presque Isle Regional Office
1235 Central Drive
Presque Isle, ME 04769

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32275
R0036583

Conservation Districts Foundation

Intended Audience General Public

Description Catalog listing films, slides, and videos on conservation, including nonpoint source pollution topics.

Order From National Association of Conservation Districts
408 East Main Street
P.O. Box 885
League City, TX 77573
(800) 825-5547

Environmental Catalog of Publications

Intended Audience Resource Managers, and Interested Citizens

Description Catalog of water quality I&E materials with respect to citizen publications, technical publications, and information services. Format of materials include handbooks, posters, brochures, fact sheets, proceedings, manuals, database services, bibliographies, and visual displays.

Order From Terrene Institute
1000 Connecticut Ave., NW
Suite 802
Washington, DC 20036
(202) 833-8317

Groundwater Education in Michigan (GEM) Materials Listing

Intended Audience General Public

Description Bibliographic listing includes groundwater education materials developed by community-based projects through the W.K. Kellogg Foundation's GEM program.

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824
(517) 353-3742

Land Management Project Bibliography of Publications

Intended Audience General Public, Government Officials

Description Bibliography listing documents available from the Land Management Project, an EPA/ Rhode Island DEM joint undertaking. Includes fact sheets concerning land use, water quality, and best management practices. Also includes data summaries of scientific research on key nonpoint sources of pollution and materials on land uses.

Order From Rhode Island Dept. of Environmental Mgmt.
Land Management Project
83 Park Street
Providence, RI 02903-1037
(401) 277-3434

Learning Materials Catalog: Publications, Computer Programs, Videotapes

Intended Audience Teachers

Description 70-page catalog of learning materials including nonpoint source pollution education materials.

Order From Michigan State University
334 Natural Resources Building
East Lansing, MI 48824
(517) 353-3742

Listing of Publications Available From SCS

Intended Audience General Public

Description Listing of factsheets, brochures, handbooks, reports, etc. available from SCS on topics including education, erosion and sedimentation, pond and lake management, landscaping, urban, and wetlands.

Order From Contact your local SCS Office

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R0036584

National Small Flows Clearinghouse Guide to Products and Services

Intended Audience Local Officials, Planners, Researchers

Description Includes listings of more than 170 free or low-cost brochures, case studies, design manuals, and videotapes dealing with innovative approaches to the treatment of wastewater, including onsite treatment systems. Funded by USEPA and West Virginia University.

Order From National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
(800) 624-8301

Our Nation's Lakes

Intended Audience General Public

Description 36-page national catalog of lake information materials to promote better ideas and understanding toward a unified goal–clean lakes.

Order From Wisconsin Department of Natural Resources
P.O. Box 7927
Madison, WI 53707-7921

Outreach Video List

Intended Audience General Public

Description Listing of videos available for loan, dealing primarily with urban and rural nonpoint source water quality issues around Puget Sound, WA.

Order From Puget Sound Water Quality Authority
P.O. Box 40900
Olympia, WA 98504-0900
(206) 493-9300

The Overwhelming Educator's Guide to Environmental Education

Intended Audience Teachers

Description 100-page directory of educational materials to assist teachers in developing environmental education curricula.

Order From Washington Office of Environmental Education
17011 Meridian Ave. North
Seattle, WA 98133

Pennsylvania Chesapeake Bay Program - Education Resource List

Intended Audience General Public

Description 15-page listing of available educational materials on bays.

Order From Pennsylvania Chesapeake Bay Education Office
225 Pine Street
Harrisburg, PA 17101
(717) 236-1006

Products and Services for the Water Environment Professional — 1993

Intended Audience Environmental Professionals, Educators, Public Officials

Description Catalog of technical publications on wastewater treatment and nonpoint source pollution. Public education brochures and materials including videos and curricula.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

R0036585

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32771

Project Water: Water Awareness Through Education and Research

Intended Audience Teachers

Description Six-panel brochure on available teaching materials dealing with water protection. Materials address nonpoint source pollution in general.

Order From Alameda County Public Works Agency
399 Elmhurst Street
Hayward, CA 94544
(415) 670-5543

Publications: Vermont Agency of Natural Resources, Department of Environmental Conservation

Intended Audience General Public, Resource Managers, Local Officials

Description Lists state publications of scientific studies, reports, legislation, newsletters, brochures, and factsheets, many on nonpoint source-related topics including runoff, acid deposition, wetlands, lake and river water quality, and monitoring.

Order From Water Quality Division
Vermont Department of Environmental Conservation
103 S. Main St, Bldg 10 North
Waterbury, VT 05671-0408

Recycling, Waste Disposal, Water, and Land Use

Intended Audience General Public, Educators, Public Officials

Description Lists and describes available publications, slide presentations, and videos dealing with a variety of environmental topics of interest to communities.

Order From Cornell University
Media Resource Center
7-8 Business and Technology Park
Ithaca, NY 14850

Resources

Intended Audience Teachers, Civic Group Leaders

Description Provides a listing of conservation and agricultural videos, slide-tape presentations and 16mm films available for rent from the Conservation Foundation's Conservation Audiovisual Service.

Order From National Association of Conservation Districts
408 East Main
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547

Virginia Department of Conservation and Recreation Publication List

Intended Audience General Public

Description One-page list of publications on conservation and recreation, including groundwater pollution.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219
(804) 786-3334

Waste Management Publications Order Form

Intended Audience General Public

Description Listing and order form for waste management brochures and leaflets on septic tanks, household hazardous waste, and recycling, as well as agricultural manure management.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

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32718
R0036586

Water Quality, Conservation and Management Publications Order Form

Intended Audience Homeowners, Farmers

Description Catalog including booklets and leaflets on water conservation, septic systems, and chemical management for farms and homes.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

Water Quality Education Bibliography

Intended Audience Teachers, General Public

Description 80-page bibliography of water quality educational materials, including nonpoint source pollution materials.

Order From Washington State University
7612 Pioneer Way East
Puyallup, WA 98371-4998
(206) 840-4556

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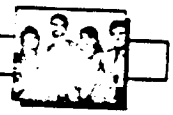
R0036587

CITIZEN'S ACTION GUIDES

R0036588



1989 Vermont Lay Monitoring Report — Volume II

Intended Audience Local Government Officials, General Public

Description 148-page booklet that discusses lake monitoring data, evaluation of data collected at each lake and monitoring station, and contacts for volunteers. Addresses nonpoint source pollution in general. Provides general educational information for local government officials.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

A Citizen's Action Guide to Community Water Conservation

Intended Audience General Public

Description A manual for concerned citizens that gives background information, guidelines, and water conservation tips. Also shows how the individual and community can make an impact.

Order From National Wildlife Federation
1400 16th Street, NW
Washington, DC 20036-2266
(202) 797-6800

A Citizen's Action Guide to River Conservation

Intended Audience Public Interest Groups, General Public

Description A "how to" book to encourage concerned citizens. Emphasizes building multi-interest citizen coalitions through community involvement and stream conservation efforts. Discusses practical steps for citizen action and conservation tools used throughout the country.

Order From The Conservation Foundation
1250 24th Street NW, Suite 500
Washington, DC 20037
(202) 778-9575

A Citizen's Directory for Water Quality Abuses

Intended Audience Citizen Groups, General Public

Description A state-by-state resource list of environmental agency telephone numbers.

Order From Save Our Streams Program
Izaak Walton League of America
1401 Wilson Blvd., Level B
Arlington, VA 22209
(703) 528-1818

A Citizen's Guide to Coastal Water Resources

APES #88-03

Intended Audience General Public, Local Officials

Description Designed to help people better understand and use coastal and marine resources. Discusses the regulatory process and potential for citizen involvement, legislation, sediment and erosion control, and nonregulatory ways for citizens to become involved in protecting water resources.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

A Citizen's Guide to Evaluating a Waterbody's Sensitivity to Acidification

Intended Audience General Public

Description Describes biological symptoms of aquatic acidification and lake and river sampling procedures. Addresses causes of nonpoint source pollution related to atmospheric deposition. 4 pages.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

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A Citizens Guide to Lake Watershed Surveys: How to Conduct a Nonpoint Source Pollution Survey

Intended Audience General Public

Description 77-page document that describes effective methods for organizing and conducting a nonpoint source pollution survey. Included with case histories are instructions for surveys, mapping site evaluations, and remedial actions for preventing further NPS pollution.

Order From Maine Dept. of Environmental Protection
Water Bureau, Lakes Section
State House Station
Augusta, ME 04333
OR
Maine Congress of Lake Associations
Bayview Street
RR 2 Box 391
Yarmouth, ME 04096

Citizen's Monitoring Manual for Louisiana

Intended Audience Volunteer Groups, Students, General Public

Description The *Citizen's Monitoring Manual for Louisiana* will describe procedures for monitoring, especially benthic macroinvertebrate sampling methods, and will explain how to set up a monitoring program in the state.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

Citizen's Water Quality Monitoring Program Pilot

APES #87-06

Intended Audience Citizen Groups, Local Officials

Description Describes the pilot Tar-Pamlico basin program, based on the Chesapeake Bay volunteer program. Weekly sampling follows strict procedures for temperature, nutrients, pH, dissolved oxygen, salinity, and turbidity. Standardized forms are used for verification and entry into a database compatible with state and federal agencies.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Community Report Card for Environmental Protection

Intended Audience General Public

Description Guide to evaluating how well a community takes care of the environment.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Contribution List

Intended Audience Volunteer Groups, General Public

Description List of supplies and equipment needed by volunteer crews for the Chesapeake Clean Up Campaign and their costs. Used to solicit contributions to finance the clean-up effort.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore MD 21201
(301) 225-4550

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Controlling Nonpoint Source Water Pollution: A Citizen's Handbook

Intended Audience Public Interest Groups, General Public

Description 170-page book outlining the state planning process for the control of nonpoint source pollution and providing tips on citizen participation. Suggests how citizens can encourage, monitor, and support efforts to assess their state's nonpoint source pollution problems and develop clean-up plans.

Order From The Conservation Foundation
1250 24th Street, NW, Suite 500
Washington, DC 20037
(202) 778-9575

Delaware Stream Watch Guide

Intended Audience Volunteers

Description Manual for Delaware Stream Water Watch, a program involving youth and adult volunteers in monitoring Delaware's waterways. 44 pages with illustrations.

Order From Delaware Nature Society
P.O Box 700
Hockessen, DE 19707
(302) 239-2334

Drinking Water: A Community Action Guide

Intended Audience General Public

Description 30-page booklet that offers an introduction to water management and protection to the public.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

Environmental Quality in the Gulf of Mexico

Intended Audience General Public

Description 132-page paperback giving a detailed introduction to the Gulf of Mexico's physical features, ecosystems, economic activities, environmental issues and opportunities for citizen involvement. Includes appendices listing many related governmental and nongovernmental organizations. Maps and photographs.

Order From Center for Marine Conservation
1725 DeSalles Street, NW
Washington, DC. 20036

Groundwater: A Community Action Guide

Intended Audience Public Interest Groups, General Public

Description 22-page booklet examining issues surrounding the use and misuse of groundwater and offering suggestions for improved management of this resource.

Order From Concern, Inc.
1794 Columbia Road, NW
Washington, DC 20009
(202) 328-8160

A Guide to Water Watching

Intended Audience General Public

Description Single-page flyer on signs of water pollution. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

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Habitat Enhancement

Intended Audience Public Interest Groups, General Public

Description Habitat check list and recruiting sheet for the Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

Homeowner's Conservation Guide

Intended Audience Homeowners

Description 32-page booklet providing information to homeowners about sound conservation practices and emphasizing their important role in protecting, preserving, and restoring the environment.

Order From Hamilton County Soil and Water Conservation District
Triangle Park Drive, Suite 2901
Cincinnati, OH 45246
(513) 772-7645

How to Do an Urban Streambank Cleanup

Intended Audience Public Interest Groups, General Public

Description 70-page Plaster Creek Cleanup Binder describing the steps necessary to organize and carry out a stream cleanup. Addresses nonpoint source pollution in general.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

New Hampshire State Assisted Lay Monitoring Program

Intended Audience Potential Volunteers

Description 29-page description of state program for citizen environmental monitoring. Addresses nonpoint source pollution in general. Provides general educational information for public interest groups and organizations.

Order From WSPCD
6 Hazen Dr., P.O. Box 95
Concord, NH 03301
(603) 271-3503

Ohio's Scenic River: Stream Quality Monitoring

Intended Audience Volunteers, Government Officials

Description 20-page booklet offering a simplified approach to stream water quality examination through collection and analysis of key indicator species of aquatic insects and other life-forms.

Order From Ohio Department of Natural Resources
Division of Natural Areas and Preserves
1889 Fountain Square Court
Columbus, OH 43224
(614) 265-6453

Public Awareness

Intended Audience Public Interest Groups, General Public

Description A checklist and recruiting sheet for groups participating in the public awareness aspect of the Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

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Public Involvement Plan 1989

APES #NV-04

Intended Audience Local Officials, Citizen Groups

Description Includes an introduction and addresses milestones and goals, information acquisition, public involvement, monitoring, priority action plans, budgets, publications, and schedule of events.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

A Resource Directory to Local Involvement in River and Stream Stewardship

Intended Audience Public Officials, General Public

Description This guide is a resource tool for citizens and public officials throughout the state. It provides information about resources that may facilitate networking, data gathering, and group organization.

Order From Illinois Environmental Protection Agency
Community Relations
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794-9276

Rhode Island Watershed Watch: Monitoring Procedures

Intended Audience Citizen Groups, Researchers

Description This technical report provides a description of the monitoring procedures used by citizen volunteer monitors in the Rhode Island Watershed Watch Program.

Order From Department of Natural Resource Science
University of Rhode Island
Kingston, RI 02881
(401) 792-2905

Save Our Streams: A Citizen Action Program

Intended Audience Citizen Groups, General Public

Description A resource packet containing a program guide, vocabulary list, bumper sticker, action guide, and project ideas.

Order From Save Our Streams Program
Izaak Walton League of America
1401 Wilson Blvd., Level B
Arlington, VA 22209
(703) 528-1818

Save Your Stream: Manage Your Streambank — A Greenbelt Management Guidebook for Citizens in the Plaster Creek Watershed

Intended Audience Property Owners, General Public

Description 139-page binder on greenbelt management practices for streambank property owners in an urban area. Addresses nonpoint source pollution effects. Provides educational information for the public.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Shore Erosion Control

Intended Audience General Public

Description Shore erosion checklist and recruiting sheet for the Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

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South Carolina Water Watch Program Manual

Intended Audience General Public, Government Officials, Organizations

Description 101-page loose-leaf manual introducing citizens to the concept and philosophy of the Water Watch Program. Topics include how to organize citizen groups, aquatic ecology, working with the media, and projects to promote and clean up adopted water bodies.

Order From South Carolina Governor's Office
Energy, Agriculture & Natural Resources
1205 Pendleton Street
Columbia, SC 29201
(803) 734-0445

Stream and Shoreline Clean Up

Intended Audience General Public

Description Shore cleanup checklist and recruiting sheet for the Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

Stream Monitoring

Intended Audience Public Interest Groups, General Public

Description A checklist and recruiting sheet for groups participating in the stream monitoring aspect of the Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

Stream Team Guidebook

Intended Audience General Public

Description 57-page guidebook on how residential and business volunteers can protect and enhance our water quality, fish, and wildlife. Addresses nonpoint source pollution in general. Provides educational information for the public.

Order From City of Bellevue
Storm and Surface Water Utility
P.O. Box 90012
Bellevue, WA 98009-9012
(206) 451-4476

Streamwalk Manual: A Field Guide to Clean Water

Intended Audience General Public

Description 40-page manual on clean stream water. Addresses nonpoint source pollution as related to streams. Provides educational information for the public.

Order From University of Maryland
Maryland Public Interest Research Group
3110 S. Campus Dining Hall
College Park, MD 20742

Take Credit for Cleaning Up New York's Waters

Intended Audience Public Interest Groups, General Public

Description Booklet describing the water quality improvement recognition program of the New York State Department of Environmental Conservation. Addresses volunteer action and nonpoint source pollution in general. Provides information for public interest groups and organizations.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

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Tree Planting

Intended Audience General Public

Description Tree planting checklist and recruitment sheet for the volunteer Chesapeake Clean Up Campaign. Addresses nonpoint source pollution in general.

Order From Chesapeake Clean Up Campaign
Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

Volunteer Lake Monitoring: A Methods Manual

Intended Audience General Public, Organizations

Description This 121-page manual presents techniques to collect reliable data for a variety of lake management purposes. It is useful to agencies, institutions, and private citizens wishing to start new monitoring efforts, as well as those who wish to improve an existing program.

Order From U.S. Environmental Protection Agency
Assessment and Watershed Protection
401 M. Street, S.W. (WH553)
Washington, DC 20460

Wanted: A Few Active Groups

Intended Audience Potential Volunteers

Description Basic information and recruitment folder aimed at organizations that might volunteer to help clean up the Chesapeake Bay. Addresses nonpoint pollution in general.

Order From Maryland Department of State Planning
301 West Preston
Baltimore, MD 21201
(301) 225-4550

Water Watch Field Guide

Intended Audience General Public

Description 29-page guide for water watching. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Water Watch Resource Manual

Intended Audience General Public

Description 12-page guide on how to organize your own water watch group. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Watershed: An Action Guide to Improving Maine Waters

Intended Audience General Public

Description This 18-page booklet, written by the Maine Dept. of Environmental Protection and the University of Maine Cooperative Extension, describes ways that homeowners can avoid contaminating water and become involved in community activities to monitor water quality.

Order From Maine Coastal Program
State Planning Office
State House Station 38
Augusta, ME 04333

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COMPUTER SOFTWARE/DATABASES

R0036596

COMPUTER SOFTWARE/DATABASES

Aquatic Plant Information Retrieval System (APIRS)

Intended Audience Researchers, Students, Aquatic Managers, Government Officials

Description Factsheet with search request form. Free searches are available, generating bibliographies from a database containing over 31,000 citations from worldwide sources dealing with aquatic plant ecology, physiology, and management. Hard copy of most references can be made available.

Order From Center for Aquatic Plants
Institute of Food and Agricultural Sciences
University of Florida
7922 NW 71st Street
Gainesville, FL 32606

Best Management Practices for Soil Erosion

Intended Audience Engineers, Planners, Resource Managers, Farmers

Description Software program providing information about soil erosion. Types of water erosion are described and illustrated, and detailed descriptions of management and structural practices to control erosion are provided. For IBM PC or compatible; VGA monitor and high-density disk drive required.

Order From Public Brand Software
P.O. Box 51315
Indianapolis, IN 46251
(800) 462-3475

Clean Lakes Clearinghouse Database

Intended Audience Researchers, Resource Managers, Government Officials

Description Database with over 3,000 sources abstracted and indexed, available on diskette for DOS computers or on-line through NTIS and EPA's Nonpoint Source Bulletin Board System. Includes Clean Lakes Program Reports and other resources on lake restoration, protection, and management including the topics of nonpoint source pollution and watershed management.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(800) 726-LAKE

Farm and Food Bytes

Intended Audience Elementary Students

Description Computer program — a teacher's guide to soil. Addresses nonpoint source pollution as it relates to soil and water conservation.

Order From National Association of Conservation Districts
408 East Main Street
P.O. Box 885
League City, TX 77573
(800) 825-5547

Groundwater Education System

Intended Audience Resource Managers, Land Users, Students

Description Software program about the nature of groundwater and the principles of groundwater protection. Concepts are backed up with definitions or interactive graphics. Includes newspaper clipping file and follow-up quiz. For IBM PC or compatible with EGA monitor.

Order From Public Brand Software
P.O. Box 51315
Indianapolis, IN 46251
(800) 462-3475

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Gulf of Mexico Program Electronic Bulletin Board

Intended Audience Researchers, Government Officials, Students

Description Bulletin board system open to anyone with a modem-equipped personal computer wanting information or contacts concerning the Gulf of Mexico environment. Includes news flashes, current event updates, and references. Toll free, 800-235-4662.

Order From Gulf of Mexico Program
Building 1103, Room 202
John C. Stennis Space Center
Stennis Space Center, MS 39529
(601) 688-3726

Penn State Runoff Quality Model

Intended Audience Environmental Managers, Planners

Description A computer simulation procedure and model to predict nonpoint source pollutant loads from urban/suburban watersheds. EPA-funded project, under the 205(j)(5) program.

Order From Pennsylvania Department of Natural Resources
Bureau of Land and Water Conservation
P.O. Box 8555
Harrisburg, PA 17105-8555

Residential Water Conservation Techniques

Intended Audience General Public

Description Software program about effective ways to save water inside and outside the home. Offers more than 100 color graphic screens and animation. Topics include efficient toilets, showerheads, faucets, leak detection, and water efficient lawn care and gardening. For IBM PC or compatible with EGA monitor.

Order From Public Brand Software
P.O. Box 51315
Indianapolis, IN 46251
(800) 462-3475

Surface Water Education System

Intended Audience Students

Description Software program using graphics and text to provide information about surface water resources. Topics include the importance of surface water, information about the quality of this resource, and detailed information about the surface water resource of Indiana. For IBM PC or compatible with VGA monitor.

Order From Public Brand Software
P.O. Box 51315
Indianapolis, IN 46251
(800) 462-3475

U.S. EPA Nonpoint Source Information Exchange Computer Bulletin Board System (BBS)

Intended Audience Researchers, Government Officials

Description A bulletin board system designed to provide state and local agencies, private organizations, businesses and concerned individuals with timely, relevant NPS information, a forum for open discussion, and the ability to exchange computer text and program files. A user's manual is available. Personal computer with modem required. BBS number: (301) 589-0205.

Order From U. S. Environmental Protection Agency
Assessment and Watershed Protection Div.
(WH-553)
401 M Street, SW
Washington, DC 20460
(202) 260-3665

Water Education Software

Intended Audience Students

Description Five water education computer games are available on a 5 1/4" diskette, for either Apple II or IBM PC (or compatible).

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $5)

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32900
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Water, Our Irreplaceable Resource

Intended Audience Students, Grades 5 - 9

Description This computer program is developed to provide students with the opportunity to increase awareness and knowledge of current water issues and topics, including the properties of water; the hydrologic cycle; Rhode Island's watersheds; distribution of the world's water supply; water pollution, conservation, and protection; and water resources issues around the world.

Order From Department of Natural Resource Science
University of Rhode Island
Kingston, RI 02881
(401) 792-2495
Contact: Thomas Husband

Wetlands Education System

Intended Audience Students

Description Software program that addresses topics such as definition and classification of wetlands, types of plants and animals that are common in wetlands, and the importance of wetland systems in flood and erosion control, water quality, and groundwater recharge. For IBM PC or compatible with VGA monitor.

Order From Public Brand Software
P.O. Box 51315
Indianapolis, IN 46251
(800) 462-3475

What Would You Do?

Intended Audience Students

Description A groundwater protection simulation that asks the player to use problem-solving techniques and investigative strategies to find the source of water well contamination in an imaginary town. Available only for Apple IIe or IIc computers with color monitors.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $5)

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FACT SHEETS

Acid Rain

Intended Audience General Public

Description Fact sheet describing acid rain. Explains sources of acid rain and how the U.S. Geological Survey is monitoring acid rain.

Order From U.S. Geological Survey
Environmental Affairs Program
National Center, MS423
Reston, VA 22092
(703) 648-6818

The Adventures of Sewerman

Intended Audience Children, General Public

Description Fact sheet providing an introduction to urban storm water pollution. Includes cartoon illustrations.

Order From NE Area Water Quality Education
University of Wisconsin Green Bay
ES-317
Green Bay, WI 54311-7001
(414) 465-2317

Amazing Stuff

Intended Audience General Public

Description This publication discusses facts about water.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Automotive Products

Intended Audience General Public

Description A 2-page fact sheet that describes health concerns, precautions, and disposal methods for automotive products such as gasoline, motor oil, antifreeze, and batteries.

Order From Connecticut Fund for the Environment
152 Temple Street
New Haven, CT 06510
(203) 787-0646

Bacterial Monitoring of Surface Waters

Intended Audience General Public

Description This fact sheet provides answers to some commonly asked questions about bacterial contamination of surface waters, specifically in Rhode Island.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Beneficial Landscape Practices

Intended Audience Residential Homeowners

Description Describes urban nonpoint source pollution and explains how to landscape to reduce it.

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715

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Boater's Guide to Marine Toilets and Marine Sanitation Devices

By Theodore B. Shelton, Ph.D., and Michael T. Olohan. Pub. FS342

Intended Audience Boaters

Description Describes the various types of marine toilets available to enable boaters to equip and operate these devices properly.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Buttermilk Bay Nitrogen Management Strategy

Intended Audience General Public

Description A summary of how the Buzzards Bay Nitrogen Management Strategy was applied to Buttermilk Bay, Massachusetts.

Order From Buzzards Bay Project
2 Spring Street
Marion, MA 02738
(508) 748-3600

Clean Water and You: What You Can Do About Nonpoint Source Pollution

Intended Audience General Public

Description Fact sheet on nonpoint source pollution and water quality.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Clean Water Begins at Home

Intended Audience General Public

Description "Tipstrip" listing pollution prevention tips for the home. Addresses nonpoint source pollution in general.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Community Forest Assistance — Program Descriptions

Intended Audience General Public

Description Companion document to "Your Map to Community Forest Assistance Programs." 6-page handout describes and lists contacts for 39 programs available for assisting Maryland communities in their tree planning and care programs.

Order From Maryland Community Forest Council
P.O. Box 2110
Annapolis, MD 21404-2110

Conservation Tips Fact Sheets on Urban Sources of Sediment

Intended Audience General Public

Description A series of nine fact sheets outlining construction sources of erosion and giving tips for the individual for controlling or preventing this erosion.

Order From New York State Dept. of Environmental Conservation
Division of Water
Public Participation Section
50 Wolf Road
Albany, NY 12233-3504
(518) 457-0669

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FACT SHEETS

Conserving Water at Home

Intended Audience General Public

Description 4-page fact sheet that cites practices for conserving water and measuring consumption. Provides educational information for citizen involvement.

Order From University of Kentucky
College of Agriculture
Agricultural Science Building
Lexington, KY 40546

Criteria for Monitoring Groundwater Pollutants

Intended Audience Field Technicians, Resource Managers

Description 4-page fact sheet providing a description of techniques for the monitoring of groundwater for organic pollutants.

Order From Cooperative Extension Service
University of Florida
Gainesville, FL 32611

Don't Mess with Our Beaches

Intended Audience General Public

Description "Tipstrip" listing tips for pollution prevention at the beach. Addresses nonpoint source pollution in general.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Educational Student Handout Set

Intended Audience Students

Description Three two-sided, three-hole-punched handouts, with the same information as the AWWA's educational poster series.

Order From American Water Works Association
6666 West Quincy Ave.
Denver, CO 80235
(303) 794-7711

Erosion Control for Home Builders

#GWQ001

Intended Audience Residential Building Contractors, Earth Movers, Inspectors

Description Describes problems associated with construction site erosion and tells how to prevent problems. Includes diagram of building site, list of control practices, and "how to" diagrams of straw bale and filter fence installation.

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715
(Free to public agencies and nonprofit organizations)

Fertilizers and Wisconsin Lakes

Intended Audience Homeowners, Land Users

Description Fact sheet on lawn fertilization and protection of lakes. Addresses effects of fertilization as nonpoint source pollution.

Order From Wisconsin Department of Natural Resources
Lake Management Program
101 South Webster
Madison, WI 53707
(608) 269-0385

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32995
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Geographic Information Systems in Rhode Island

Intended Audience Planners, Resource Managers

Description Fact sheet designed to answer some questions and concerns about Geographic Information System (GIS) technology and how this relates to Rhode Island through the Rhode Island Geographic Information System (RIGIS). Provides a glossary of GIS terms and sources of additional information. Should serve as a valuable tool for anyone interested in using GIS technology for land use planning, management, and natural resources protection.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Get Your Feet Wet / Cultivate Clean Water

Intended Audience General Public

Description "Tipstrip" listing tips for pollution prevention around the home. Addresses pollution potential around the home, including the lawn.

Order From New York Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Groundwater: A Source of Alaska's Drinking Water

Pub. #100G-00948

Intended Audience General Public

Description This fact sheet describes public drinking water systems, listing the percent that rely on groundwater, and discusses the quality of Alaska's groundwater.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Groundwater and Contamination: From the Watershed Into the Well

Intended Audience General Public

Description 2-page fact sheet explaining how groundwater contamination occurs. Addresses nonpoint source pollution in general.

Order From Massachusetts Audubon Society
South Great Road
Lincoln, MA 01773
(617) 259-9500

Groundwater and Well Contamination

Pub. #MF-932

Intended Audience General Public

Description 4-page fact sheet discussing groundwater movement and how groundwater may become contaminated. Addresses nonpoint source pollution in general. Provides general educational information to land users.

Order From Distribution Center
Umberger Hall, Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830
(Cost: $.30)

Groundwater Factsheet Series

Intended Audience Homeowners, Land Users

Description Eight double-sided fact sheets including What Is Groundwater, Waterborne Disease and Groundwater, Protecting a Homeowner's Well Supply, Waste Disposal and Groundwater, Septic Tank Systems and Groundwater, and Agricultural Activities and Groundwater

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

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32996
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A Groundwater Planning Group for Your Community

Pub. #100G-00945

Intended Audience General Public

Description This fact sheet offers suggestions for forming a community group which focuses on local groundwater issues and protection.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Groundwater Protection for Rhode Island Noncropland Weed Control

Intended Audience Land Managers

Description This bulletin describes groundwater protection practices that can be adopted to reduce the risks of pesticide leaching in noncrop weed control. General information is provided about a number of pesticides used to control noncropland weeds, with alternatives provided for those that may pose a threat to groundwater.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Groundwater Protection for Rhode Island Tree and Shrub Pesticide Applicators

Intended Audience Landscape Businesses, Homeowners

Description This bulletin describes groundwater protection practices that tree and shrub pesticide applicators can adopt to reduce the risks of pesticide leaching. General information is provided about a number of pesticides used on trees and shrubs, with alternatives provided for those that may pose a threat to groundwater.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Groundwater Protection for Rhode Island Turf Growers and Managers

Intended Audience Landscape Businesses, Homeowners

Description This bulletin describes groundwater protection practices that turfgrass growers can adopt to reduce the risks of pesticide leaching. General information is provided about a number of pesticides used on turfgrass, with alternatives provided for those that may pose a threat to groundwater.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Groundwater: The Hidden Resource

Intended Audience General Public

Description 4-page fact sheet describing groundwater within the context of the water cycle. Discusses pollution and depletion as they threaten groundwater. Addresses causes of groundwater pollution. Includes a section on groundwater protection.

Order From University of Florida
Publication Distribution Center
IFAS Building 664
Gainesville, FL 32611

Guidance on How to Dispose of Common Household Hazardous Waste

Intended Audience General Public

Description 5" x 8" card with common hazardous waste sources listed in four categories (Automotive, Lawn and Garden, Home Improvement, and Household items) and appropriate disposal methods for each source.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
(Free)

VOL 12
32997
R0036605

A Guide to Using National Wetlands Inventory Maps in Vermont

Intended Audience Local Government Officials, Planners

Description 8-page booklet that explains how to use National Wetlands Inventory (NWI) maps and the wetland classification system. Provides information for ordering NWI maps. Helpful in dealing with nonpoint source pollution issues as they relate to wetland use.

Order From Department of Environmental Conservation
Water Quality Division
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

Guidelines For Household Toxic Materials

Intended Audience General Public

Description Small wall chart/checklist on household toxics. Addresses nonpoint source pollution potential of hazardous waste.

Order From Association of Bay Area Governments
P.O. Box 2050
Oakland, CA 94604-2050
(415) 464-7900

Gulf of Mexico Program: Gulf Facts

Intended Audience General Public

Description A series of fact sheets covering issues vital to the Gulf of Mexico's environment and population, including topics such as organization of the Gulf of Mexico Program, nutrient enrichment, marine debris, habitat degradation, and coastal erosion. Each sheet includes suggestions for citizen involvement.

Order From Gulf of Mexico Program
Building 1103, Room 202
John C. Stennis Space Center
Stennis Space Center, MS 39529
(601) 688-3726

Handling and Underground Storage of Fuels

Intended Audience General Public

Description Fact sheet on underground fuel storage. Addresses potential for groundwater pollution.

Order From Michigan State University
Cooperative Extension Service
Director's Office, Agricultural Hall
East Lansing, MI 48824-1039

Hazardous Chemicals in Your Home: Proper Use and Disposal

By Theodore B. Shelton, Ph.D. Pub FS271

Intended Audience General Public

Description Double-sided fact sheet with definition and description of hazardous household products. Disposal recommendations for more than a dozen categories of household chemicals.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Health Effects of Drinking Water Contaminants

Intended Audience General Public

Description 8-page fact sheet on health effects of drinking water contaminants. Addresses various pollutants in drinking water.

Order From University of Maine Cooperative Extension
Waldo County Office
RFD 2, Box 641
Belfast, ME 04915
(207) 342-5971

VOL 12
32998
R0036606

Home and Garden Practices for Lake Protection

Intended Audience General Public

Description Describes ways to manage land use practices for lake preservation. Ways of reducing runoff, controlling soil and shoreline erosion, and preventing chemical pollution are all outlined.

Order From Wisconsin Department of Natural Resources
Lake Management Section
P.O. Box 7921
Madison, WI 53707
(608) 269-0385

Home Lawns

Intended Audience Homeowners, Local Officials, Planners

Description Fact sheet on the dangers of home lawn care fertilizers, pesticides, etc., including nonpoint source pollution.

Order From Rhode Island Dept. of Environmental Mgmt.
Land Management Project
83 Park Street
Providence, RI 02903-1037
(401) 277-3434

Home Yard Irrigation

Intended Audience Homeowners

Description Fact sheet on how and when to irrigate soil. Addresses nonpoint source pollution issues in gardening.

Order From University of Arizona
College of Agriculture
Tucson, AZ 85721

Homeowner's Guide to Managing Your Lawn to Protect Water Quality

Intended Audience Homeowners

Description This bulletin describes the consequences of overfertilization of lawns and six steps homeowners can take in maintaining their lawns that will protect water quality.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Household Cleaners: Environmentally Safe Alternatives

Intended Audience General Public

Description Discusses tested alternatives to commercial cleaning products with harsh components.

Order From Rutgers Cooperative Extension
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Household Cleaners: Suggestions for Environmentally Safer Alternatives

By Joseph Ponessa, Ph.D., and Susan Lance. Pub. FS582

Intended Audience General Public

Description Describes do-it-yourself, alternative recipes for common household cleaning products.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

VOL 12
32999
R0036607

Household Cleaning Products: Informed Purchases Help the Environment

Intended Audience General Public

Description Phosphate-based cleaners also add arsenic compounds to the environment. Some alternatives are suggested.

Order From Rutgers Cooperative Extension
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Household Cleaning Products: Making Informed Purchasing Decisions to Help Protect the Environment

By Joseph Ponessa, Ph.D., and Susan Lance. Pub. FS581

Intended Audience General Public

Description Lists the heavy metal makeup of common household cleaning products, allowing consumers to make informed purchasing decisions and protect water quality.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Household Hazardous Waste

Intended Audience General Public

Description This fact sheet discusses household hazardous chemicals and their disposal. Included are potential health effects, how hazardous waste can pollute, and actions the homeowner can take to reduce potential pollution.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Household Product Disposal Guide

By G. Morgan Powell and Michael H. Bradshaw
Fact Sheet #MF-965

Intended Audience General Public

Description Addresses the proper disposal of home products and their containers. Home products discussed are auto care, chemicals, cleaning, paint/preservatives, personal care, pesticides and fertilizers, and miscellaneous products.

Order From Distribution Center
Umberger Hall, Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830
(Cost: $.30)

How Alaska's Groundwater Is Contaminated

Pub. #100G-00947

Intended Audience General Public

Description This fact sheet lists some of the common activities with potential for groundwater contamination.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

How Does Land Use Affect Narragansett Bay?

Intended Audience General Public

Description Fact sheet on the effects of land use on Narragansett Bay. Addresses urban runoff nonpoint source pollution.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

VOL 12
3300
R0036608

How To Care . . . For Missouri Streams

Intended Audience General Public, Citizen Groups

Description Fact sheet describing proper care of Missouri streams. Addresses volunteer programs relating to various pollutants of streams and rivers.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

How to Reduce, Recycle and Safely Dispose of Household Hazardous Wastes

Intended Audience Householders

Description Fact sheet on disposal of household waste. Addresses possible nonpoint source pollution effects of household toxics.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711

If You See It, Report It!

Intended Audience General Public

Description "Tipstrip" on pollution and whom to report it to. Addresses NPS pollution in general.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

An Integrated Pest Management Program for Turfgrass

Intended Audience Landscape Managers, Homeowners

Description 6-page fact sheet on turfgrass integrated pest management.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

An Introduction to Groundwater and Aquifers

Intended Audience General Public

Description 2-page fact sheet on groundwater and aquifers. Addresses nonpoint source pollution in general.

Order From Massachusetts Audubon Society
South Great Road
Lincoln, MA 01773
(617) 259-9500

Lake Protection Through Town Planning

Intended Audience Local Government Officials, Planners, Local Groups

Description Suggested measures to include in town plans to prevent or solve lake water quality and recreational use problems.

Order From Lake Protection Program
Vermont Department of Environmental Conservation
103 S. Main Street, Bldg. 10 North
Waterbury, VT 05671-0408

R0036609

VOL 12 3301

Lawn & Garden Fertilizers

Pub. #GWQ002

Intended Audience People with Lawns

Description Do's and Don'ts of lawn fertilizing.

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715

Lawn & Garden Pesticides

Pub. #GWQ011

Intended Audience People with Lawns and Gardens

Description Describes a variety of nonchemical methods of pest control and offers tips for environmentally sound usage of pesticides.

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715

Leaking Heating Oil Tanks: Homeowner Responsibility

Intended Audience Homeowners

Description "Tipstrip" instructing homeowners on how to avoid oil tank leaks.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Maintaining Your Septic System

Intended Audience Homeowners

Description This fact sheet contains information that will help homeowners maintain their septic systems. It also provides a place to record and store vital information about a system.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Managing Nitrogen to Sensitive Embayments

Intended Audience General Public

Description A discussion of why nitrogen is a problem in coastal waters and a proposed strategy for nitrogen management within the watersheds of coastal embayments.

Order From Buzzards Bay Project
2 Spring Street
Marion, MA 02738
(508) 748-3600

Miami Valley Groundwater Protection and Management Program

Intended Audience General Public

Description 9-page fact sheet on groundwater protection in the Miami Valley. Addresses nonpoint source pollution in general.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

VOL 12
3302
R0036610

The Nature of Groundwater

Intended Audience General Public

Description 4-page fact sheet concerning groundwater. Addresses urban runoff and fertilizers in groundwater.

Order From University of Arkansas
2201 Brookwood Dr.
P.O. Box 391
Little Rock, AR 72203
(501) 671-2000

New Jersey Water Watch: What You Can Do About Nonpoint Source Pollution

Intended Audience General Public

Description Fact sheet about nonpoint source pollution. Provides educational information for the public.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Nonpoint Pollution of Alabama Waters

Intended Audience General Public

Description 4-page fact sheet on nonpoint source pollution of Alabama waters. Addresses pollution of streams and rivers.

Order From Alabama Cooperative Extension Service
100 Comer Hall
Auburn University, AL 36849
(205) 844-4962

Nonpoint Source Pollution

Intended Audience General Public

Description Fact sheet concerning effects of nonpoint source pollution on Narragansett Bay.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Nonpoint Source Pollution Control

Intended Audience General Public

Description 3-page fact sheet on nonpoint source pollution control.

Order From Maine Department of Environmental Protection
Bureau of Water Quality Control
State House, Station 17
Augusta, ME 04333
(207) 289-7659

The Nonpoint Story

Intended Audience General Public

Description Defines nonpoint source pollution, summarizes program history, and discusses current program implementation, with emphasis on public-private sector cooperative role in best management practice identification and implementation.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205

VOL 12
33003
R0036611

Nonpoint Source Pollution Fact Cards

Intended Audience General Public, Upper-Level Students

Description Six 3.5" x 11" multicolor cards providing tips on use and disposal of household hazardous wastes, automobile products, and paints. Two of the cards describe ways that people can help prevent nonpoint source pollution around their homes and provide numbers to call if illegal dumping has been observed.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

Nutrient Pollution

Intended Audience General Public

Description 2-page fact sheet on harmful effects of excessive nutrients on the Bay. Addresses nonpoint source pollution issues.

Order From Chesapeake Bay Estuary Program
U.S. Fish and Wildlife Service
900 Bestgate Road, Suite 401
Annapolis, MD 21401
(301) 224-2732

Nutrient Pollution and the Chesapeake: A Nonpoint Perspective

Intended Audience General Public

Description 8-page fact sheet addressing the problem of nutrient nonpoint source pollution in the Chesapeake Bay and solutions.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

Organic Pollutants in Groundwater: 1. Health Effects

Intended Audience General Public, Planners

Description 3-page fact sheet of introductory information explaining organic pollutants in groundwater. Defines groundwater and organic pollutants and explains how organic pollutants contaminate groundwater. Includes a section on health effects.

Order From University of Florida
Publication Distribution Center
IFAS Building 664
Gainesville, FL 32611

Organic Pollutants in Groundwater: 2. Risk Management

Intended Audience Planners

Description 6-page fact sheet on organic pollutants in groundwater from all sources. Addresses nonpoint source pollution in general. Provides high-technology information for professional planners.

Order From University of Florida
Publication Distribution Center
IFAS Building 664
Gainesville, FL 32611

The Pawcatuck Watershed

Intended Audience General Public

Description Describes the surface and groundwater resources and nonpoint source pollution concerns in the Pawcatuck Watershed, located in southwestern Rhode Island. In 1990 this watershed was selected by the USDA as a Hydrologic Unit Area to receive special funding to help protect its water resources.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

VOL 12
33304
R0036612

Pesticide Use and Groundwater Protection

Intended Audience Homeowners

Description Describes Rhode Island's groundwater resources and their vulnerability to contamination by pesticides. Specific soil, pesticide, site, and management factors that affect the leaching of pesticides are discussed, as well as specific examples of how pesticides can be safely used, stored, and disposed of.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Pet Waste and Water Quality

Intended Audience Pet Owners

Description Discusses water quality and health issues related to improper disposal of pet waste; describes alternatives for proper disposal. (Written and produced by U. W. Extension.)

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715

Phosphorus: Pollutant and Essential Plant Element

Intended Audience Farmers, Foresters, Homeowners

Description 4-page fact sheet on phosphorus fertilizer. Addresses NPS pollution to groundwater in general. Provides educational information for land users.

Order From Michigan State University
Cooperative Extension Service
Director's Office, Agricultural Hall
East Lansing, MI 48824-1039

Plastics: Out of Sight, Out of Mind?

Intended Audience General Public

Description Fact sheet concerning the effects of disposable containers on Narragansett Bay. Addresses nonpoint source pollution in general.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Play it Safe With Groundwater

Intended Audience General Public

Description 4-page fact sheet on groundwater and dangers to it. Addresses concerns associated with various pollutants.

Order From University of Maine Cooperative Extension
Waldo County Office
RFD 2, Box 641
Belfast, ME 04915
(207) 342-5971

Potential Audience Questions on Miami Groundwater Protection Program

Intended Audience Public Interest Groups, Government Officials

Description 5-page question-and-answer sheet on a groundwater protection program. Addresses nonpoint source pollution in general. Directed at public interest groups and organizations.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

VOL 12
3305
R0036613

Preventing Pollution Problems from Lawn and Garden Fertilizers

Intended Audience Urban and Suburban Homeowners

Description Technical information linking use of lawn and garden fertilizers, runoff and drainage waters, and pollution of lakes and groundwater. Includes information on soil testing, selecting a fertilizer, applying fertilizer, and landscape maintenance.

Order From Distribution Center
Minnesota Extension Service
3 Coffey Hall, 1420 Eckles
University of Minnesota
St. Paul, MN 55108

Protecting the Lawn

Intended Audience Homeowners

Description 6-page fact sheet on proper use of lawn care products.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

Protecting Your Water Supply

Intended Audience General Public

Description 3-page fact sheet that addresses nonpoint source pollution in groundwater. Provides general educational information for the public.

Order From University of Maryland
Cooperative Extension Service
Symons Hall, Room 1200
College Park, MD 20742
(301) 405-2907

Quality Action for Quality Waters

Pub. PUBL-WR-169 87

Intended Audience General

Description Actions to take around the farm, home, and community to prevent NPS pollution. (Produced by U.W. Extension.)

Order From NPS Publications
WDNR - WR/2
P.O. Box 7921
Madison, WI 53707

Recycling Used Motor Oil in New Jersey

By Theodore B. Shelton, Ph.D. Pub. FS417

Intended Audience General Public

Description Discusses the problem of used motor oil including how much is dumped and the harm it causes. Includes five easy steps for recycling used motor oil.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Rethinking Yard Care

Intended Audience People with Lawns and Gardens, Car Owners

Description Offers a practical and environmentally sound approach to yard care.

Order From NPS Publications
WDNR - WR/2
P.O. Box 7921
Madison, WI 53707

VOL 12 3306

R0036614

River Factsheets

Intended Audience General Public

Description Eight double-sided fact sheets that include history, culture, environmental problems and issues, and what people can do to help improve conditions. Rivers covered are the Susquehanna, Conestoga, Elizabeth, Gunpowder, Chester, Potomac, Rappahannock, and Anacostia.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

Road Salt and Salt Storage

Intended Audience Local Government Officials, Planners

Description Fact sheet on road salt. Addresses nonpoint source pollution effects of urban road runoff.

Order From Rhode Island Dept. of Environmental Mgmt.
Land Management Project
83 Park Street
Providence, RI 02903-1037
(401) 277-3434

Road Salt and Salted Sand Storage Guidelines

Intended Audience Local Government Officials, Planners

Description 2-page fact sheet aimed at the reduction of the risks of groundwater contamination. Addresses nonpoint source pollution effects of urban road runoff.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

Rules of Thumb for Clean Water

Intended Audience People with Lawns and Gardens, Car Owners

Description Describes how common urban activities such as yard care and auto use cause water pollution. Provides tips on reducing pollution. (Shortened version of "Rethinking Yard Care.")

Order From Extension Publications
30 N. Murray Street, Room 245
Madison, WI 53715

Safe Disposal of Household Use Products

Guide G-311

Intended Audience General Public

Description Tells how to safely and legally dispose of general-use pesticides and empty containers.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

A Safer Home: Reducing Your Use of Hazardous Household Products

Intended Audience General Public

Description 4-page fact sheet on reducing the use of toxics at home. Provides educational information for householders.

Order From Washington Toxics Coalition
4516 University Way
Seattle, WA 98105
(206) 632-1545

VOL 12
33307
R0036615

Septic Systems

Intended Audience Local Officials, Homeowners

Description Fact sheet on the effects of septic systems on groundwater NPS pollution. Provides educational information for local government officials and planners.

Order From Rhode Island Dept. of Environmental Mgmt.
Land Management Project
83 Park Street
Providence, RI 02903-1037
(401) 277-3434

Septic Systems: Operation and Maintenance of On-Site Sewage Disposal Systems

Intended Audience Homeowners

Description 8-page fact sheet on operation and maintenance of on-site sewage disposal systems. Addresses wastewater pollution.

Order From Cooperative Extension Service
University of Illinois
122 Mumford Hall
1301 W. Gregory
Urbana, IL 61801

Septic Tank Maintenance

By G. Morgan Powell and Judith M. Willingham.
Fact Sheet #MF-947

Intended Audience Homeowners

Description Lists the estimated septic tank pumping frequencies by septic tank size and the number of people in the household.

Order From Distribution Center
Umberger Hall Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830
(Cost: $.35)

Septic Tank Soil Absorption Systems

Intended Audience Homeowners

Description Fact sheet on septic tank systems. Addresses potential polluting effects of septic tanks.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

Septic Tank Systems and Groundwater

Intended Audience General Public

Description Describes septic tank systems and how the public can help prevent groundwater from being contaminated with septic wastes.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Snapshot of New York's Water Resources

Intended Audience General Public

Description Fact sheet containing an overview of water resources. Addresses nonpoint source pollution of surface water and groundwater.

Order From New York Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

VOL 12
3308
R0036616

Soil and Water Conservation: An Introduction for Woodland Owners

Intended Audience Woodland Owners

Description 4-page fact sheet describing how common woodland management activities can influence soil and water resources. Outlines ways to avoid or minimize related watershed problems.

Order From Oregon State University
Agricultural Communications, Publications
Administrative Services, Room 422
Corvallis, OR 97331-2119
(503) 737-2513

Soil Evaluation for Home Septic Systems

By G. Morgan Powell. Fact Sheet #MF-945

Intended Audience Contractors, Local Government Officials, Homeowners

Description A review of the soil requirements; lists soil depth, percolation test, and slope criteria as important in the evaluation for home septic systems.

Order From Distribution Center
Umberger Hall Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830
(Cost: $.35)

Stop Storm Drain Pollution

Intended Audience General Public

Description In addition to a general description of storm drain pollution, specific information on safer alternatives, proper disposal of household hazardous wastes, and recycling are provided, as well as informational hotlines.

Order From The Lindsay Museum
1902 First Avenue
Walnut Creek, CA 94596

Stop Storm Drain Pollution

Intended Audience General Public

Description Fact sheet that provides a general description of storm drain pollution and a description of community volunteer activities offered through the Lindsay Museum: storm drain stenciling and "Watershed Watchers," a volunteer water quality monitoring program. To be distributed door-to-door as volunteers stencil nearby storm drains.

Order From The Lindsay Museum
1902 First Avenue
Walnut Creek, CA 94596

Storm Drain Stenciling

Intended Audience Citizen Groups, General Public

Description This bulletin explains how to organize a community storm drain stenciling project.

Order From Carolyn Johnson
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

The Story of Nutrient Enrichment of the Chesapeake Bay

Intended Audience Teachers

Description 4-page fact sheet suggesting projects to educate youth about nonpoint pollution in the Chesapeake Bay. Provides teachers with educational information.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

VOL 12
33309
R0036617

The Story of Submerged Aquatic Vegetation in the Chesapeake Bay

Intended Audience Teachers

Description 4-page fact sheet suggesting projects to educate youth about nonpoint pollution and its effects on aquatic plants in the Chesapeake Bay. Provides teachers with educational information.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

T by 2000 - Illinois Erosion Control Goals

Intended Audience Homeowners, Land Users

Description 6-page fact sheet on Illinois' long-term goals to prevent soil erosion. Addresses nonpoint source pollution prevention through soil and water conservation.

Order From Cooperative Extension Service
University of Illinois
122 Mumford Hall, 1301 W. Gregory
Urbana, IL 61801

Things You Can Do To Help Protect the Miami Valley's Groundwater

Intended Audience General Public

Description Fact sheet on groundwater protection for the Miami Valley. Addresses nonpoint source pollution in general.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

Tips on Protecting Your Soil

Intended Audience Homeowners, General Public

Description Describes backyard and garden practices for preventing erosion and enriching soil. Also lists interesting facts concerning soil erosion and ecology.

Order From National Wildlife Federation
1400 16th Street, NW
Washington, DC 20036-2266
(202) 797-6800

Understanding Sediments: Problems and Solutions

Intended Audience Farmers, Foresters, Homeowners

Description 4-page fact sheet on sediments. Addresses land use issues. Provides low-technology best management practices for land users.

Order From Michigan State University
Cooperative Extension Service
Director's Office, Agricultural Hall
East Lansing, MI 48824-1039

VOL 12
3310
R0036618

Urban Nonpoint Source/Stormwater Management Factsheets

Intended Audience Government Officials, Planners, General Public

Description A series of 4 to 6-page fact sheets prepared for EPA Region 5 covering stormwater impacts, several types of BMP designs, programs in various states, and management issues. Titles include: *Retrofitting Stormwater Management Basins for Phosphorus Control, Facts About Stormwater Management Programs in the State of Florida, Financing Mechanisms for BMPs, Impacts of Changes in Hydrology Due to Urbanization, Integrated Stream Management Programs Reduce Impacts to Aquatic Habitat, Stormwater Management Ordinances for Local Governments, Institutional Support for Stormwater Management Planning, Urban Runoff Impacts to Receiving Waters, Delaware's Sediment Control and Stormwater Management Program,* and *Sand Filter Design for Water Quality Treatment.*

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006

Urban Water Quality Fact Sheet

Intended Audience General Public

Description An 11" x 17" sheet, folded in half, in two colors. Discusses how urban and suburban homeowners affect water quality. A nonpoint source pollution control information and education tool for urban homeowners.

Order From Jefferson Soil Conservation District
730 Sims Street, Room 416
Golden, CO 80401

Using Water Wisely in Household Cleaning and Outdoor Uses

Intended Audience General Public

Description 2-page fact sheet on home water conservation. Provides best management practices for homeowners.

Order From University of Florida
Publications Distribution Center
IFAS Building 644
Gainesville, FL 32611

Vermont Groundwater Resources

Intended Audience Fact Sheet

Description Fact sheet on groundwater in Vermont. Addresses nonpoint source pollution in general.

Order From U.S. Geological Survey
RFD 2 525 Clinton Street
Bow, NH 03301

Volunteer Lake Monitoring Programs

Intended Audience Interested Citizens and Organizations

Description Describes the three levels of lake monitoring: Secchi Disk, Trophic Status Index, and Dissolved Oxygen programs. Also mentions the water milfoil alert and zebra mussel watch program.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

R0036619

VOL 12

Waste Disposal and Groundwater

Intended Audience General Public

Description Describes how disposal of solid and hazardous wastes can contaminate water supplies and how individuals can get more information and become involved in this issue.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Water Conservation for Homes, Institutions and Businesses

Pub. FS107

Intended Audience General Public

Description Double-sided fact sheet presenting tips on water conservation, such as installing water saving devices, fixing a leaking faucet, and curbing water use. Includes simple illustrations of how to install water savers such as a low-flow shower head.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762

Water Conservation In and Around the Home

Intended Audience General Public

Description Describes ways in which people can conserve water in and around their homes. An insert compares the amount of water used for a variety of normal and conservation practices and provides some water saving tips.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Water Fact Sheet

Intended Audience General Public

Description Double-sided fact sheet describing the Regional Aquifer System Analysis (RASA) Program of the U.S. Geological Survey, which will study the Nation's groundwater systems on a regional scale. Discusses groundwater availability and quality.

Order From U.S. Geological Survey
Environmental Affairs Program
National Center, MS 423
Reston, VA 22092
(703) 648-6818

Water Pollution Through Erosion

Intended Audience Land Users, Homeowners

Description Fact sheet on water pollution through erosion. Addresses how to determine whether erosion and nonpoint source pollution are occurring.

Order From University of Maryland
Cooperative Extension Service
Symons Hall, Room 1200
College Park, MD 20742
(301) 405-2907

Water Quality

Intended Audience General Public

Description Three fact sheets that discuss the effects of pollution, pesticides, and septic tanks on water quality.

Order From Alabama Cooperative Extension Service
100 Comer Hall
Auburn University, AL 36849
(205) 844-4962

VOL 12
3 3 1 2
R0036620

Water Quality

Intended Audience Homeowners

Description Series of 15 fact sheets on testing of water. They address nonpoint source pollution in groundwater and provide information on water quality and treatment for homeowners.

Order From Purdue University
Media Distribution Center
301 South 2nd Street
Lafayette, IN 47905-1092
(317) 494-6792

Water Saving Tips for the Home

Intended Audience General Public

Description Covers average U.S. home water use, home water-saving practices and devices, and urban landscape water conservation practices.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Watershed Watch

Intended Audience General Public

Description This fact sheet discusses the Rhode Island Watershed Watch Program, which trains citizen volunteers to monitor freshwater lakes and rivers.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Weed Control for Healthy Lawns and Cleaner Water

Intended Audience Homeowners

Description Fact sheet on weed control methods for cleaner water. Addresses urban nonpoint source pollution. Part of a series entitled "Yard Care and the Environment."

Order From Southeastern Wisconsin Regional Planning Commission
916 N. East Ave.
Waukesha, WI 53187-1607
(414) 547-6721

What Is a Lake Association?

Intended Audience General Public

Description Defines a qualified lake association and outlines the requirements under chapter 181 Wisconsin Statutes.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

What Is a Lake District?

Intended Audience General Public

Description Defines a qualified Lake District and outlines requirements for designation.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

R0036621

VOL 12 3313

What Is a Shoreland Buffer Zone?

Intended Audience WI Lake Shore Residents

Description Describes benefits of buffer strips suggestions for vegetation.

Order From NPS Publications
WDNR-WR/2 - P.O. Box 7921
Madison, WI 53707
Pub # PUBL-WR-169 87REV

What Is a Watershed?

Intended Audience General Public

Description This fact sheet describes the concept of a watershed and introduces watershed management planning. Included are descriptions of hydrology, aquatic ecosystems, ways in which people affect the ecosystems, and what they can do to protect the water quality within their watershed.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

What Is a Watershed?

Intended Audience Homeowners, General Public

Description 2-page fact sheet describing watersheds and addressing reduction of runoff. Provides general nonpoint source pollution educational information and low-technology best management practices for homeowners.

Order From Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

What Is Groundwater?

Intended Audience General Public

Description Provides general educational information concerning groundwater.

Order From Tip of the Mitt Watershed Council
P.O. Box 300
Conway, MI 49722
(616) 347-1181

What Is Stormwater Runoff?

Intended Audience General Public

Description Defines stormwater runoff and describes its effects on lakes. Also explains storm sewers and the goals of stormwater management. Provides ideas for reducing runoff and descriptions of potential problems.

Order From Wisconsin Department of Natural Resources
Lake Management Section
P.O. Box 7921
Madison, WI 53707
(608) 267-0385

What Price Conservation? The Economics of Soil Conservation

Intended Audience Land Users, Homeowners

Description 6-page article discussing the benefits of soil conservation. Provides nonpoint source pollution educational information for land users.

Order From Cooperative Extension Service
University of Illinois
122 Mumford Hall, 1301 W. Gregory
Urbana, IL 61801

VOL 12
3314
R0036622

Why Do Septic Systems Fail?

By G. Morgan Powell and Emily Kling. Fact Sheet #MF-946

Intended Audience Homeowners

Description Describes some common problems of septic systems and the corrective action required for too much water, physical damages, improper design and construction, and the lack of maintenance.

Order From Distribution Center
Umberger Hall Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830
(Cost: $.35)

Why Do Septic Tanks Fail?

Intended Audience Homeowners

Description Fact sheet on determining whether a septic tank is working properly. Addresses potential pollution from septic tanks.

Order From Texas Agricultural Extension Service
Distribution and Supply Center
104 System Building, TAMU
College Station, TX 77843-7101
(409) 845-6474

Why Groundwater Protection Practices Are Important for Household and Building Pesticide Applicators

Intended Audience Pest Control Businesses

Description This bulletin describes why groundwater protection is important and provides general information about groundwater protection practices that can be adopted in household and building pest control to reduce the risk of pesticide leaching.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Why Groundwater Protection Practices Are Important for Mosquito, Tick, and Biting Insect Control Applicators

Intended Audience Pest Control Businesses

Description This bulletin describes why groundwater protection is important and provides general information about groundwater protection practices that can be adopted in mosquito, tick, and biting insect control to reduce the risk of pesticide leaching.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Why Groundwater Protection Practices Are Important for Termiticide Applicators

Intended Audience Pest Control Businesses

Description This bulletin describes why groundwater protection is important and provides general information about groundwater protection practices that can be adopted by termiticide applicators to reduce the risk of pesticide leaching.

Order From Department of Plant Sciences
University of Rhode Island
Kingston, RI 02881
(401) 792-5998

Working Together to Save the Bay — Water Quality Education

Intended Audience Land Users, General Public

Description Fact sheet on improving water quality of Chesapeake Bay. Addresses nonpoint source pollution in general with respect to the Bay. Provides educational information for land users.

Order From Department of Agricultural Engineering
Pennsylvania State University
State College, PA
(814) 865-7685

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3315
R0036623

Yard Care and the Environment — Landscape Practices for Healthier Plants and Improved Water Quality

Intended Audience Homeowners

Description Describes methods and benefits of planting beds, natural landscapes, buffer strips, and good plant selection.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

Yard Care and the Environment — Lawn and Garden Pesticides

Intended Audience Homeowners

Description Describes alternatives to pesticides, such as Integrated Pest Management, planting pest-resistant varieties, and using hand-weeding and mulches to reduce weeds. Also outlines guidelines for pesticide use and disposal.

Order From University of Wisconsin Extension
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

Your Map to Community Forest Assistance Programs

Intended Audience General Public

Description 3-page handout that lists programs available for assisting communities in their tree planting and care programs. Lists areas of interest such as landowner, business, schools, etc. and programs available for each area.

Order From Maryland Community Forest Council
P.O. Box 2110
Annapolis,MD 21404-2110

VOL 12
3316
R0036624

HANDBOOKS/MANUALS

VOL 12

R00036625

Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas — Draft

Intended Audience Local Officials, Contractors

Description Handbook in three-ring binder that provides guidelines for developing plans and implementing measures that prevent or minimize related problems of sediment and stormwater.

Order From Alabama Soil and Water Conservation Committee
Hillwood Office Center, Suite 200-9
Montgomery, AL 36106-2686
(205) 242-2620

Best Management Practice Guidebook for Urban Development

Intended Audience Planners, Engineers, Designers, Developers

Description This guidebook has been prepared to address a comprehensive array of BMPs to minimize the adverse impacts of development on water resource functions. While the guidebook is not a design manual, it discusses effectiveness, site suitability, design guidance, costs, and maintenance of urban BMPs applicable in Northern Illinois.

Order From Northern Illinois Planning Commission
400 West Madison Street, Room 200
Chicago, IL 60606
(312) 454-0400

Best Management Practices for Municipal and New Development

Intended Audience Local Officials, Planners, Developers

Description Final draft BMP manual that updates and revises the existing state stormwater guidance entitled *A Guide to Stormwater Management Practices in New Jersey*, dated 1986. Identifies proven concepts and technologies that should be considered for effective stormwater and nonpoint source pollution management. Emphasizes preventive measures such as land use measures such as land use measures, density policies, innovative site design, pollutant loading controls, and waste minimization over traditional structural controls. 243 pages.

Order From NJ Dept. of Envir. Protection and Energy
Environmental Regulation
Office of Regulatory Policy
CN423
Trenton, NJ 08625-0423
(609) 292-2113

Best Management Practices: Good for Your Business, Good for the Environment

Intended Audience Businesses

Description 36-page manual describing best management practices for businesses that are incidental users of toxic materials. Suggests best management practices that can be easily incorporated into business practices.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281
(Cost: $5)

R0036626

VOL 12 3318

Business Partners for Clean Water

Intended Audience Business Owners

Description Series of five manuals targeting construction, automotive, landscaping, food-related, and building maintenance businesses. Manuals provide information on water quality and stream protection.

Order From City of Bellevue
Storm and Surface Water Utility
P.O. Box 90012
Bellevue, WA 98009-9012
(206) 451-4476

A Citizen's Handbook for Wetland Protection in the Rocky Mountains and Northern Great Plains Region

Intended Audience General Public, Land Users

Description Handbook on wetland ecology for six Rocky Mountain and northern Great Plains states: Utah, Colorado, North Dakota, South Dakota, Wyoming, and Montana. Addresses private land conservation, wetland acquisition, tax incentives, citizen monitoring, and best management practices.

Order From U.S. EPA Region 8
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 293-1583

Composting to Reduce the Waste Stream: A Guide to Small Scale Food and Yard Waste Composting

Pub. NRAES-43

Intended Audience Homeowners, Composting Program Participants

Description Composting reduces the waste stream and enriches the soil by transforming organic wastes into a soil-like material called compost. This publication promotes small-scale composting of yard, garden, and vegetative food wastes. Topics covered are the composting process, composting methods and alternatives, making and maintaining a compost pile, using compost, and using the guide as an educational resource.

Order From MidWest Plan Service
122 Davidson Hall
Iowa State University
Ames IA, 50011-3080

Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices

By Thomas Schueler. Document 87703

Intended Audience Engineers, Planners, Local Officials

Description The first text on the design of urban best management practices (BMPs) to protect streams, wetlands, and lakes during the development process.

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $40)

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3319
R0036627

A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone

By T.R. Schueler, P.A. Kumble, and M.A. Heraty. Document 92705

Intended Audience Government Officials, Planners

Description A series of fact sheets with sample site drawings and summaries of functions and benefits of and concerns with several types of stormwater best management practices including ponds, wetlands, infiltration systems, and swales. With references, glossary, tables of removal efficiencies.

Order From Department of Environmental Programs
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $30)

Decisionmaker's Stormwater Handbook: A Primer

By Nancy Phillips, USEPA Region 5

Intended Audience Government Officials

Description Contains an introduction to stormwater pollution, factsheets for several types of structural and nonstructural best management practices, outline of possible funding mechanisms, and several folded sheets with a prototype stormwater control site plan.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317

Delaware Sediment and Stormwater Regulations. 1991.

Intended Audience Government Officials, Resource Managers

Description 41-page guidance for local governments concerning watershed designation, the implementation of stormwater management plans, and stormwater utilities.

Order From Division of Soil and Water Conservation
Dept. of Natural Resources and Envir. Control
89 Kings Highway, P.O. Box 1401
Dover, DE 19903

Developer's Handbook for Freshwater Wetlands

Intended Audience Developers, Land Users

Description 103-page guidebook dealing with the issue of development in wetlands. Provides low-technology best management practices for the public and developers.

Order From South Carolina Coastal Council
4130 Faber Place, #300
Charleston, SC 29405
(803) 744-5838

Draft Urban Runoff Handbook

Intended Audience Local Officials, Builders

Description Handbook providing best management/general practices for mitigating urban impacts for the State of Arizona.

Order From Arizona Dept. of Environmental Quality
Nonpoint Source Unit
3033 N. Central Ave.
Phoenix, AZ 85012
(602) 207-4511

VOL 12
33320
R0036628

Environmental Planning for Onsite Wastewater Treatment, Volume I

Intended Audience Engineers, Planners, Builders

Description Technical basis for standards of construction, siting, and lot sizing for onsite septic systems while maintaining an acceptable level of groundwater and surface water quality.

Order From Rockingham County Conservation District
32 Front Street
Exeter, NH 03833-2705
(603) 772-4385

Erosion and Sediment Pollution Control Manual (Pennsylvania)

Intended Audience Builders, Contractors, Planners, Inspectors

Description The official manual used for the preparation and review of erosion and sediment control plans.

Order From PA Department of Environmental Resources
Bureau of Land and Water Conservation
P.O. Box 8555
Harrisburg, PA 17105-8555

Field Manual for Implementation and Inspection of Erosion and Sediment Control Plans

Prepared by the Urban Committee of the Association of Illinois Soil and Water Conservation Districts

Intended Audience Developers, Engineers, Planners, Inspectors

Description Hip-pocket version of the *Illinois Procedures and Standards* handbook, developed for field use in the implementation of erosion and sediment control plans in an environmentally sensible manner. 73 pages.

Order From North Cook County Soil and Water Conservation District
675 North Court, Suite 120
Palatine, IL 60067-8106
(Cost: $5)

Florida Development Manual: A Guide to Sound Land and Water Management

Intended Audience Planners, Developers, Local Government Officials

Description Two large three-ring binders (800 pages) on land and water management, including urban runoff nonpoint source pollution. Provides high-technology best management practices for land users.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Forest Conservation Manual

Intended Audience Planners, Foresters, Developers

Description This manual contains information used in the preparation of forest stand delineations and forest conservation plans, including methods for determining the size, location, and orientation of forest areas to be retained and protection techniques for retained forests and specimen trees.

Order From Maryland Division of State Documents
P.O. Box 2249
Annapolis, MD 21404-2249

Ground Water Resource Protection: A Handbook for Local Planners and Decision Makers in Washington State

Intended Audience Local Government Officials, Planners

Description A handbook on how to protect groundwater through local land use planning and development control. Includes basic groundwater hydrology, threats to groundwater, identification of sensitive areas, and how to incorporate groundwater protection into local planning.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

VOL 12
3321
R0036629

Guide for Evaluating the Outstanding Rivers and Streams of Vermont

Intended Audience Local Government Officials, Planners

Description 365-page book that identifies rivers and streams of exceptional value; determines how many are currently threatened and how they can be protected. Addresses surface water nonpoint source pollution. Describes high-technology best management practices.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-5638

A Guide to Conservation Plantings on Critical Areas

Intended Audience Contractors, Land Managers

Description Technical publication by the USDA Soil Conservation Service for those who need to stabilize eroding roadbanks, streambanks, etc. Seeding, liming, fertilizing, planting, and mulching recommendations are discussed.

Order From New York State Dept. of Envir. Conservation
Division of Water Resources
Nonpoint Source Section
50 Wolf Road
Albany, NY 12233-3501
(518) 457-0669

A Guide to Site Development and Best Management Practices for Stormwater Management and Sediment Control

By SC Land Resources Commission and Woolpert Consultants

Intended Audience Builders, Contractors, Planners, Inspectors

Description Resource/reference publication containing state laws and regulations, a procedure to follow in analyzing a site for development, a description of best management practices suitable for stormwater management and sediment control, and an analysis of the master plan for a residential development.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205

Handle with Care: Your Guide to Preventing Water Pollution

Intended Audience General Public

Description A 30-page illustrated booklet on how to pollution-proof your home and take personal responsibility for pollution prevention.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317
(Cost: $9.95)

How to Protect Your Lakeshore Property

Intended Audience Lake Dwellers

Description 20-page handbook on sound management practices for lakeshore property owners.

Order From Lake Champlain Committee
14 South Williams Street
Burlington, VT 05401
(802) 658-1414

VOL 12
3322
R0036630

Indiana Handbook for Erosion Control in Developing Areas — Guidelines for Protecting Water Quality Through the Control of Soil Erosion and Sedimentation on Construction Sites

Intended Audience Developers, Engineers, Planners, Inspectors

Description Contains discussion of Indiana Administrative Code 327-15-5, or "Rule 5," which concerns the control of runoff in areas undergoing construction activities. Includes descriptions of many practices to control erosion and sedimentation and excerpts from the USDA SCS Tech Guide specifications for practices that might be used in urbanizing conditions. Approx. 200 pages.

Order From Urban Conservation Program
Division of Soil Conservation
Indiana Department of Natural Resources
402 W. Washington St., Room W-265
Indianapolis, IN 46204-2748

Industrial Stormwater Pollution Control Compliance

Intended Audience Business Owners, Industrial Managers

Description Comprehensive sourcebook regarding federal, state, and local regulatory requirements and information resources. Contains a sample stormwater pollution prevention plan, EPA regulations, the industrial permit, and industrial BMP manual.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600
(Cost: $25)

How to Create a Storm Water Pollution Prevention Campaign

Intended Audience Local Governments, Community Groups

Description A how-to manual designed to be a resource for a municipality, community group, neighborhood association, or other group interested in educating the public about prevention of stormwater pollution. Also includes blackline masters for watershed protection calendar, a watershed guide, and a final evaluation of the multifaceted Chollas Watershed Protection Project.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281
(Cost: $25)

Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices

Intended Audience Development Consultants, Planners, Engineers, Designers, Developers

Description This 200-page document, written by the Maine Dept. of Environmental Protection and the Cumberland Soil and Water Conservation District, was designed to help land development consultants incorporate urban BMPs for erosion and sedimentation into their project design, planning, and construction programs. Material specifications, along with structural and nonstructural methods, are discussed.

Order From Cumberland County Soil and Water Conservation District
14 Karen Drive
Westbrook, ME 04092

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R0036631

Managing Nonpoint Pollution: An Action Plan Handbook for Puget Sound Watersheds

Intended Audience Local Officials, Citizen Groups

Description 300-page handbook describing nonpoint source pollution controls for the 12 counties bordering Puget Sound.

Order From Puget Sound Water Quality Authority
217 Pine St., Suite 1100
Seattle, WA 98101
(206) 464-7320

The Massachusetts Conservation Restriction Handbook

Intended Audience Landowners, Planners, Government Officials, Environmental Groups

Description Description of the steps in drafting a conservation restriction (easement) in Massachusetts. 44 pages.

Order From Environmental Affairs
Division of Environmental Services
100 Cambridge Street
Boston, MA 02202

Method of Comparative Evaluation of Nontidal Wetlands in New Hampshire

Intended Audience Local Officials, Planners, Researchers

Description Provides a method of wetland evaluation for use by public officials and others with some familiarity with wetlands and is intended to be used for planning, education, and wetland inventory purposes.

Order From NH Dept. of Environmental Services
Water Resources Division, Wetlands Bureau
P.O. Box 2008
Concord, NH 03302-2008
(603) 271-2975

Missouri Stream Team Inventory Manual

Intended Audience Volunteers, General Public

Description 18-page manual for Missouri Stream Team Inventory volunteers. Describes means for assessing the condition of a stream.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Model Soil Erosion and Sediment Control Ordinance

Intended Audience Local Government, Planners

Description This model ordinance will assist local governments in better regulating construction site erosion impacts.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Model Storm Water Drainage Detention Ordinance

Intended Audience Local Governments, Planners

Description This model will assist local governments in better planning storm water management systems.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago,IL 60606
(312) 454-0400

VOL 12
3324
R0036632

Model Stream and Wetland Protection Ordinance

Intended Audience Local Government Officials, Planners

Description This model ordinance will assist local governments in better preserving the benefits provided by natural streams, wetlands, and other water bodies.

Order From Northern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Model Subdivision Regulations for Soil-Based Lot Size

Intended Audience Engineers, Planners, Builders

Description Incorporates the technical findings of *Environmental Planning for Onsite Wastewater Treatment, Volume I* into a subdivision regulation that directs and controls the density of development to maintain the drinking water quality of surface waters and groundwaters.

Order From Rockingham County Conservation District
32 Front Street
Exeter, NH 03833-2705
(603) 772-4385

New York Guidelines for Urban Erosion and Sediment Control

Intended Audience Local Officials, Planners, Contractors

Description Contains standards and specifications for erosion and sediment control measures commonly used on construction sites. Both vegetative and structural measures (permanent and temporary) are included in the manual. The manual is a valuable tool for planners, engineers, local officials, contractors and others involved in land development activities.

Order From Empire State Chapter, Soil and Water Conservation Society
P.O. Box 7172
Syracuse, NY 31261-7172

North Dakota Urban Forestry Handbook

Intended Audience Civic Groups, Environmental Groups, Government Officials

Description A handbook for residents and community leaders that discusses all aspects of community forestry from initiating a shade tree program to long-term program planning.

Order From Community Forestry Coordinator
North Dakota Forest Service
1511 East Interstate Avenue
Bismarck, ND 58501

Onsite Domestic Sewage Disposal

Pub. MWPS-24

Intended Audience Homeowners

Description Homeowners are given information to plan, design, install, and maintain a private sewage treatment and disposal system. Site selection, septic tanks, pump selection, soil absorption system design, distribution systems, and alternative sewage disposal systems are examined.

Order From MidWest Plan Service
122 Davidson Hall
Iowa State University
Ames IA, 50011-3080

Organizing Lake Users: A Practical Guide

Intended Audience Lake Dwellers

Description Handbook for grassroots organizers on how to form a lake association and make it work. Includes section on lake management.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317
(Cost: $10)

VOL 12
3325
R0036633

Planning for Lake Water Quality Protection

Intended Audience Local Government Officials, Planners

Description This 113-page manual is a discussion of a lake planning process including inventory suggestions and implementation ideas for protecting lake water quality. The manual contains information about many land use activities and jurisdiction over them.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-5638

Planning for the Future Forest — A Supplement to the Planning Manual for Vermont Communities

Intended Audience Government Officials

Description Forestry planning manual to assist municipalities in developing land-use plans. Includes Forest Land Evaluation and Site Assessment model.

Order From Urban and Community Forestry Program
Department of Forests, Parks and Recreation
103 S. Main Street, Bldg. 10 South
Waterbury, VT 05671-0601

Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois

By the Urban Committee of the Association of Illinois Soil and Water Conservation Districts

Intended Audience Developers, Engineers, Planners, Inspectors

Description Manual of principles, procedures, and standards for the effective control of soil erosion during land development. Details the preparation of a soil erosion and sedimentation control site plan. 203 pages, in notebook.

Order From North Cook County Soil and Water Conservation District
675 North Court, Suite 120
Palatine, IL 60067-8106
(Cost: $20)

Protecting Water Quality in Urban Areas: BMPs for Minnesota

Intended Audience Contractors, Engineers Local Officials Resource Managers

Description Comprehensive Manual documenting how implementation of specific BMPs can prevent NPS pollution. Major chapters include: 1) Implementing BMPs to Prevent NPS Pollution, 2) Storm Water BMPs, 3) Housekeeping BMPs, 4) Construction Site Erosion and Sediment Control Practices, and 5) Urban Hydrology.

Order From Minnesota PCA
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
~~(Free)~~ $25.00
Minnesota $25.00
(612) 296-3253

A Quick Guide for New Hampshire Towns

Intended Audience Local Officials and Workers

Description This series has been developed for local road agents, public works personnel, highway crews, and other local officials and contractors as an aid to help complete common tasks with a minimum of erosion, sedimentation, and flooding problems.

Order From North Country RC&D
103 Main Street, Suite 1
Meredith, NH 03253
(603) 279-6546

Reducing the Impacts of Stormwater Runoff from New Development

Intended Audience Local Officials, Builders

Description 178-page manual outlining the effects of stormwater runoff and explaining opportunities that local government has to address the problems. Contains a model ordinance.

Order From Empire State Chapter, Soil and Water Conservation Society
P.O. Box 7172
Syracuse, NY 31261-7172

VOL 12
3326
R0036634

Rhode Island Watershed Watch: Shoreline Survey Manual for Lakes, Rivers, and Streams

Intended Audience Researchers, Volunteer Groups

Description This technical report describes the Shoreline Survey Program, including the planning and conducting of surveys, reporting of results, and using survey results to protect water quality.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Saving the Farm: A Handbook for Conserving Agricultural Land

Intended Audience Local Governments, Private Agencies, Individuals

Description Provides tools for implementing effective farmland conservation programs, offering detailed guidance on subjects such as zoning techniques, general plan policies, and raising funds for conservation programs. Appendices include model policies and programs from throughout California, although it has applications from coast to coast. 150 pages.

Order From American Farmland Trust
Publications Department
1920 N Street, NW, Suite 400
Washington, DC 20036
(Cost: $20 plus $4.50 shipping)

Soil Manual for Site Evaluations in New Hampshire, 2nd Edition

Intended Audience Builders, Engineers, Local Officials

Description This manual offers general guidance for those involved with small residential and commercial site evaluation and development.

Order From NH Dept. of Environmental Services
Public Information and Permitting Office
P.O. Box 2008
Concord, NH 03302-2008
(603) 271-2975

Sources of Pollutants in Wisconsin Stormwater

Intended Audience Engineering Consultants, Urban Govt. Decisionmakers

Description Results of study from a Wisconsin city that identified sources of solids, phosphorus, 5 heavy metals, and total hardness from residential, commercial, and industrial land uses in Madison. Not peer reviewed. Expected to be ready early 1993.

Order From NPS Publications
WDNR-WR/2
P.O. Box 7921
Madison, WI 53707

South Carolina Stormwater Management and Sediment Reduction Act and Regulations

Intended Audience Local Government Officials, Planners

Description 1991 act and 1992 regulations establishing a statewide combined stormwater management and sediment reduction program of regulation, education, and technical assistance; authorizing the establishment of "designated watersheds" for master land development planning; and authorizing local governments to create stormwater utilities.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205

VOL 12
3327
R0036635

Stormwater Detention for Water Quality Benefits

Intended Audience Planners, Engineers, Designers, Developers

Description This 25-page guidebook presents recommendations for achieving a storm water detention facility that not only controls flooding, but also optimally removes urban storm water pollutants. Also includes biological and maintenance considerations. Prepared for Illinois EPA.

Order From Northeastern Illinois Planning Commissions
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire

Intended Audience Local Officials, Planners, Builders

Description Provides best management practices for stormwater management and erosion and sediment control in the State of New Hampshire.

Order From NH Dept. of Environmental Services
Public Information and Permitting Office
P.O. Box 2008
Concord, NH 03302-2008
(603) 271-2975

Stormwater Management Manual for the Puget Sound Basin — Volumes 1 - 4

Intended Audience Local Officials, Planners, Developers

Description A four-volume technical guidance manual, including minimum requirements for new development and redevelopment, best management practices (BMPs) for erosion and sediment control, runoff control BMPs, and urban land use BMPs.

Order From Washington State Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, WA 98504-7600

Stormwater Management Utility Implementation Manual

By SC Land Resources Commission and Woolpert Consultants

Intended Audience Local Government Officials, Planners

Description "How-to" publication explaining use of a stormwater utility to fund stormwater management programs and providing instructions on the establishment and operation of a utility.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205

Stormwater Program Guidance Manual for the Puget Sound Basin, Volumes 1 and 2

Pub. 92-32 and 92-33

Intended Audience Government Officials, Planners, Environmental Groups

Description Volume 1 is a program implementation guidance with a review of issues involved, an overview of state and local programs, and requirements of programs. Volume 2 contains guidance for local plan development, many suggestions for creating community involvement, numerous examples of educational materials, and a model stormwater management ordinance. Approximately 500 pages.

Order From Urban Nonpoint Unit
Washington State Department of Ecology
P.O. Box 48711
Olympia, WA 98504-8711

VOL 12
3328
R0036636

Streambank Protection Alternatives

Intended Audience Land Users, General Public

Description 20-page handbook discussing the problems associated with streambank erosion and solutions. Addresses effects of streambank modifications on nonpoint source pollution. Provides low-technology best management practices for land users.

Order From Colorado Department of Natural Resources
State Soil Conservation Board
1313 Sherman Street, Room 219
Denver, CO 80203

The Use of Wetlands for Controlling Stormwater Pollution

By E.W. Strecker, J.M. Kersar, E.D. Driscoll, and Dr. R.R. Horner

Intended Audience Federal, State, and Local Technical Personnel

Description A technical document reviewing past and ongoing research into the impacts of urban runoff on natural wetlands and the ability of both natural and constructed wetlands to treat urban runoff.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317

Urban Targeting and BMP Selection

Intended Audience State NPS Engineers and Managers

Description An information and guidance manual that covers urban nonpoint source pollutants; runoff hydrology, water quality, and receiving water problems; best management practices such as detention basins, retention device, vegetative controls, and source controls, and targeting areas for control. Distributed for EPA Office of Water and Region 5 Watershed Management Unit, Water Division. 54 pages.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317
(Cost: $10)

Vermont Streambank Conservation Manual

Intended Audience Landowners

Description 65-page booklet that underscores important and complex functions of the streambank environment. Describes steps landowners can take to conserve vegetation, water, and wildlife. Addresses nonpoint source pollution.

Order From Agency of Environmental Conservation
State Office Building
Montpelier, VT 05602

Virginia Erosion and Sediment Control Handbook

Intended Audience Planners, Engineers, Designers, Developers

Description This manual covers everything concerning Virginia's erosion and sediment control program.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

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332 9
R0036637

Water Management and Sediment Control in Urban Areas

Intended Audience Local Officials, Builders

Description Ohio's existing erosion and sediment control handbook is being revised to include specifications for all BMPs implemented during site development, including urban runoff practices and channel modifications.

Order From Ohio Department of Natural Resources
Division of Soil and Water Conservation
Fountain Square, 2-E
Columbus, OH 43224
(614) 265-6610

Wisconsin Construction Site Handbook

Intended Audience Builders, Construction Inspectors, and Others Involved With Construction Industry

Description Technical guide of BMPs to control erosion from construction sites.

Order From Document Sales
202 S. Thornton Avenue
P.O. Box 7840
Madison, WI 53707

Wisconsin Stormwater Manual

Intended Audience Govt. Administrators, Engineers, Developers, Planners, Architects, Inspectors, Public Works Directors

Description Handbook covering NPS pollution prevention, engineering standards for structures, statistical methods to estimate, alternatives for administration and financing, state and federal stormwater regulations, guidelines for stormwater planning, and model ordinances to implement stormwater plans. Project is in draft form; expected completion is early 1993.

Order From Document Sales
202 S. Thornton Avenue
P.O. Box 7840
Madison, WI 53707

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R0036638

NEWSLETTERS/MAGAZINES

VOL 12

R0036639

NEWSLETTERS/MAGAZINES

Bay Monitor

Intended Audience General Public

Description Quarterly newsletter featuring news and issues related to restoration of Sarasota Bay, Florida.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Carolina Currents Newsletter

Intended Audience Land Users, General Public

Description 4-page sample newsletter. Addresses nonpoint source pollution effects on surface waters.

Order From South Carolina Coastal Council
4130 Faber Place #300
Charleston, SC 29405
(803) 744-5838

Channels

Intended Audience Citizen Groups

Description 12-page newsletter on surface water ecosystem conservation. Encourages public involvement in cleaning streams and rivers. Provides general educational information to public interest groups and organizations.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Chesapeake Citizen Report

Intended Audience General Public

Description 8-page newsletter on Chesapeake Bay. Addresses urban runoff and other toxics in the Bay.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(~~289~~) 377-6270
410

Fields and Streets

Intended Audience People Associated With or Interested in Wisconsin's NPS Program

Description Quarterly updates on Wisconsin's NPS program. Includes recent publications/features on priority watershed projects, volunteer activities, NPS issues.

Order From NPS Publications
WDNR - WR/2
P.O. Box 7921
Madison, WI 53707

Gulfwatch

Intended Audience Agencies and Individuals Interested in the Gulf of Mexico Program

Description Marine and coastal environmental newsletter for the National Association of Conservation Districts' Gulf of Mexico Program. Encourages individual and community involvement.

Order From Gulfwatch
National Association of Conservation Districts
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547

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R0036640

WATER

VOL 12

Habitat: Journal of the Maine Audubon Society 9(3)

Intended Audience General Public

Description This 36-page issue of *Habitat* focuses on Casco Bay: Maine's Urban Coast. Contains articles by the Casco Bay Estuary Staff.

Order From Maine Audubon Society
Gilsland Farm
118 U.S. Route One
Falmouth, ME 04105

James Valley Digest

Intended Audience General Public

Description Newsletter dealing with land use and water conservation issues. Addresses nonpoint source pollution in general.

Order From James River Water Development District
P.O. Box 849
Huron, SD 57350
(605) 352-0600

The Journal of Soil and Water Conservation

Intended Audience Resource Managers

Description Multidisciplinary journal, covering such subjects as soil erosion and sedimentation, water resources and water quality management, conservation tillage, mined land reclamation, farmland protection and rural planning, forest and range management, wildlife habitat development, and outdoor recreation.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL
(4 3-7645

Keeping Current

Intended Audience People Associated With or Interested in Wisconsin's NPS Program

Description Bimonthly publication that focuses on educational aspects of NPS program; features Rural and Urban Notes.

Order From Environmental Resources Center
University of Wisconsin
Agriculture Hall, Room 216
1450 Linden Drive
Madison, WI 53706

Lake Champlain Committee Newsletter

Intended Audience General Public

Description Newsletter published three times a year by the Lake Champlain Committee. Focuses on water quality, land use, and recreational issues.

Order From Lake Champlain Committee
14 South Williams Street
Burlington, VT 05401
(802) 658-1414

Lake Watch Newsletter

Intended Audience Lakeshore Homeowners and Local Water Planners

Description A quarterly newsletter that focuses on stewardship, management, and restoration of Minnesota lakes and their watersheds.

Order From Minnesota PCA
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

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Man, Land and Sea

Intended Audience General Public

Description 4-page newsletter to acquaint the public with the functions of the Guam Coastal Management Program in protecting coastal resources. Natural resources, issues, and concerns are some of the topics addressed.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

Minnesota Environment

Intended Audience General Public

Description Newsletter that focuses on discussions of key environmental issues, significant agency actions, and environmental achievements throughout Minnesota. Published six times a year.

Order From Minnesota PCA
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Missouri Conservationist

Intended Audience General Public

Description 45-page magazine dealing with conservation in Missouri. Addresses various pollutants in streams and rivers, and effects on wildlife.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Nonpoint Source

Intended Audience Local Government Officials, Planners, Citizen Groups

Description Quarterly newsletter describing state nonpoint source program accomplishments and providing general nonpoint source pollution educational material.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

Maine EnvironNews

Intended Audience General Public

Description 8-page newsletter dealing with environmental issues in Maine. Provides general nonpoint source pollution educational information.

Order From Maine Department of Environmental Protection
State House, Station 17
Augusta, ME 04333

The Nonpoint Source

Intended Audience Resource Managers, Concerned Citizens

Description Quarterly newsletter on current nonpoint source issues, projects, and programs.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205

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Nonpoint Source News-Notes

Intended Audience Government Officials, Researchers

Description Updates on the condition of the environment and the control of NPS pollution around the country, including features on educational programs. Also provides information on EPA's NPS Bulletin Board System.

Order From NPS News-Notes (WH-553)
Assessment and Watershed Protection Division
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
(202) 260-3665

Out of the Blue

Intended Audience Citizen Groups, General Public

Description Newsletter providing general educational information on lake ecology and lake protection.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-5638

Perspective

Intended Audience General Public

Description 2-page newsletter that presents general educational information on a variety of water management issues in New Castle County, Delaware, including occasional articles on nonpoint source pollution.

Order From Delaware Water Resources Agency
2701 Capitol Trail
Newark, DE 19711

Please Don't Feed the Animals, Stop Storm Drain Pollution! A Lindsay Museum Public Education Campaign.

Intended Audience General Public

Description The newsletter will be a 4-page insert in Walnut Creek's city newsletter, *The Nutshell*. It will cover background information on stormwater regulations, storm drain pollution, safer alternatives, proper disposal of household hazardous wastes, and recycling, as well as an in-depth description of the volunteer community activities offered by the Lindsay Museum. A map of the Walnut Creek watershed will be included.

Order From The Lindsay Museum
1902 First Avenue
Walnut Creek, CA 94596

Pointless Pollution

Intended Audience Local Government Officials, Planners

Description Quarterly newsletter on nonpoint source pollution.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
401-272-3540

Pointless Pollution Newsletter

Intended Audience General Public

Description Bimonthly newsletter dedicated to nonpoint source pollution in South Dakota. Topics cover urban and rural nonpoint source pollution problems and prevention.

Order From Pointless Pollution
c/o South Dakota Water Congress
P.O. Box 7041
Pierre, SD 57501-7041

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Save the Bay

Intended Audience General Public

Description 18-page newspaper addressing nonpoint source pollution in Narragansett Bay.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Seven Mile — Silver Creek Lake Association Newsletter

Intended Audience Homeowners, General Public

Description This lake association newsletter addresses nonpoint source pollution effects on lakes. Provides general educational information for homeowners.

Order From University of Wisconsin Green Bay
ES-317
Green Bay, WI 54311-7001
(414) 465-2317

Soil and Water Grassroots

Intended Audience General Public

Description Newsletter concerned with soil and water conservation within the state of Virginia. Addresses public involvement in clean waterways.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Sound Waves

Intended Audience General Public, Environmental Groups

Description Newsletter covering current social and legal developments in protection of Puget Sound

Order From Puget Sound Water Quality Authority
P.O. Box 40900
Olympia, WA 98504-0900

Vermont River Current

Intended Audience General Public

Description Quarterly newsletter reporting activities of citizens working to protect Vermont rivers. Features articles and a river basin project chart listing active individuals and organizations. 8 pages (varies).

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

The Virgin Islands UST Quarterly

Intended Audience Service Station Owners

Description Eight-page brochure series conveying information about the Underground Storage Tank Program in the U.S. Virgin Islands. Outlines consequences of tank leakage and owner responsibilities.

Order From The Virgin Islands UST Quarterly
Dept. of Planning and Natural Resources
1118 Watergut
Christiansted, VI 00820-5065

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Voice of the River

Intended Audience General Public

Description Newsletter concerning restoration of the Anacostia River in Washington, DC, and adjacent Maryland. Addresses effects of various pollutants.

Order From Anacostia Watershed Society
4740 Corridor P, Suite A
Beltsville, MD 20705
(301) 595-2398

Water News

Intended Audience General Public

Description A monthly newsletter that reports local, state, regional, and national water-related events.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $1.25/month)

Water Quality Today

Intended Audience General Public

Description 11-page newspaper on issues related to groundwater. Addresses various pollutants in groundwater.

Order From Cooperative Extension Service
University of Illinois
122 Mumford Hall
1301 W. Gregory
Urbana, IL 61801

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OTHER IDEAS

R0036646

Analysis of Urban BMP Performance and Longevity

Document 92711

Intended Audience Engineers, Planners, Government Officials

Description Field study of the longevity and performance of 156 urban BMPs installed since the early 1980s in Prince Georges County, MD. Study analyzes the strengths and weaknesses of numerous BMP designs and makes specific recommendations on how to improve their pollutant removal capability, longevity, maintenance, safety, and environmental attributes. 204 pages.

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $20)

Application of Urban Targeting and BMP Selection Methodology to Butterfield Creek

Intended Audience Planners

Description This report describes the Butterfield Creek project. The project was used to demonstrate the applicability of a methodology developed by Woodward-Clyde Consultants for the U.S. EPA to select and target BMPs in an urban watershed.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Autecology of Bassia (Kochia) scoparia *in Urban Areas*

Intended Audience Researchers, Urban Resource Managers

Description The autecology of *Bassia scoparia* was analyzed on an urban roadside where it grows in abundance. Analysis showed a positive relationship between plant biomass and road salt, pH, and organic matter in soil. This species, not native to the United States, is typically found on urban roadsides and is presumed to grow there because of the salting of roads in the winter. The plant has economic significance in that it requires mowing late in the season and can impair vision at intersections. Unpublished manuscript.

Order From Dr. Orin G. Gelderloos
University of Michigan-Dearborn
Department of Natural Sciences
Dearborn, MI 48128-1491

The Chesapeake Bay Program

Intended Audience General Public

Description Door hanger providing information on how to prevent pollution of the Chesapeake Bay. Addresses various pollutants.

Order From Housing and Environmental Regulation Administration
614 H Street, NW
Washington, DC 20001

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Chollas Creek Watershed Protection Calendar

Intended Audience General Public

Description A bilingual, full-color, 12-month calendar featuring student drawings for each month and tips on how residents can prevent stormwater pollution. Categories include oil recycling, mass transit, safe substitutes for household hazardous materials, toxic use reduction by businesses, pesticide use reduction, composting, reporting illegal dumping, and storm drain stenciling.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281
(Cost: $5)

Clean Water: What Are We Doing About It?

Intended Audience General Public

Description A free-standing, self-contained exhibit, 7 ft high by 8 ft wide (requires an 8-ft by 8-ft space). Focuses on how land use affects water quality and what TVA is doing to combat water resource problems. Topics include urban runoff, municipal and industrial wastewaters, acid rain, failing septic systems, cropland erosion, animal waste, eroding minelands, and reservoir releases.

Order From Environmental Education Section
Tennessee Valley Authority
Forestry Building
Ridgeway Road
Norris, TN 37828-2002
(615) 632-1599

A Commitment to Restore Our Home River: An Action Plan to Restore the Anacostia River

Document 91708

Intended Audience Government Officials, Citizen Groups

Description Summary of a six-point plan to restore water quality and aquatic habitat in the highly urbanized Anacostia Watershed located in the Washington, DC, metropolitan area. Provides information on innovative techniques and retrofit strategies being employed in the watershed.

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $15)

Communicating With the Media

Intended Audience Public Interest Groups

Description 3-page article on how organizations can communicate more effectively with the media. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Design of Urban Runoff Quality Controls

Intended Audience Government Officials, Planners

Description 20-page report of the proceedings of a conference on urban quality held July 10-15, 1988. Addresses urban runoff pollution to surface water. Provides high-technology guidance for governmental officials and planners.

Order From American Society of Civil Engineers
345 East 47th Street
New York, NY 10017-2398

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3340
R0036648

Development of an Urban Nonpoint Source Management Plan for Butterfield Creek

Intended Audience Planners

Description This report, prepared by the Northeastern Illinois Planning Commission, describes the Butterfield Creek 319 nonpoint source plan demonstration project. Identifies the causative factors of Butterfield Creek impairment and recommends measures to reduce adverse impacts.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Eco-Nomic Sustainability: A Planning Guide for Mission Bay

Intended Audience Local Officials

Description This 19-page report uses San Diego's Mission Bay to illustrate how Eco-nomically Integrated Planning (EIP) principles can be used to protect bodies of water from contamination and contribute toward general economic and ecological health.

Order From Ecological Life Systems Institute, Inc.
2923 East Spruce Street
San Diego, CA 92104
(619) 281-1447

Effective Nonpoint Source Public Education and Outreach: A Review of Selected Programs in Region 10

Intended Audience Government Officials, Planners

Description 44-page booklet on nonpoint source pollution public education and outreach programs, evaluating programs and financing by local governments.

Order From U.S. EPA Region 10
1200 Sixth Ave.
Seattle, WA 98101
(206) 442-4181

Effectiveness of Urban Soil Erosion and Sediment Control Programs in Northeastern Illinois

Intended Audience Development Consultants, Planners, Engineers, Designers, Developers

Description This report evaluates soil erosion and sediment control measures currently required for many construction activities in northeastern Illinois.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Environmental Management Strategies: Comparative Analysis and Selected Case Studies

APES #92-01

Intended Audience Government Officials

Description An overview survey of 70 environmental programs around the world: coastal and inland, state, regional, and federal. Information was gathered on mandate, organizational structure, staffing, budget, and public involvement for each program.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Erosion/Sediment/Flooding: A Survey to Identify Problem Areas

Intended Audience General Public

Description 2-page questionnaire for the general public to report problems. Concerned with nonpoint source pollution in general.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

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3341
R0036649

Evaluation of Environmental Management and Resource Protection Programs in the A/P Region

APES #90-02

Intended Audience Government Officials

Description 17 programs in 9 "program areas" were analyzed from the perspective of implementation. Areas include onsite treatment systems, urban stormwater regulations, erosion and sedimentation controls, marina siting and marine waste disposal, and wetland protection. Findings, key issues of concern, and recommendations for each program are supplied.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Evaluation of Storm Water Detention Effectiveness in Northern Illinois

Intended Audience Development Consultants, Planners, Engineers, Designers, Developers

Description This report assesses existing detention practices throughout northern Illinois and the various ordinances currently in effect regarding storm water detention.

Order From Northern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606

Existing Management Programs

APES #88-06

Intended Audience Local Officials

Description Publication classifies federal and state legislation according to the environmental problems addressed. Includes legislation addressing specific environmental problems and general land use. Brief description of the legislation and of the tools and techniques available to local jurisdictions for managing development.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Forest Conservation Act and Regulations

Intended Audience Government Officials, Builders, Land Users

Description The provisions of the Maryland Forest Conservation Program legislation, including thresholds and afforestation and reforestation standards that are applicable to any subdivision plan or application for grading or sediment control permit on areas 40,000 square feet or more.

Order From Division of State Documents
P.O. Box 2249
Annapolis, MD 21404-2249

"Gee Whiz" Water Quiz

Intended Audience General Public

Description Water quiz.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
(Free)

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Heal the Bay Summer Beach Report

Intended Audience Local Government Officials, General Public

Description A technical paper examining bacterial levels in samples taken at several local beaches from April 1991 through March 1992. The report lists several bacteria-laden hot spots and discusses the country's lack of an adequate beach closure protocol. Grades areas on an A-F basis and includes a map of the Santa Monica area.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

Hidden Toxins in Our Homes: The Hazardous Waste Crisis (1991)

Intended Audience Local Officials, Citizen Groups, General Public

Description A first-of-its-kind technical paper specifically studying Los Angeles County. Gives important statistics on several types of household hazardous wastes, disposal problems, the inadequacies of current programs, and possible solutions.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

I Drink Groundwater

Intended Audience General Public

Description Two-inch button proclaiming "I Drink Groundwater."

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

Implementation Plan for a Soil Erosion and Sediment Control Program for Marshall, Peoria, Tazewell and Woodford Counties

Intended Audience Public Officials, Planners

Description This report evaluates a multiple-county project that researched erosion control regulation and needs, potential management structures and enforcement mechanisms, a model ordinance to control erosion, and a plan for the implementation of an erosion control program.

Order From Environmental Science and Engineering, Inc.
8901 North Industrial Road
Peoria, IL 61615

An Interpretive Atlas of Narragansett Bay

Intended Audience General Public, Researchers, Government Officials

Description 82-page colorful and informative atlas of Narragansett Bay, RI. Explains the Bay ecosystem and describes the role the Bay has played in Rhode Island's history. Illustrated with color maps and charts, historical scenes, marine life, etc.

Order From University of Rhode Island
Rhode Island Sea Grant College Program
Graduate School of Oceanography
Narragansett, RI 02882-1197
(401) 792-6800

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R0036651

The Lake Game—For Adults, The Lake Game—Youth

Intended Audience Adults (Water Planners and Citizen Groups), Students

Description The game for adults is a role-playing exercise that introduces participants to differing viewpoints and helps them consider the challenges of developing a lake management program. The youth game allows students to participate in a simulation in which they are asked to assume roles that represent a variety of individuals who use a lake or lake water. The game is designed to introduce youth to differing environmental values and to help them learn how to protect water resources.

Order From Minnesota Sea Grant Extension Program
208 Washburn Hall
University of Minnesota
Duluth, MN 55812
(218) 726-8106
Contact: Barb Liukkonen

Model Flood Plain Ordinance for Communities Within Northeastern Illinois

Intended Audience Local Government Officials, Planners

Description A 41-page model ordinance that includes consideration of nonpoint source pollution from urban runoff. Provides some high-technology best management practices.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

Model Ordinance for Urban Stormwater Runoff

Intended Audience Local Officials, Environmental Groups

Description A guide for parishes (counties) and municipalities for drafting an ordinance that incorporates best management practices for the prevention and/or treatment of stormwater runoff.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

Model Stormwatsr Control Ordinance

Intended Audience Local Officials, Planners

Description A 26-page guide to the regulation of stormwater management practices for new development and redevelopment. Identifies appropriate onsite measures that can be used to address adverse stormwater impacts of land development and can be implemented through the site plan and subdivision review process. Also establishes responsibility prior to construction for the continued maintenance, repair, and safety of stormwater management facilities.

Order From NJ Dept. of Envir. Protection and Energy
Environmental Regulation
Office of Regulatory Policy
CN423
Trenton, NJ 08625-0423
(609) 292-2113

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Model Stream and Wetland Protection: for the Creation of a Lowland Conservancy Overlay District

Intended Audience Local Government Officials, Planners

Description A model ordinance for the preservation of streams and wetlands. Includes consideration of nonpoint source pollution in relation to land use. Provides some high-technology best management practices.

Order From Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, IL 60606
(312) 454-0400

MPCA — Pollution Fighter Handbook 2: The Sequel

Intended Audience Grade School Children

Description Cartoon book about an evil rat who pollutes the kind dragon's lake through a series of NPS wrongs, but meets his undoing in the end; also a coloring book with secret code puzzles about NPS.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Nonpoint Source Information Education Plan

Intended Audience General Public

Description 61-page draft of a 4-year NPS pollution information and education plan for South Dakota.

Order From Nonpoint Source Information and Educ. Coordinator
South Dakota Department of Agriculture
445 E Capitol, Anderson Bldg
Pierre, SD 57501
(605) 773-3258

Nonpoint Source Strategy

Intended Audience Government Officials, Planners

Description Final draft document that provides a comprehensive strategy for investigation, survey, planning, and implementation to initiate statewide nonpoint source (NPS) management per section 319 of the federal Clean Water Act. Includes a phased implementation approach addressing institutional, economic, and other considerations, as well as the relationship of the NPS program to other programs within the New Jersey Department of Environmental Protection and Energy. The program includes a statewide NPS education program for all sectors of the community.

Order From NJ Dept. of Envir. Protection and Energy
Environmental Regulation
Office of Regulatory Policy
CN423
Trenton, NJ 08625-0423
(609) 292-2113

Nonpoint Source Water Quality Contacts — 1992 Directory

Intended Audience Government Officials, Researchers, Citizen Groups

Description Listing of nonpoint source pollution contact persons in state, territorial, and federal agencies including State Soil and Water Conservation Agencies, State Water Quality Agencies, USDA Soil Conservation Service, Cooperative Extension Service, USDA Agricultural Stabilization and Conservation Service, State Coastal Zone Management Agencies, and the U.S. EPA.

Order From Conservation Technology Information Center
1220 Potter Drive, Room 170
West Lafayette, IN 47906-1383
(317) 494-9555

VOL 12
3345
R0036653

"Paint the Drain Campaign" materials

Intended Audience Local Officials, Citizen Groups

Description Background materials developed to help cities and counties launch storm drain stenciling programs with the use of volunteers. Includes flyer, brochure, instructions, and stencil.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 946-2050

Performance of Current Sediment Control Measures at Maryland Construction Sites

Document 89705

Intended Audience Engineers, Planners, Government Officials

Description Field study on the effectiveness of six sediment traps and basins, as well as the effect of vegetative cover. Presents sediment settling curve data, and makes design and inspection recommendations.

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $15)

Plaster Creek Watershed Display

Intended Audience General Public

Description Map showing the boundaries of the watershed with several photos of good and bad management examples. Addresses nonpoint source pollution in general. Not available for distribution, but the Council will answer inquiries.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Please Don't Feed the Animals, Stop Storm Drain Pollution!

Intended Audience General Public

Description Public service announcements (PSAs), mass-transit billboards, magazine ads, and shopping bag imprint program intended to create public awareness of how motor oil, household garden products, and household toxics end up in the storm drain system nationwide and how storm drains lead directly to wildlife areas and waterways. A call-to-action toll-free number is included.

Order From The Lindsay Museum
1902 First Avenue
Walnut Creek, CA 94596

Public Service Announcements

Intended Audience Television and Radio Stations

Description A PSA packet introducing the concept of nonpoint source pollution. The packet contains the following informational fact sheets: nonpoint source pollution, household hazardous waste disposal, recycling, proper disposal of waste, listing of water quality newsletters, listing of existing water quality improvement projects in Hawaii, opportunities to volunteer, and (for the kids) a coloring book and comic book about water pollution.

Order From Environmental Planning Office
State Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4370

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The Regional Nature of Lake Water Quality Across Minnesota: An Analysis for Improving Resource Management

Intended Audience Scientists, Lake Managers

Description A technical paper using the ecoregion approach to characterize regional patterns in Minnesota's lakes and watersheds. Includes discussion on the implications of the findings for lake management applications.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
(Free)

State of the Estuary

Intended Audience General Public, Government Officials, Environmental Groups, Resource Managers

Description A 260-page report on conditions and problems in the San Francisco Bay-Delta Estuary.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

The State of the Marina: Marina del Rey, CA

Intended Audience Local Government Officials, General Public

Description An in-depth study on how boater pollution and urban runoff affect marine life in the Marina del Rey harbor. This document lists sources of pollution, discusses present harbor conditions, and makes recommendations for pollution abatement measures.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

Storm Drain Stencil

Intended Audience Local Governments, Volunteers

Description Stencil says "No dumping — Flows to Bay!" and features program logo and Clapper Rail silhouette. Comes with cover letter and instruction sheet for cities or volunteers. Stenciling is a best management practice for business and industry.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Storm Drain Stenciling

Intended Audience General Public, Volunteer Groups

Description A stenciling packet with a slide show and materials for stenciling the message "DUMP NO WASTE, GOES TO OCEAN" to be sprayed adjacent to storm drain inlets, to inform the general public that materials washed down or poured into storm drains are delivered directly to the streams and oceans without treatment.

Order From Environmental Planning Office
State Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4370

Storm Drain Stenciling Door Hangers

Intended Audience General Public

Description Door knob hangers that explain the storm drain stenciling project on the front. Seven simple things people can do to reduce stormwater pollution are listed on the back.

Order From Carolyn Johnson
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

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Storm Drains, the Year in Review (1991 Update)

Intended Audience Citizen Groups, General Public

Description An updated version of the 1990 White Paper. Explains the storm drain system and pollution sources. Outlines in detail Heal the Bay's plan of attack to clean up the largest single polluter of Santa Monica Bay.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

Stormwater Exhibit

Intended Audience General Public

Description This interactive game/exhibit shows how Twin Cities area watersheds are linked to streams and lakes. Emphasizes the history of water quality in the Mississippi and illustrates how people in urban neighborhoods affect the river by contaminating stormwater. Portable version located at Fort Snelling State Park may be available for loan.

Order From Minnesota Department of Education
Office of Environment Education Council
550 Cedar Street
St. Paul, MN 55105

Stormwater Management Act (NJ)

Intended Audience Local Officials, Planners, Developers

Description Part of Article 13 of New Jersey's Municipal Land Use Law (MLUL). This Act amended and supplemented the MLUL by incorporating stormwater management practices as part of the review process for subdivision and site plan reviews. 2 pages.

Order From NJ Dept. of Envir. Protection and Energy
Environmental Regulation
Office of Regulatory Policy
CN423
Trenton, NJ 08625-0423
(609) 292-2113

Stormwater Management Rules

Intended Audience Local Officials, Planners, Developers

Description Phase I reviews local stormwater management and zoning ordinances to determine consistency with state stormwater management policy. Phase II reviews stormwater management via a watershed approach. The Stormwater Management Rules are being amended to include comprehensive nonpoint source and stormwater requirements emanating from the New Jersey Department of Environmental Protection and Energy's Statewide Nonpoint Source Strategy/Stormwater Management Program (NPS/SWMP).

Order From NJ Dept. of Envir. Protection and Energy
Environmental Regulation
Office of Regulatory Policy
CN423
Trenton, NJ 08625-0423
(609) 292-2113

Streamwalk

Intended Audience General Public

Description 14-page packet designed to be promoted and used by volunteers to gather data that will be stored at EPA for use by all interested parties. Addresses nonpoint source pollution in relation to streams and rivers.

Order From U.S. EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-4181

R0036656

VOL 12 33348

Thermal Impacts Associated with Urbanization and Urban Best Management Practices

By John Galli and Robert Dubose. Document 91708

Intended Audience Government Officials, Planners, Researchers

Description 140-page report of the first detailed investigation of stream warming phenomena in urban streams due to development and stormwater ponds. Presents summary data on the effect of increased temperature on aquatic organisms.

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $20)

Urban BMPs (Best Management Practices): A Stormwater Demonstration Project

Intended Audience Government Officials, Researchers

Description 130-page report outlining a case study designed to research the effectiveness of the construction of a stormwater detention pond in a Pamlico-Tar River watershed.

Order From City of Greenville
P.O. Box 7207
Greenville, NC 27835-7207
(919) 733-0314

Urban Hydrology Symposium Proceedings

Edited by Marshal Jennings

Intended Audience Researchers, Government Officials, Planners

Description Proceedings of the American Water Resources Association's Urban Hydrology Symposium.

Order From American Water Resources Association
5410 Grosvenor Lane, Suite 220
Bethesda, MD 20814-2192
(301) 493-8600

The Urban Runoff Challenge

Intended Audience News Media Personnel

Description A media kit on nonpoint source pollution prepared for media covering the America's Cup. Includes photo sites, Mission and San Diego Bay watershed maps, and short informational items on nonpoint source pollution prevention and storm drain stenciling.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281

Urban Stormwater Runoff Contamination of the Chesapeake Bay: Sources and Mitigation

By Richard G. Cohn-Lee and Diane M. Cameron. 1991

Intended Audience Researchers, Government Officials, Environmental Groups

Description A technical paper providing an overview of the urban runoff problem in the Chesapeake Bay area, summarizing the methods and results of a computer modeling system applied to four urban areas in the bay's watershed. Includes discussion of the net increase of pollutants entering the bay, due to poorly planned urban expansion, in spite of the application of stormwater controls.

Order From Water and Coastal Program
Natural Resources Defense Council
1350 New York Avenue, NW, Suite 300
Washington, DC 20005

VOL 12
33349
R0036657

Vermont Wetlands Owner Attitude Survey

Intended Audience Local Officials, Planners

Description 95-page report on wetland owners' attitudes toward environmental values of wetlands and wetland protection. Discusses nonpoint source pollution functions of wetlands. Provides useful information to local government officials and planners.

Order From Vermont Department of Water Resources and Environmental Engineering
State Office Building
Montpelier, VT 05602

Water Conservation with Water Saving Devices

Edited by Theodore B. Shelton, Ph.D. Pub. EB421

Intended Audience Resource Managers, Homeowners

Description Proceedings of November 30, 1976, Conference on Water Conservation with Water Saving Devices.

Order From Publications Distribution Center
Cook College - Rutgers University
P.O. Box 231
New Brunswick, NJ 08903
(201) 932-9762
(Cost: $5)

Water Pollution: It Begins on the Land

Intended Audience Schools, Citizen Groups

Description 3-dimensional tabletop exhibit that depicts how pollution happens by pouring water into a stream at the beginning of the watershed and watching it become polluted as it runs through the watershed into the lake.

Order From Terrene Institute
1000 Connecticut Ave., NW
Suite 802
Washington, DC 20036
(202) 833-8317

Water Wisdom

Intended Audience General Public

Description A series of seven 1-page games covering such topics as groundwater protection and water conservation. Formats include matching, multiple choice, and scrambles.

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824
(517) 353-3742

Watershed Restoration Sourcebook

Document 92701

Intended Audience Government Officials, Researchers, Planners

Description Collected papers on various aspects of urban watershed restoration, including case studies drawn from the Anacostia Watershed restoration effort. Paper topics include: urban retrofits, stream restoration, bioengineering techniques, tidal wetland creation, pondscaping, environmental impacts of ponds, peat/sand filter design, and riparian reforestation. 268 pages

Order From Information Center
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201
(202) 962-3256
(Cost: $35)

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3350
R0036658

Who's Who of Nonpoint Source Pollution Control

Intended Audience Local Government Officials, Planners

Description A directory of agencies and organizations in New York involved in controlling nonpoint source water pollution.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Street, Room 310
Albany, NY 12233-3501
(518) 457-0669

R0036659

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PAMPHLETS/BROCHURES

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PAMPHLETS/BROCHURES

Acid Rain in Vermont

Intended Audience General Public

Description Brochure that describes acid rain and its effects on waters, forests, air quality, and health. Suggests ways to help efforts against acid rain. Addresses atmospheric deposition as a source of nonpoint source pollution.

Order From Vermont Agency of Natural Resources
Division of Water Quality
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

Alliance for the Chesapeake Bay Programs and Services

Intended Audience General Public

Description 6-panel brochure describing the Alliance for the Chesapeake Bay Programs and Services. Addresses groundwater nonpoint source pollution of the bay and how to help. Provides educational information for the general public and recruits.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

Aquatic Organisms and Wildlife

Intended Audience General Public

Description 4-panel brochure discussing the status and trends of the estuary's relevant species and organisms.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Automotive Waste and the Do-It-Yourselfer

Intended Audience Home Mechanics

Description 8-panel brochure providing tips on how to reduce, recycle, and dispose of automotive waste properly and avoid toxic releases for do-it-yourselfers.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-76001

The Bay Begins at Your Front Door

Intended Audience General Public

Description Brochure unfolding to 18" x 11 3/4", in English, Spanish, or Vietnamese, explaining issues and origins of nonpoint source pollution, specifically the anatomy of a storm drain system and specific activities that, while seeming innocuous, contribute to nonpoint source pollution. A companion poster is also available.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

The Best Urban BMP Is Planning

Intended Audience Developers, General Public

Description This brochure discusses best management practices for land development.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

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R0036661

PAMPHLETS/BROCHURES

Be Water Wise

Intended Audience General Public

Description A 6-panel, cartoon-illustrated brochure that describes ways to conserve water around the home.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060

Before You Work in A Wetland

Intended Audience Land Users

Description Brochure describing wetlands and explaining wetland regulations. Addresses nonpoint source pollution effects of dredging.

Order From Indiana Department of Natural Resources
Division of Soil Conservation, FLX 1 Building
Purdue University
West Lafayette, IN 47907
(317) 494-8387

Beneficial Landscape Practices

Intended Audience General Public

Description A 2-page, two-color bulletin from the "Yard Care and the Environment" series that describes the environmental benefits of planting beds, natural landscapes, and buffer strips.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Brown Water, Green Weeds: Familiar Signs of Nonpoint Source Pollution

Intended Audience General Public

Description 4-page bulletin that uses cartoons to illustrate the impacts of sediment and nutrients on surface water quality, fish, and wildlife.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Caring for Our Water is Everybody's Business

Intended Audience General Public

Description Tips for the protection of water quality around the home. Covers lawn and garden, runoff control, septic systems, and other topics.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-7600

CCMP (Comprehensive Conservation and Management Plan)

Intended Audience General Public

Description 4-panel brochure about the development of, the proposed goals and objectives of, and the strategies for implementation of a CCMP.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

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The Chesapeake Bay and You

Intended Audience General Public

Description 6-panel brochure on the Chesapeake Bay. Addresses effects of nonpoint source pollution on the Bay.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

The Chesapeake Bay Is . . .

Intended Audience General Public

Description 8-panel brochure describing Virginia's effort to clean up the Chesapeake Bay. Explains sources of pollution to the Bay. Provides information about public involvement in the Chesapeake Bay Program.

Order From Council on the Environment
903 Ninth Street Office Building
Richmond, VA 23219

Chesapeake Bay: Time to Give Something Back

Intended Audience General Public

Description 6-panel recruitment brochure on Chesapeake Bay. Encourages public involvement in cleaning up the Bay.

Order From Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
(301) 377-6270

Citizens Lake Improvement Program

Intended Audience Home Owners, Concerned Citizens

Description Pamphlet with a brief description of nonpoint source pollutants and their impacts on lakes, and information concerning the volunteer monitoring and education program, a joint U.S. EPA and Ohio government undertaking.

Order From CLIP-Ohio Department of Natural Resources
Division of Parks and Recreation
1952 Belcher Drive
Columbus, OH 43224

Clean Lakes Program

Intended Audience General Public

Description A 10-page brochure explaining the EPA's Clean Lakes Program and how it works.

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317

Clean Water is Everybody's Business

Intended Audience General Public

Description 8-panel brochure providing tips to protecting water quality around the home.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711

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Clean Water Series

Intended Audience General Public

Description A series from Delaware of 12-panel brochures concerning water pollution prevention. Titles include Detergents and Phosphorus, Oil Recycling, Septic Systems, Household Hazardous Wastes, Water Conservation, Soil Conservation, Boats and Water Pollution, Surface Water, Groundwater, and NPS Pollution in the Middle Run/Upper Pike Creek Watershed.

Order From Division of Soil and Water Conservation
DE Dept. of Natural Resources and Envir. Control
89 Kings Highway, P.O. Box 1401
Dover, DE 19903

Clean Water Starts With You

Intended Audience General Public

Description 8-page brochure on nutrients and sediments. Provides general information for the public.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Clean Water . . . There Is No Substitute

Intended Audience General Public

Description This brochure describes the importance of water and the legislation that exists to protect the natural resource.

Order From Assoc. of Illinois Soil and Water Cons. Districts
40 Adloff Lane
Springfield, IL 62703

Clean Water: A Community Commitment to Protecting New York's Watersheds

Intended Audience General Public

Description Describes how nonpoint sources of pollution cause water quality problems in the watershed. Emphasizes addressing all nonpoint sources through a watershed planning process. Illustrates management practices applied in the watershed.

Order From New York State Dept. of Environmental Conservation
Division of Water
Public Participation Section
50 Wolf Road
Albany, NY 12233-3504

A Clear Choice for Bush River and Camping Creek

Intended Audience General Public

Description 8-panel brochure providing tips on how to keep a lake clean. Encourages citizen involvement and lists involved agencies.

Order From Clemson Cooperative Extension Service
Clemson, SC 29631

A Clear Choice for Lake Bowen

Intended Audience General Public

Description 10-panel brochure providing tips on how to keep a lake clean. Encourages citizen involvement and lists involved agencies.

Order From Clemson Cooperative Extension Service
Clemson, SC 29631

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Community Tree Restoration Program

Intended Audience Local Officials, Citizen Groups, General Public

Description 6-panel brochure describing Maryland's involvement with the Municipal Tree Restoration Program (MTRP). MTRP is a cooperative venture that is offering Maryland communities advice and aid in restoring and managing their trees.

Order From Urban and Community Forestry
DNR-Forestry Programs
Tawes State Office Building
Annapolis, MD 21401

Construction Site Erosion Control Practices

Intended Audience Home Builders, Land owners, Subcontractors

Description Describes no-cost and low-cost approaches to controlling erosion on construction sites.

Order From NPS Publications
Wisconsin Department of Natural Resources
WR/2
P.O. Box 7921
Madison, WI 53707

Consumer Tip: Lawn Service

Intended Audience Homeowners

Description 6-panel brochure on selection of a lawn service with consideration of nonpoint source pollution impacts.

Order From Montgomery County Government
100 Maryland Ave., 3rd Floor
Rockville, MD 20850
(301) 217-7373

Controlling Erosion From Construction Sites: Answers to Questions Asked by Local Governments

Intended Audience Local Officials, Planners, Contractors

Description This bulletin provides answers to questions about construction erosion control ordinances.

Order From Carolyn Johnson
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

Controlling Urban Runoff With Detention Ponds

Intended Audience Local Officials, Planners

Description A 4-page bulletin that provides an overview of detention ponds: why they are used, their effectiveness in removing pollutants, and general design considerations.

Order From Carolyn Johnson
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

Creating a Water Conserving Landscape

Intended Audience Homeowners

Description 6-page brochure about making water-saving landscapes. Discusses designing a water-saving yard, which plants to use, and how to set a good planting and watering schedule.

Order From East Bay Municipal Utility District
P.O. Box 24055
Oakland, CA 94623
(415) 835-3000

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PAMPHLETS/BROCHURES

The Creek in Your Backyard

Intended Audience General Public

Description 6-panel brochure concerning the preservation of urban creeks. Addresses nonpoint source pollution in general.

Order From Coyote Hills Interpretive Center
8000 Patterson Ranch Road
Fremont CA 94536
(415) 795-9385

Delaware Estuary Program

Intended Audience General Public

Description Informational brochure on Delaware Estuary Program. Addresses nonpoint source pollution in general.

Order From Delaware Estuary Program
Delaware Department of Natural Resources
P.O. Box 1401
Dover, DE 19903
(302) 739-4590

Developers and Builders . . . Soil Surveys Can Help You

SCS Program Aid No. 1049

Intended Audience Developers and Builders

Description 8-panel pamphlet describing potential uses of soil survey information, including soil erosion prevention, and stressing conservation planning.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Don't Dump: A Storm Drain Painting Project

Intended Audience General Public

Description Pamphlet on painting neighborhood storm drains. Addresses urban runoff nonpoint source pollution.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

A Dozen Questions and Answers About Soil and Water Conservation Districts

Intended Audience General Public

Description Brochure on soil and water conservation. Addresses nonpoint source pollution in general. Provides educational information to land users.

Order From Division of Soil Conservation
Purdue University
FLX1 Building
West Lafayette, IN 47907
(317) 494-8387

The Earth Needs You . . . Join Our Team

Intended Audience General Public

Description 8-page brochure containing information on how an individual can make a difference in the community by becoming an Earth Team Volunteer.

Order From Soil Conservation Service
Public Information Division
U.S. Department of Agriculture
P.O. Box 2890
Washington, DC 20013

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Educational and Technical Assistance

Intended Audience Land Users, General Public

Description Brochure detailing "T by 2000" program. Components of the program include soil conservation education assistance, agricultural erosion control technical assistance, cropland erosion control cost-sharing, and urban erosion control technical assistance.

Order From Indiana Department of Natural Resources
Division of Soil Conservation, FLX 1 Building
Purdue University
West Lafayette, IN 47907
(317) 494-8387

Eight Ways You Can Protect Alaska's Water Quality

Pub. #100G-546

Intended Audience General Public

Description Describes what can be done at the individual level to protect groundwater.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Ensuring Safe Drinking Water

Pub. #MF-952

Intended Audience General Public

Description 8-page "newspaper" discussing water quality problems and solutions for public and private water supplies. Addresses nonpoint source pollution in general.

Order From Distribution Center
Umberger Hall, Room 16
Kansas State University
Manhattan, KS 66506-3406
(913) 532-5830

Erosion and Sediment Control/Stormwater Management Certification

Intended Audience Developers

Description This brochure describes Virginia's E&S/SWM certification.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) -371-8884

Erosion Control for Home Builders

Intended Audience Contractors

Description This 4-page, two-color bulletin describes and illustrates proper procedures for controlling erosion on residential and construction sites and explains why construction site erosion is a problem.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Erosion, Sediment and Flooding Survey

Intended Audience General Public

Description Form for citizens to identify erosion, sediment, and flooding problems and report them to soil and water conservation districts and the SC Land Resources Commission.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

R0036667

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33359

Factors Affecting Pesticide and Nutrient Movement in Alaska

Pub. #100G-00543

Intended Audience General Public

Description Describes the leaching and surface loss potential of the most commonly used pesticides in Alaska.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Facts About Virginia's Waters

Intended Audience General Public

Description A full-color brochure that describes the state's surface waters, the Chesapeake Bay, and groundwater. Includes a map showing the outline of each river basin.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060

Facts: Stormwater and Storm Drain Impacts on Santa Monica Bay

Intended Audience General Public

Description This pamphlet gives background information on the storm drain system, how it contributes to the pollution of Santa Monica Bay, and what is being done to correct the problem,. Also lists phone numbers for the reporting of illegal dumping.

Order From City of Los Angeles, Dept of Public Works
360 East Second Street, Suite 702
Los Angeles, CA 90012

For Your Lake's Sake

Intended Audience General Public

Description Brochure about how phosphorus gets into lakes and how to reduce inputs.

Order From Southern Maine Regional Planning Commission
P.O. Box Q
Sanford, ME 04073
(207) 324-2952

Gardening on the Contour

SCS Home and Garden Bulletin Number 179

Intended Audience Rural and Suburban Gardeners

Description Discusses basic home garden contouring and terracing for soil erosion prevention.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Great Lakes Bulletin Series

Intended Audience General Public

Description Six brochures covering water, land, and shoreline use, economic data, unusual facts, points of interest, population statistics, resource problems and improvements. Map on one side; folds into pocket-sized brochure.

Order From Michigan State University
Bulletin Office
10B Agricultural Hall
East Lansing, MI 48824-1039
(517) 353-6740

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3360
R0036668

Ground Water Protection Practices for Motor Vehicle Services

Intended Audience Automotive Businesses

Description 6-page brochure for auto shops outlining key pollution problems, groundwater protection practices, material storage, hazardous material handling, waste material recycling, and public education needs.

Order From New Jersey Dept. of Envir. Protection and Energy
Bureau of Water Supply Planning
CN 029
Trenton, NJ 08625
(609) 633-1179

Ground Water Protection Practices for Roadway Deicing

Intended Audience Local Governments, General Public

Description 6-page brochure describing key problems associated with deicing salts, groundwater protection practices, salt storage and handling practices, application rates, and alternatives. Includes references and checklist.

Order From New Jersey Dept. of Envir. Protection and Energy
Bureau of Water Supply Planning
CN 029
Trenton, NJ 08625
(609) 633-1179

Ground Water Protection Practices for Septic Systems

Intended Audience General Public, Local Authorities

Description 8-page brochure outlining septic system functions, key problems, system siting and maintenance, improper disposal of materials, and public education needs. Includes references, lists of hazardous household chemicals and alternatives, and on-site wastewater disposal checklist.

Order From New Jersey Dept. of Envir. Protection and Energy
Bureau of Water Supply Planning
CN 029
Trenton, NJ 08625
(609) 633-1179

Ground Water Protection Practices for Unregulated Underground Storage Tanks

Intended Audience Businesses, General Public

Description 10-page brochure describing key problems associated with underground tanks, proper construction and installation, leak detection, and spill reporting procedures. Includes listings of involved agencies, references, and checklist.

Order From New Jersey Dept. of Envir. Protection and Energy
Bureau of Water Supply Planning
CN 029
Trenton, NJ 08625
(609) 633-1179

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Ground Water Protection Practices for Urban/ Suburban Landscaping

Intended Audience Municipalities, General Public

Description 8-page brochure discussing proper management of fertilizers in landscaping. Outlines key problems and several groundwater protection practices for reducing fertilizer impacts. Includes references, groundcover list, and landscaping checklist.

Order From New Jersey Dept. of Envir. Protection and Energy
Bureau of Water Supply Planning
CN 029
Trenton, NJ 08625
(609) 633-1179

Groundwater

Intended Audience General Public

Description 8-panel brochure answering frequently asked questions about groundwater.

Order From Natural Resources Department
Lower Platte South
P.O. Box 83581
Lincoln, NE 68501
(404) 476-2729

Groundwater and Public Policy Series

Intended Audience General Public

Description Series of 14 leaflets. Topics include sources of groundwater contamination, costs of groundwater contamination, BMPs for groundwater contamination, protecting groundwater quality by managing land use, and policy choices in groundwater quality management.

Order From The Freshwater Foundation
2500 Shadywood Road
Navarre, MN 55392
(612) 471-5407

Groundwater Protection Begins at the Source

Intended Audience General Public

Description Pamphlet discussing groundwater and how it becomes contaminated. Discusses four-tiered wellhead protection strategy.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Groundwater

Pub. #100G-00940

Intended Audience General Public

Description Tells what groundwater is and explains the hydrologic cycle.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Groundwater: Why You Should Care

Intended Audience General Public

Description Discusses basic groundwater hydrology, usage, pollution sources, cleanup, and pollution prevention.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

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33662
R0036670

Groundwater: Your Groundwater At Risk

Intended Audience General Public

Description 6-panel brochure on groundwater quality. Addresses nonpoint source pollution in general.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

Groundwater: Understanding Our Hidden Resource

Intended Audience General Public

Description 10-page brochure concerning groundwater.

Order From The Freshwater Foundation
2500 Shadywood Road
Navarre, MN 55392
(612) 471-5407

Groundwater?!

Intended Audience General Public

Description 8-panel brochure outlining the most frequently asked questions concerning groundwater quantity and quality.

Order From Lower Platte South Natural Resources Dist.
3125 Portia, P.O. Box 83581
Lincoln, NE 68501-3581
(402) 476-2729

The Gulf of Maine: Sustaining Our Common Heritage

Intended Audience General Public

Description This brochure is a 4-page Executive Summary of a report on the Gulf of Maine. The brochure addresses the international program undertaken to manage the resource shared by Maine, New Hampshire, Massachusetts, New Brunswick, and Nova Scotia.

Order From Gulf of Maine Program
Maine Coastal Program
State House Station 38
Augusta, ME 04333

Have a Healthy Lawn Without Using Toxics

Intended Audience Homeowners

Description 6-panel informational/recruitment brochure. Addresses urban runoff as nonpoint source pollution.

Order From Audubon Naturalist Society
8940 Jones Mill
Chevy Chase, MD 20815
(301) 652-9188

Hazardous Household Substances: Alternatives that Are Relatively Free of Toxic Effects

Guide G-315

Intended Audience General Public

Description Alternatives to household chemical products are presented along with general rules for managing toxic household products, preventative measures, and safety considerations. Information on where to purchase alternative product ingredients is also given.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

VOL 12
33663
R0036671

Hazardous Waste is Everybody's Problem

Intended Audience General Public

Description Brochure on hazardous waste. Addresses nonpoint source pollution potential of hazardous waste.

Order From South Carolina Water Resources Commission
3830 Forest Dr.
P.O. Box 4440
Columbia, SC 29240
(803) 524-1995

Hazardous Waste Reduction

Intended Audience Small Businesses

Description Illustrates how small businesses can reduce the amount of hazardous waste they generate.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

Hazardous Wastes Are Everybody's Problem

Intended Audience General Public

Description Question-and-answer brochure that defines the problem and discusses a six-point management plan for dealing with it.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Help Protect Your Neighbors

Intended Audience General Public

Description Brochure unfolding to 18" x 11 3/4" takes the concepts in "The Bay Begins at Your Front Door" one step further by offering examples of consumer products that are healthier in that they do not contribute significantly to heavy metals concentrations in the Bay, either through the storm drain system or through the sanitary system.

Order From San Jose Department of Environmental Services
777 N. First Street, Third Floor
San Jose, CA 95112
(408) 277-5533

Help Us Monitor Your Lake

Intended Audience General Public

Description 8-panel brochure on volunteer lake monitoring. Addresses groundwater nonpoint source pollution in lakes, and explains the lake monitoring volunteer program. Provides information for education and recruitment.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 297-3363

Hen Cove Nonpoint Source Pollution Mitigation Project

Intended Audience General Public

Description A discussion of typical nonpoint source pollutants and an explanation of stormwater treatment devices being installed at Hen Cove by the Buzzards Bay Project.

Order From Buzzards Bay Project
2 Spring Street
Marion, MA 02738
(508) 748-3600

VOL 12
33364
R0036672

Here Lies the Problem . . . Leaking Underground Storage Systems

Intended Audience Service Station Owners, Farmers

Description Pamphlet describing the use of underground storage tanks and problems with associated leaks. Discusses why tanks leak and the cost of cleaning up contaminated sites. Provides basic information on federal law and methods for preventing leaks.

Order From New England Interstate Water Pollution Control Commission
85 Merrimac Street
Boston, MA 02114
(617) 367-8522

Homeowner's Guide to a Green Lawn and Clean Water

Intended Audience Homeowners

Description 8-panel brochure describing low-technology best management practices for managing a lawn. Addresses urban runoff as nonpoint source pollution.

Order From Rhode Island Dept. of Environmental Management
Land Management Project
83 Park Street
Providence, RI 02908
(401) 277-3434

Horse and Small Farms — Waste Disposal — How to Handle This Important Responsibility in an Increasingly Urbanizing Community

Intended Audience Horse Owners

Description 6-panel brochure providing information on do's and don'ts of manure disposal, especially for King County, WA. By the Washington State Horse Council.

Order From King Conservation District
935 Powell Ave., SW
Renton, WA 98055

Household Hazardous Waste: What You Should and Shouldn't Do

Intended Audience General Public

Description 12-panel brochure describing types of household hazardous waste, their dangers, and home- and community-based measures to reduce waste volume and dispose of waste properly.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

Household Hazardous Wastes

Guide G-313

Intended Audience General Public

Description Proper use and care of selected household cleaning and personal use products is discussed. A chart of products, alternatives, harmful effects, and disposal options is included.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

How Ground Water Contamination Occurs

Pub. #100G-00545.

Intended Audience General Public

Description Factors that determine whether a chemical is likely to reach the groundwater and become a groundwater contaminant.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

VOL 12
3365
R0036673

How We Use the Estuary's Water

Intended Audience General Public

Description 4-panel brochure about the history, uses, and concerns of the estuary. Contains a hand-drawn map.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

How You Can Prevent Pollution in Chollas Creek! / Como Usted Puede Prevenir La Contaminacion a la Bahia de San Diego

Intended Audience General Public

Description A 1-page brochure listing a brief description of the problem of stormwater pollution and the do's and don'ts of prevention.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281

In BRIEF

Intended Audience General Public

Description This brochure describes the five divisions of the Virginia Dept. of Conservation and Recreation.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Is Water Quality Going Down the Drain in Your Garage?

Intended Audience Garage Operators, General Public

Description 8-panel brochure providing tips on how service station operators can help prevent groundwater contamination.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711

Join the Missouri Stream Team

Intended Audience General Public

Description 6-panel brochure on Missouri program for stream protection. Encourages public involvement in stream protection and restoration. Provides educational information for the public.

Order From Conservation Federation of Missouri
728 West Main Street
Jefferson City, MO 65101-1534

Lake and Watershed Association of South Carolina

Intended Audience Resource Managers, General Public

Description 8-panel brochure explaining the purpose, objectives, and activities of the LWASC, and containing membership information and application.

Order From Lake and Watershed Association of South Carolina
P.O. Box 869
Irmo, SC 29063-0869

VOL 12
33666
R0036674

Lake Enhancement Program

Intended Audience Farmers, General Public

Description Brochure detailing efforts at controlling sediments at public lakes under the "T by 2000" program. Provides general educational information for land users.

Order From Indiana Department of Natural Resources
Division of Soil Conservation, FLX 1 Building
Purdue University
West Lafayette, IN 47907
(317) 494-8387

Land Use and Population

Intended Audience General Public

Description 4-panel information brochure about the past, present, and future land use and population of the 12 counties in the bay and delta.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Land Use Planners . . . Soil Surveys Can Help You

SCS Program Aid No. 1049

Intended Audience Land Use Planners

Description 8-panel pamphlet describing potential uses of soil surveys including planning for erosion prevention, septic tank and landfill siting, and prime agricultural land preservation.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Land, Water and You

Intended Audience General Public

Description 6-panel brochure explaining how nonpoint source pollution from construction, urban runoff, and other activities affects individual citizens, and how citizens can become involved in addressing problems.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

Lawn and Garden Fertilizers

Intended Audience General Public

Description A 4-page, two-color bulletin from the "Yard Care and the Environment" bulletin series that describes the relationship between fertilizer use and water quality, and outlines a water-friendly fertilizer program.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Lawn and Garden Pesticides

Intended Audience General Public

Description A 4-page, two-color bulletin from the "Yard Care and the Environment" bulletin series that discusses the effects of pesticide use on non-target organisms. It also provides guidelines for an integrated pest management program and the proper use, storage, and disposal of pesticides.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

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Lawn Care Tips — Help for the Consumer

Intended Audience General Public

Description A flier prepared by the Maryland Department of Agriculture to provide the public with alternatives to pesticide use.

Order From Maryland Cooperative Extension Service
Home and Garden Information Center
(800) 342-2507

Lawn Watering

Intended Audience General Public

Description A 4-page publication in the "Yard Care and the Environment" series that describes proper lawn watering practices. It also describes water quality and turf management problems associated with improper watering techniques.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Lawn Weed Control

Intended Audience General Public

Description An 8-page publication in the "Yard Care and the Environment" series that describes an effective lawn weed control program using basic turf management principles.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Local Government's Role in Groundwater Protection

Pub. #100G-941

Intended Audience General Public.

Description Describes how city and state governments are involved in groundwater protection.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Louisiana's Storm Drain Stencil Program

Intended Audience Local Officials, Volunteer Groups

Description Multipanel brochure that describes nonpoint source pollution and provides explicit details on how to stencil storm drains with the message "DUMP NO WASTE. DRAINS TO LAKE" (or BAYOU or STREAM). Also provides a sign-up form to be removed, filled in, and returned to DEQ for participation in the program.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

R0036676

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Louisiana's Urban Nonpoint Source Pollution Program

Intended Audience General Public, Upper-Level Students

Description Multipanel brochure that opens into a poster describing urban runoff, providing information on threats to Louisiana's waters from urban runoff, and Louisiana's program implementation measures. The inside poster gives tips on what individuals can do to prevent contamination of urban stormwater runoff.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

Maine Lake Protection: Using the Phosphorus Control Method to Improve a Subdivision

Intended Audience Developers, Planners, Local Citizens

Description This 4-page brochure describes the basic methodology of a phosphorus control plan for subdivisions. The application of pre-acre phosphorus goals is discussed.

Order From Maine Dept. of Environmental Protection
Water Bureau, Lakes Section
State House Station 17
Augusta ME 04333

Maintaining Your Septic System

Intended Audience Homeowners

Description 4-panel folder on septic system maintenance. Addresses problems of septic tank leaks. Provides educational information for the public.

Order From Michigan State University
334 Natural Resources Building
East Lansing, MI 48824
(517) 353-3742

Managing Stormwater

Intended Audience Homeowners, General Public

Description General brochure on stormwater. Addresses surface runoff nonpoint source pollution.

Order From Maryland Department of the Environment
Sediment Admin.
2500 Broenig Highway
Baltimore, MD 21224
(301) 631-3552

Managing the Stream Side Forest

Intended Audience General Public

Description 6-panel brochure on proper management of the stream-side forest. Stresses public education for clean streams and rivers.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Middle Run/Upper Pike Creek Watershed: Surface Water, Groundwater and Nonpoint Source Pollution

Intended Audience General Public

Description 8-panel brochure on the Middle Run/Upper Pike Creek Watershed. Addresses surface water and groundwater nonpoint source pollution.

Order From New Castle Conservation District
6 Peoples Plaza
Newark, DE 19072
(302) 834-3560

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Minnesota River Assessment Project

Intended Audience General Public

Description 6-panel brochure describing the Minnesota River Assessment Project and identifying nonpoint source pollution as a major cause of pollution in the Minnesota River.

Order From Minnesota Pollution Control Agency
520 Lafayette
St. Paul, MN 55155
(612) 296-7356

Monitoring and Research

Intended Audience General Public

Description 4-panel brochure containing information about currently existing and planned projects in research and monitoring in the San Francisco Bay Estuary.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Mulches for Your Garden

SCS Home and Garden Bulletin #185

Intended Audience Rural and Suburban Gardeners

Description Discusses basic garden mulching and composting methods and benefits, including erosion prevention and yard waste recycling.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

The Nashua River Greenway

Intended Audience General Public

Description Brochure that includes a map of the extensive protected greenway areas along the Nashua river and its major tributaries. Describes the importance of preserving river corridors for recreation, wildlife habitat, flood control, and other purposes.

Order From Nashua River Watershed Association
484 Main Street
Fitchburg, MA 01420
(617) 342-3506

National Celebration of the Outdoors

Intended Audience General Public

Description 14-panel brochure urging communities to organize programs for the preservation of parks, outdoor recreation areas, open spaces, and greenways. Addresses nonpoint source pollution resulting from land development. Provides information on volunteer programs.

Order From The Conservation Foundation
1250 24th Street, NW, Suite 500
Washington, DC 20037

The Natural Areas and Scenic Rivers Preservation Movement in Ohio

Intended Audience General Public

Description 7-page brochure discussing the Scenic Rivers Act and scenic river designation. Also describes the protection process, the Natural Areas Act, and the preservation of natural areas.

Order From Ohio Division of Natural Areas and Preserves
1889 Fountain Square Court
Columbus, OH 43224
(614) 265-6453

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Nature's Caretakers: You Can Be One

Intended Audience General Public

Description Informative, easy to read pamphlet about environmental awareness, with emphasis in taking action to protect the environment. For distribution to children and their families in eastern North Carolina.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

A Navy Resident's Guide to Cleaning Up the Chesapeake Bay

Intended Audience Navy Personnel, General Public

Description Large 6-panel brochure. Addresses urban runoff from military bases.

Order From Department of the Navy
Commander, Naval Base
Environmental Programs Dept. (Code N4)
Norfolk, VA 23511-6002
(804) 444-3009

News Bulletin

Intended Audience Students, Junior High

Description Brochure addressing nonpoint source pollution in general.

Order From Belknap County Conservation District
719 N. Main Street, Room 203
Laconia, NH 032426
(603) 528-8713

Nonpoint Source Educational Brochures

Intended Audience General Public

Description Brochures providing topic-specific educational information that is focused on reduction and prevention of nonpoint source pollution. Titles include Understanding Your Septic System, Water Efficient Landscaping, Protect Your Well Water, The Fragile Water System of Reno-Sparks, Erosion Control Begins at Home, and How to Prevent Urban Water Pollution.

Order From University of Nevada
Cooperative Extension
P.O. Box 11130
Reno, NV 89520-0027

Nonpoint Source Pollution

Intended Audience General Public

Description 3-panel brochure describing nonpoint source pollution.

Order From Office of Regulatory Policy
New Jersey Dept. of Envir. Protection and Energy
CN 423
Trenton, NJ 08625-0423
(609) 292-2113

Nonpoint Source Pollution

Intended Audience General Public

Description 8-panel brochure providing pictures, questions and answers, and "what you can do" about nonpoint source pollution.

Order From Environmental Planning Office
State Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4370

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Nonpoint Source Pollution Resource Agency Listing

Intended Audience General Public

Description This brochure lists Virginia's nonpoint source pollution resource agencies.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

NPS

Intended Audience General Public

Description This brochure describes nonpoint source pollution.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

Oil Recycling

Intended Audience General Public

Description 6-panel brochure on recycling motor oil. Addresses urban runoff nonpoint source pollution.

Order From Delaware Department of Natural Resources
89 Kings Highway
P.O. Box 1401
Dover, DE 19903
(302) 736-3689

Oil Recycling — A Boost for the Bay

Intended Audience General Public

Description Brochure about used motor oil recycling. Explains why oil should be recycled.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

On-Site Septic Systems

Intended Audience Homeowners

Description 8-panel brochure on maintenance of on-site septic systems. Addresses nonpoint source pollution in regards to septic system maintenance.

Order From Cooperative Extension
University of Massachusetts
Cottage A, Thatcher Way
Amherst, MA 01003
(413) 545-2717

Over 30 Ways Your Local NRD Can Help You Solve the Natural Resources Puzzle

Intended Audience General Public

Description Eight-panel brochure listing the Lower Platte South NRD's programs and projects.

Order From Lower Platte South Natural Resources Dist.
3125 Portia, P.O. Box 83581
Lincoln, NE 68501-3581
(402) 476-2729

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Paint the Way to a Better Bay

Intended Audience General Public

Description Explains the damage caused by stormwater pollution and improper waste disposal. Promotes participation in volunteer storm drain stenciling project.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Pennsylvania Chesapeake Bay Program: Cleaning the Bay in PA

Intended Audience General Public

Description 2-page brochure on Pennsylvania Chesapeake Bay Program. Explains public involvement in the Bay cleanup.

Order From Pennsylvania Chesapeake Bay Education Office
225 Pine Street
Harrisburg PA 17101
(717) 236-1006

Pennsylvania — Detergents, Phosphorus and the Bay

Intended Audience General Public

Description 4-page brochure that rates detergents by phosphorus content.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

Pests Bugging You?

Intended Audience General Public

Description Integrated Pest Management (IPM) brochure for homeowners. Addresses specific unwanted guests such as ants, cockroaches, and fleas, with suggestions for choosing and caring for plants and pets. Available in English and Spanish.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

Pet Wastes and Water Quality

Intended Audience Pet Owners

Description A 2-page, two-color bulletin that examines water quality and health issues related to improper disposal of pet wastes. It also lists alternatives for proper disposal.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Planting the Future

Intended Audience General Public

Description This brochure describes the benefits of planting trees, methods of planting seedlings, and the benefits of urban reforestation.

Order From Maryland Department of Natural Resources
Public Lands and Forestry Programs
Tawes State Office Building
Annapolis, MD 21401
(410) 974-3776

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33773
R0036681

Please Don't Feed the Animals, Stop Storm Drain Pollution!

Intended Audience General Public

Description Point-of-sale flyers to inform the public how particular pollutants end up in the storm drain system, suggest recycling alternatives, and discuss proper disposal of household hazardous wastes. A call-to-action toll-free number is included.

Order From The Lindsay Museum
1902 First Avenue
Walnut Creek, CA 94596

Polluted

Intended Audience General Public

Description 8-panel brochure offering an overview of nonpoint source pollution and information on the location of EPA offices.

Order From U.S. Environmental Protection Agency
Nonpoint Source Information Exchange
401 M Street, SW (WH-553)
Washington, DC 20460
(202) 260-3665

Pollution

Intended Audience General Public

Description 4-panel brochure about pollutant pathways and current environmental concerns about pollution in the San Francisco Bay Estuary.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Potential Effects of Waste on Groundwater

Pub. #100G-00949

Intended Audience General Public

Description This fact sheet describes the potential for solid, hazardous, and human waste to contaminate groundwater, and what households can do to improve waste management.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Practical Tips for Home and Yard

Intended Audience General Public

Description A shortened version of "Rethinking Yard Care" that includes a colorful 2-page illustration of "home hot spots for water quality" and a list of water quality actions for the home.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

Proper Pesticide Use — Help for the Consumer

Intended Audience General Public

Description A flier, prepared by the Maryland Department of Agriculture, to provide the public with information on when and how to use pesticides safely.

Order From Maryland Cooperative Extension Service
Home and Garden Information Center
(800) 342-2507

VOL 12
33714
R0036682

Protect Your Land for the Future . . . With a Conservation Easement

Intended Audience Land Owners

Description 6-panel brochure that describes what conservation easements are and how they benefit landowners. A mail-in form is provided for interested persons to receive more information.

Order From Lower Platte South Natural Resources Dist.
3125 Portia, P.O. Box 83581
Lincoln, NE 68501-3581
(402) 476-2729

Protecting Alaska's Groundwater Quality

Pub. #100G-00544

Intended Audience General Public

Description Preventative measures for protection of groundwater.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Protecting Groundwater

Pub. #100G-00946

Intended Audience General Public

Description Tells citizens where they can go to find more information about groundwater at the state level.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

Reduce — Reuse — Recycle: Alternatives for Waste Management

Guide G-314

Intended Audience General Public

Description An overview of New Mexico's solid waste management legislation and how it impacts communities is presented. Ways consumers can reduce the waste stream and strategies for environmentally smart selection and reuse of products are given. Popular recycling programs are discussed, and a guide for products that are recyclable is provided.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

Restoring Stream Banks with Willows

Intended Audience Conservation Groups, Landowners, General Public

Description Eight-panel brochure on restoring stream banks with willows. Describes the benefits of willows along streams and how to plant them.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Rethinking Yard Care

Intended Audience General Public

Description An 8-page, four-color bulletin from the "Yard Care and the Environment" bulletin series that provides an overview of environmentally sound yard care activities and includes a colorful 2-page illustration showing "home hot spots for water quality."

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

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33715
R0036683

Sacramento-San Joaquin Delta

Intended Audience General Public

Description An overview of the issues surrounding the delta.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Safe Use and Disposal of Household Chemicals

Guide G-312

Intended Audience General Public

Description Information on household chemical products commonly used around the home is presented. Guidelines on safe use, storage and disposal are given.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

Safe Use of Household Greywater

Guide M-106

Intended Audience General Public

Description 4-page brochure that outlines treatment options, possible uses, and precautions to take when reusing household wastewater. Lists characteristics of wastewater from different household sources and the proper treatment options for those characteristics.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

Safe Use of Household Pesticides and Chemicals

Intended Audience General Public

Description Bilingual (English/Spanish) brochure that outlines precautions to take when using, storing, and disposing of household chemicals and pesticides. Lists products that may be hazardous and proper disposal methods for those products. Provides information on recognizing and dealing with poisoning and emergency telephone numbers on a detachable card.

Order From Cooperative Extension Service
New Mexico State University
Box 30003, Dept. 3AI
Las Cruces, MN 88003
(505) 646-1132

San Francisco Bay-Delta Estuary

Intended Audience General Public

Description 4-panel overview of the San Francisco Bay-Delta Estuary.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Sarasota Bay Program

Intended Audience General Public

Description Describes major issues facing Sarasota Bay, Florida. Explains function of Sarasota Bay National Estuary Program and encourages citizen participation in bay restoration.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

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33716
R0036684

Sarasota BayWalk

Intended Audience General Public

Description Four-fold brochure that narrates a self-guided tour of restored salt marsh habitat along Sarasota Bay, Florida. Discusses issues of shoreline hardening, habitat loss, pollution, etc.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Save America's Future Environment

Intended Audience General Public, Children

Description An informative brochure on common household hazardous materials, designed to create public awareness of the potential impact of these materials on drinking water supplies and the environment. Featuring cheerful "Kleen-Up Kops" in pursuit of villainous polluters.

Order From Irvine Ranch Water District
P.O. Box 6025
Irvine, CA 92716-6025
(714) 476-7504

Save Your Stream: Manage Your Stormwater — A Stormwater Management Guidebook for Citizens in the Plaster Creek Corridor

Intended Audience General Public

Description 90-page binder detailing stormwater management methods for citizens in an urban watershed. Provides background on relevant legislation and stormwater concepts.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

Securing the Future

Intended Audience General Public

Description Describes some of California's water supply management programs for ensuring water supply into the 21st century.

Order From East Bay Municipal Utility District
P.O. Box 24055
Oakland, CA 94623
(415) 835-3000

Sediment Control Plans

Intended Audience Developers

Description 6-panel brochure on preventing water pollution due to erosion from construction sites. Addresses nonpoint source pollution from runoff.

Order From West Virginia Department of Natural Resources
1201 Greenbriar Street
Charleston WV 25311

Sediment Is Just a Dirty Word

Intended Audience General Public

Description Flyer defining sediment and erosion with phone numbers to report problems. Addresses sediment nonpoint source pollution in general.

Order From Maryland Department of the Environment
Sediment Administration
2500 Broenig Highway
Baltimore MD 21224
(301) 631-3552

R0036685

VOL 12 33377

Septic Systems

Intended Audience Homeowners

Description 8-panel informational brochure. Addresses septic tank pollution potential.

Order From Delaware Department of Natural Resources
89 Kings Highway
P.O. Box 1401
Dover, DE 19903
(302) 736-4411

Soil and Water Conservation Districts: A Special Role in Water Quality

Intended Audience General Public, Organizations

Description 6-panel brochure on forming conservation districts. Provides general educational information to public interest groups and organizations

Order From Conservation Technology Information Center
1220 Potter Dr., Room 170
West Lafayette, IN 47906-1334
(317) 494-9555

Septic System Blues

Intended Audience Homeowners

Description Brochure on septic tank maintenance. Addresses septic tank pollution of groundwater. Provides educational information for homeowners.

Order From Save the Bay
434 Smith Street
Providence, RI 02908
(401) 272-3540

Soil and Water Conservation in the New Castle Conservation District

Intended Audience General Public

Description 6-panel informational brochure about the soil and water conservation in the New Castle District. Addresses nonpoint source pollution in general.

Order From Delaware Conservation District
New Castle County
6 Peoples Plaza
Newark, DE 19702
(302) 834-3533

Soil Conservation Around Your Home

Intended Audience Homeowners, General Public

Description 6-panel brochure on soil conservation at home.

Order From Delaware Dept. of Natural Resources
Division of Soil and Water Conservation
89 Kings Hwy., P.O. Box 1401
Dover, DE 19903
(302) 736-4411

Storm Sewers — The Rivers Beneath Our Feet (WI)

Intended Audience General Public

Description A four-page, three-color bulletin with a large illustration showing how pollutants reach water bodies through storm sewers. Also summarizes what individuals and local governments can do to reduce stormwater pollution.

Order From Extension Publications
30 N. Murray Street
Madison, WI 53715
(608) 262-3346

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R0036686

Storm Sewers — The Rivers Beneath Our Feet (NY)

Intended Audience General Public

Description 4-page brochure originally produced by Wisconsin, revised and reprinted for New York conditions. Explains to citizens the impacts that their actions have on degrading water quality and outlines things that children and adults can do to help. Stormie, a cartoon character, is featured.

Order From New York State Dept. of Environmental Conservation
Division of Water
Public Participation Section
50 Wolf Road
Albany, NY 12233-3504

Stormwater and Watershed Management in Florida

Intended Audience General Public

Description 6-panel brochure on storm water management in Florida. Addresses urban runoff nonpoint source pollution.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Stormwater Management

Intended Audience General Public

Description 8-panel brochure on stormwater management. Addresses urban runoff nonpoint source pollution.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

The Stormwater Utility

Intended Audience General Public

Description 6-panel brochure about stormwater utilities. Addresses urban runoff nonpoint source pollution.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Streams for the Future

Intended Audience Land Owners, General Public

Description 6-panel brochure explaining a Missouri stream protection program. Stresses public education for clean streams and rivers.

Order From Missouri Department of Conservation
P.O. Box 180
2901 W. Truman
Jefferson City, MO 65102
(314) 751-4115

Streams of Illinois Poster Education Guide

Intended Audience General Public

Description 4-page educational guide to accompany the Streams of Illinois habitat poster produced by the Conservation Natural Heritage Division.

Order From Illinois Department of Conservation
Education Program
524 S. Second St.
Springfield, IL 62701-1787

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Streamside Forests: The Vital Beneficial Resource

Intended Audience General Public

Description 18-page, full-color brochure on streamside forests. Addresses nonpoint source pollution role of streambanks.

Order From University of Maryland
Cooperative Extension Service
Symons Hall, Room 1200
College Park MD 20742
(301) 405-2907

Toxics in the Home

Intended Audience General Public

Description Brochure about toxic products in the home. Addresses hazardous waste nonpoint source pollution.

Order From Public Information Coordinator
New Jersey Dept. of Envir. Protection and Energy
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Timing Nitrogen Applications for Your Lawn

Intended Audience Homeowners

Description Two-page brochure on lawn fertilization. Addresses urban runoff nonpoint source pollution. Part of a series entitled "Yard Care and the Environment."

Order From Southeastern Wisconsin Regional Planning Commission
916 N. East Ave.
Waukesha, WI 53187-1607
(414) 547-6721

TREE-MENDOUS MARYLAND . . . and You

Intended Audience General Public

Description Three-color, 8-panel brochure describing the TREE-MENDOUS program developed at the request of Maryland's governor. This program helps the citizens of Maryland to learn to plant trees and care for them. Also describes the "Give the Gift of Trees" program under which donations will go to planting a memorial tree in the donor's community.

Order From TREE-MENDOUS MARYLAND
DNR-Forestry Programs
Tawes State Office Building
Annapolis, MD 21401

Trees for a Cleaner Bay

Intended Audience Foresters, General Public

Description 6-panel brochure explaining the benefits of good forest management. Discusses the role of streambanks and forests in nonpoint source pollution and prevention.

Order From Bay Watershed Foresters
2 Bond Street
Bel Air, MD 21014
(301) 836-4550

Trees for the Monocacy Watershed

Intended Audience General Public

Description A brochure relating how trees and forests are extremely important in the effort to improve the water quality in Maryland's Monocacy Watershed.

Order From Maryland Department of Natural Resources
Public Lands and Forestry Programs
Tawes State Office Building
Annapolis, MD 21401
(410) 974-3776

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3380
R0036688

Trees Make a Difference

Intended Audience General Public

Description 6-panel brochure that provides information about NRD's cost-sharing Tree Planting Program. The program provides advice, financial incentives, and equipment to persons/organizations interested in participating. Outlines instructions for participation and tips for successful planting.

Order From Lower Platte South Natural Resources Dist.
3125 Portia, P.O. Box 83581
Lincoln, NE 68501-3581
(402) 476-2729

TVA Demonstrates Solution to Nonpoint Source Pollution

Intended Audience General Public

Description Describes what nonpoint source pollution is and what is being done to identify and solve nonpoint source pollution problems.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Twenty-Five Things You Can Do to Prevent Water Waste

Intended Audience General Public

Description Small 8-panel brochure on preventing water waste. Addresses nonpoint source pollution in general.

Order From Santa Clara City Water District
5750 Almaden Expressway
San Jose, CA 95118

Understanding Groundwater

Intended Audience General Public

Description 6-panel brochure providing basic overview of groundwater and contamination in Michigan.

Order From Michigan State University
Macomb County Cooperative Extension Service
21885 Dunham
Clinton Township, MI 48036
(313) 469-6440

Urban Runoff: How Polluted Is It?

Intended Audience Local Officials, Planners

Description A 6-page bulletin that uses pie charts and tables to show the types, amounts, and sources of the most common urban stormwater pollutants.

Order From Carolyn Johnson
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

Use This To Help Clean Up the Chesapeake Bay

Intended Audience General Public, Homeowners

Description Brochure that gives 10 tips and phone numbers for additional information. Addresses nonpoint source pollution in general. Provides educational information to homeowners and the public.

Order From Maryland Department of the Environment
Sediment Administration
2500 Broenig Highway
Baltimore, MD 21224
(301) 631-3552

R0036689

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Using Integrated Pest Management — Help for the Consumer

Intended Audience General Public

Description A flier prepared by the Maryland Dept. of Agriculture to provide consumers with information on controlling pests through the use of Integrated Pest Management (IPM), a combination of cultural, biological, mechanical, and chemical methods.

Order From Maryland Cooperative Extension Service
Home and Garden Information Center
(800) 342-2507

Using Water Wisely: A Guide to Reducing Home Water Use

Intended Audience General Public

Description 4-panel brochure on conserving home water. Provides best management practices for the public.

Order From University of Florida
Publications Distribution Center
IFAS Building 644
Gainesville, FL 32611

Vermont Wetlands: A Landowner's Guide to Protection

Intended Audience Landowners

Description Brochure that defines wetlands and discusses the need for wetland protection, the major protection regulations, and activities allowed in wetlands.

Order From Department of Environmental Conservation
Water Quality Division
103 South Main Street
Waterbury, VT 05676
(802) 244-6951

VirGis

Intended Audience Local Government Officials, Planners

Description 6-panel brochure explaining VirGis — the Virginia Geographic Information System, which can estimate potential nonpoint source pollution from specific land areas.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219
(804) 786-3334

Volunteer Lake Monitoring Program

Intended Audience General Public

Description 6-panel brochure on volunteer lake monitoring. Addresses public involvement in prevention of nonpoint source pollution of lakes. Provides educational and recruitment information to the general public.

Order From Indiana University
Department of Environmental Management
SPEA 340
Bloomington, IN 47405
(812) 855-4556

Water Quality Protection — Frank Answers to the 20 Most Frequently Asked Questions

Intended Audience General Public

Description Three-color brochure describing, in question-and-answer format, pesticide risks to groundwater and surface water, and efforts in the public and private sectors to minimize risks.

Order From Alliance for a Clean Rural Environment
1155 15th Street NW, Suite 900
Washington, DC 20005

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Water Quality . . . What Does It Mean?

Intended Audience General Public

Description 6-page brochure concerning water quality, including nonpoint source pollution effects.

Order From Idaho Department of Health and Welfare
Division of Environmental Quality
1410 North Hilton
Boise, ID 83720

Water Quality: It's not Just a Drop in the Bucket — You Can Make a Difference (NPS Pollution Fact Sheet Series)

Intended Audience General Public

Description A series of 8-panel brochures suggesting individual actions to reduce NPS pollution. Titles include Landscape Management, Lawn Management for Conservation, Plant Selection for Conservation, Pest Management Around Your Home, and several agricultural topics.

Order From Division of Soil and Water Conservation
DE Dept. of Natural Resources and Envir. Control
89 Kings Highway, P.O. Box 1401
Dover, DE 19903

Watershed Enhancement: A Guide to Improving Your Urban Watershed

Intended Audience General Public

Description 8-panel brochure on urban watershed enhancement. Addresses NPS pollution in general. Provides educational information for the public.

Order From Governor's Watershed Enhancement Board
3850 Portland Road NE
Salem, OR 97310
(503) 378-3739

The Wetlands of Guam: "I Sesonyan Siha" — A Precious Resource for Guam

Intended Audience General Public

Description Brochure providing tips on what a wetland is and why it is important to protect these valuable resources.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

We Would Like to Clean Up a Few Things Related to Lawn Care

Intended Audience General Public

Description Describes lawn care practices and their relationships to nonpoint source pollution and water quality.

Order From VA Dept. of Conservation and Recreation
203 Governor St., Suite 206
Richmond, VA 23219

Wetlands

Intended Audience General Public

Description 4-panel brochure about the value of, pressure on, and preservation of wetlands.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

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Wetlands: More Important Than You Think

Intended Audience General Public

Description General discussion of the various types, benefits, and functions of wetlands. Discusses threats to wetlands and wetland conservation actions for citizens.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

What Is a Riparian Zone?

Intended Audience Landowners

Description Provides facts about stream corridor management in the Puget Sound Basin. Includes information on why riparian zones are important; how people affect riparian zones; proper riparian zone management; and incentives for sound management.

Order From Washington State Department of Ecology
Publications Office, MS PV-11
Olympia, WA 98504-8711
(206) 438-7472

When It Rains, It Pours, Off the Streets and Into the Ocean

Intended Audience General Public

Description Eight-panel, bilingual brochure providing information on storm drains, phone numbers to report illegal dumping, and ways to reduce storm drain pollution.

Order From Heal the Bay
1640 Fifth Street, Suite 112
Santa Monica, CA 90401

When to Water — A Guide to Watering Your Lawn

Intended Audience Homeowners

Description This brochure is designed to help homeowners determine the proper lawn watering schedule to conserve water while giving the lawn the water it needs to grow.

Order From Cooperative Extension Education Center
University of Rhode Island
Kingston, RI 02881
(800) 448-1011

Who Manages the Bay and Delta?

Intended Audience General Public

Description 6-panel brochure listing information on various government, state, and regional agencies concerned with the estuary.

Order From San Francisco Estuary Project
P.O. Box 2050
Oakland, CA 94604-2050

Why Should I Save Water?

Intended Audience General Public

Description Pamphlet describing the importance of water conservation and its benefits to the individual and community. Offers suggestions for water conservation in the home.

Order From New England Interstate Water Pollution Control Commission
85 Merrimac Street
Boston, MA 02114
(617) 367-8522

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You Can Be a Part of the Solution to Water Pollution

Intended Audience General Public

Description Brochure on how the public can prevent pollution. Addresses nonpoint source pollution with respect to surface water.

Order From Public Information Coordinator
New Jersey Dept. of Envir. Protection and Energy
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Your Guide to SIP — The Stewardship Incentive Program

Intended Audience Private Landowners

Description 8-panel brochure providing information for nonindustrial private landowners on participation in the Stewardship Incentive Program.

Order From Maryland Department of Natural Resources
Forestry Programs E-1
Tawes State Office Building
580 Taylor Avenue
Annapolis, MD 21401

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POSTERS

Chesapeake Bay: Its Beauty and Bounty...At Risk

Intended Audience General Public

Description Poster on Chesapeake Bay. Addresses effects of nonpoint source pollution on the Bay.

Order From U.S. Fish and Wildlife Service
1825 Virginia Avenue
Annapolis, MD 21401

City Life Poster

Intended Audience Students

Description Poster and teacher guide representing animal life in the city.

Order From New York State Dept. of Envir. Conservation
Division of Lands and Forests
50 Wolf Road
Albany, NY 12233-4253

Educational Poster Series

Intended Audience Students, General Public

Description Three two-sided, 28" x 22" posters illustrating basic water processes and answering commonly asked questions. Set includes three full-color posters with black-and-white bonus posters on reverse, and covers water systems, treatment plants, groundwater systems, the water cycle, water careers, and wise water use.

Order From American Water Works Association
6666 West Quincy Ave.
Denver, CO 80235
(303) 794-7711

Familiar Fishes on Guam

Intended Audience Students, General Public

Description 18" x 24" poster that illustrates familiar fishes found on the reefs around Guam. These posters are used to educate the public and particularly students on identifying the various species of fishes found in Guam's waters.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

Farming on the Fringe (Map)

Intended Audience General Public

Description This colorful, detailed, 38" x 25" map of the United States shows that many of the Nation's most important farming counties are next to, or inside, rapidly growing metropolitan areas. Based on information from the 1980 Population Census and the 1974, 1978, and 1982 Agricultural Censuses.

Order From American Farmland Trust
Publications Department
1920 N Street, NW, Suite 400
Washington, DC 20036
(Cost: $2 plus $3.50 shipping)

Fill Yourself In, Before Our Lakes Do

Intended Audience General Public

Description Picture of weed-infested lake with information request form in the middle of the scene.

Order From Minnesota Pollution
Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

R0036695

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33387

Green Shores — Forest Buffers

Intended Audience General Public

Description Poster on one side, information on forest buffers on the other. Addresses nonpoint source pollution in general.

Order From Maryland Forest, Park & Wildlife Service
Tawes Office Building
Annapolis, MD 21401
(301) 974-3776

Groundwater: A Vital Resource

Intended Audience General Public

Description Poster encouraging citizens to write for more information about groundwater resources in the Tennessee Valley.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Guam's Vanishing Wildlife

Intended Audience General Public

Description 18" x 24" poster that illustrates and identifies the different species of birds found in Guam's forest. These birds are listed as endangered species and are protected by local public laws.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

Habitats of Illinois Poster Series

Intended Audience General Public

Description Series of habitat posters including Spring Woodland Wildflowers, Summer Prairie Wildflowers, Southern Illinois Wetlands, Northern Illinois Wetlands, and Streams of Illinois.

Order From Illinois Department of Conservation
Education Program
524 S. Second St.
Springfield, IL 62701-1787

Habitats on Guam

Intended Audience Students, General Public

Description 18" x 24" poster that illustrates forest birds of Guam including those which are extinct or endangered species. These posters are used to educate the public and particularly students on forest and land birds of Guam.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

How Do We Treat Our Wastewater?

Intended Audience Students, Middle School

Description Colorful 35" x 25" poster depicting cartoon landscape illustrating urban and rural communities with many types of wastewater sources and treatment methods. Back contains text and graphics describing wastewater treatment methods and water use audit activities and defining terms. Also available in a black-and-white version that students can color.

Order From U.S. Geological Survey
Books and Open-File Reports Section
Box 2425, Mail Stop 517
Denver Federal Center
Denver, CO 80225-0425

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3388
R0036696

If Minnesota Doesn't Catch Its Problem Now, This May Be What We'll Be Catching Later

Intended Audience General Public

Description A picture of a grossly deformed imaginary fish.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

It Took a Glacier Two Million Years to Carve Out MN's Lakes. It'll Take Man A Few Hundred Years to Fill Them Back In.

Intended Audience General Public

Description Color photo of a Minnesota lake at sunrise with narrative explaining impacts of runoff on lakes and how to get more information.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300
(Free)

A Lake Is a Reflection of Its Watershed; Use BMPs to Protect Water Quality

Intended Audience General Public

Description Large-size poster showing an imaginary watershed and a variety of common activities going on within the watershed that are causing NPS pollution.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Land for Life

Intended Audience Preschool Students

Description Fold-out 18" x 22" activity poster about soil. Provides general nonpoint source pollution educational information for preschoolers.

Order From National Association of Conservation Districts
408 East Main Street
P.O. Box 885
League City, TX 77573
(800) 825-5547

Lost

Intended Audience General Public

Description Poster concerning the problem of shoreline erosion.

Order From Shoreline Erosion Advisory Service
P.O. Box 1024
Gloucester Point VA 23062
(804) 642-7121

Man, Land and Sea

Intended Audience General Public

Description 18" x 24" poster that portrays man living in harmony with his environment.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

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New Jersey Water Watch

Intended Audience General Public

Description Poster of lake, promoting clean water. Addresses nonpoint source pollution in general.

Order From Public Information Coordinator
New Jersey Department of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Nonpoint Source Pollution

Intended Audience General Public

Description Poster about nonpoint source pollution.

Order From New Jersey Dept. of Environmental Protection
Division of Water Resources, CN-029
Trenton, NJ 08625-0029
(609) 633-7021

Nonpoint Source Pollution: It Adds Up

Intended Audience General Public

Description Poster on nonpoint source pollution in general.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Nonpoint Source Series

Intended Audience General Public

Description A four-poster series about water quality graphically showing urban and rural problems and sound management practices. Titles include: *Pollution Begins and Ends with You; Rural Water Quality: It's Worth Protecting; Rural Water Quality: Sound Management Makes It Happen; and Urban Water Quality: Sound Management Makes It Happen.*

Order From Terrene Institute
1700 K Street, NW, Suite 1005
Washington, DC 20006
(202) 833-8317
(Cost: $25)

Protect Chollas Creek / Protege el Arroyo Chollas

Intended Audience Students

Description Classroom poster featuring a watershed painting of the Chollas Creek Watershed by artist Victor Ochoa. Back side contains learning activities and teaching information on basic concepts of watershed, food web, safe substitutes for household toxics, and stormwater pollution.

Order From Clean Bay Campaign
Environmental Health Coalition
1717 Kettner, Suite 100
San Diego, CA 92101
(619) 235-0281

Protecting Our Water Is Everybody's Business

Intended Audience General Public

Description Poster for protecting water. Addresses nonpoint source pollution of surface water.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

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3390
R0036698

Recycle Your Used Motor Oil

Intended Audience General Public, Home Mechanics

Description Poster holding tear-off informational pads giving information on curbside, service station, and collection event alternatives for waste oil recycling.

Order From Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 94544
(408) 265-2600

The Role of Land Use and Geology in the Water Cycle

Intended Audience General Public, Land Users

Description Fold-out poster with information on the back side. Addresses nonpoint source pollution in general.

Order From Iowa State University
Department of Agricultural Education
208 Davidson Hall
Ames IA, 50011-3080
(515) 294-6673

The Susquehanna Watershed . . . Your River, Your Bay

Intended Audience General Public

Description Poster describing the problems that sedimentation and nutrient runoff cause and programs implemented to prevent it. Addresses nonpoint source pollution, forests, and soil and water conservation.

Order From Maryland Forest, Park & Wildlife Service
Tawes Office Building
Annapolis, MD 21401
(301) 974-3776

Tampa Bay: Paradise at Risk

Intended Audience General Public

Description Brochure on Tampa Bay National Estuary Program featuring poster-size foldout and information on the Tampa Bay Estuary.

Order From Tampa Bay National Estuary Program
c/o Tampa Bay Regional Planning Council
9455 Koger Blvd.
St. Petersburg, FL 33702-2491
(813) 577-5151

Ten Steps to Protect Your Drinking Water

Intended Audience General Public

Description 11" x 17" poster detailing steps people can take to protect their domestic water supply. Included are underground storage tanks, water testing, hazardous waste disposal, septic system operation, and farming and gardening.

Order From South Dakota Dept. of Agriculture
NPS Information and Education Program
445 East Capitol Avenue
Pierre, SD 57501-3185

The Wetlands of Guam: "I Sesonyan Sihe"

Intended Audience General Public

Description 16" x 28" poster that depicts a wetland area on Guam.

Order From Bureau of Planning
Guam Coastal Management Program
P.O. Box 2950
Agana, Guam 96910

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3391
R0036699

Water: The Resource That Gets Used & Used & Used for Everything

Intended Audience Students, Middle School

Description Colorful 35" x 25" poster depicting cartoon landscape illustrating urban and rural communities and water uses from supply to treatment including offstream industrial, domestic, and agricultural use and instream recreational natural and transportation uses. Back includes text and graphics describing water distribution on earth and U.S. water use patterns. Also available in black-and-white version that students can color.

Order From U.S. Geological Survey
Books and Open-File Reports Section
Box 2425, Mail Stop 517
Denver Federal Center
Denver, CO 80225-0425

Wetlands: Water, Wildlife, Plants, & People

Intended Audience Students, Middle School

Description Colorful 35" x 25" poster depicting cartoon landscape illustrating basic wetland types and uses. Back contains text describing wetland types and some classroom activities including one on sediment removal. Also available in black-and-white version that students can color.

Order From U.S. Geological Survey
Books and Open-File Reports Section
Box 2425, Mail Stop 517
Denver Federal Center
Denver, CO 80225-0425

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R0036700

SLIDE SHOWS

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EMOE

R0036701

SLIDE SHOWS

Applying Pesticides Safely for the Environment

Intended Audience Landscape Professionals, Farmers

Description 47 slides with accompanying text. This program discusses when to use pesticides; types of pesticides, the mixing, application and storage of pesticides; environmental considerations; and cleaning of equipment.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Calibrating your Spreader

Intended Audience Homeowners, Landscape Professionals, Farmers

Description 32 slides with accompanying text. Program describes types of fertilizer spreaders and explains methods of determining optimum amounts of fertilizer and procedures for calibrating spreaders.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Chesapeake Bay Youth Watershed Education Program

Intended Audience Students, Secondary

Description Slides and script on what students can do to improve the quality of Chesapeake Bay water. Addresses nonpoint source pollution in general.

Order From Chesapeake Bay Foundation
1001 E Main St., Suite 815
Richmond VA 23219
(804) 780-1392

The Conservative Ones

Intended Audience Homeowners

Description 60 slides with script describing the various types of water conservation devices that can be installed in the home.

Order From Theodore B. Shelton, Ph.D.
Natural Resources Dept.
Cook College
P.O. Box 231
New Brunswick, NJ 08903
(Copy Charge: $60)

Erosion and Sediment Control and Storm Water Management

Intended Audience General Public

Description 8-page transcript with slide show discussing agriculture, erosion, sediment, and stormwater issues. Addresses nonpoint source pollution in agriculture, silviculture, urban stormwater runoff, and construction.

Order From South Carolina Land Resources Commission
2221 Devine Street, Suite 222
Columbia, SC 29205
(803) 734-9100

Estimating Buffer Strip Survival

Intended Audience Resource Managers, Foresters

Description Slide show describing seven factors that can damage streamside buffer strips for minimizing water resource impacts of forestry practices. Outlines a procedure for predicting survival of planned buffer strips.

Order From Oregon State University
Forestry Media Center
PV Hall, Room 248
Corvallis, OR 97331-5702
(503) 737-4702

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R0036702

SLIDE SHOWS

Fertilizing Home Lawns in Virginia

Intended Audience Homeowners, Landscape Professionals

Description 40 slides with accompanying text. Discusses lawn fertilizer nutrient content, cool- and warm-weather season grasses, and methods of determining optimum amounts of fertilizer.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Fertilizing Home Vegetable Gardens

Intended Audience General Public

Description 40 slides with accompanying text. This slide program examines chemical and organic fertilizers, their nutrient composition, soil testing, and the timing and application of fertilizer to home vegetable gardens.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Ground Water: Resource at Risk

Intended Audience General Public

Description Slide show answering commonly asked questions about groundwater. Also available in videocassette format.

Order From Pennsylvania Environmental Council
1211 Chestnut Street, Suite 900
Philadelphia, PA 19107
(215) 563-0250

Groundwater: Your Water at Risk

Intended Audience General Public

Description Slide program with 12-page script concerning groundwater. Addresses nonpoint source pollution in general. Provides general educational information to public interest groups and organizations.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

The Land Use Connection

Intended Audience General Public

Description 28-page introductory booklet on nonpoint source pollution with companion slide or video show.

Order From Minnesota Pollution Control Agency
Public Information Office
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Nonpoint Source Pollution: An Introduction

Intended Audience Citizen's Groups, Students

Description Slide-tape or video program introducing concept of nonpoint source pollution. Provides general nonpoint source pollution information in relation to surface water.

Order From New York State Dept. of Environmental Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

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R0036703

Reading and Understanding Pesticide Labels for the Lawn and Garden

Intended Audience Homeowners, Landscape Professionals

Description 40 slides with accompanying text. Uses labels from various pesticides as examples. Explains the meaning of label sections such as "Common and Chemical Names," "Ingredient Statement," "Precautionary Statement," "Directions for Use," "Storage and Disposal," and "Persistence and Accumulation."

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Students Study Water Quality: A Networking Approach

Intended Audience Students, General Public

Description 15-minute show describing TVA Teacher/Student Water Quality Monitoring Network Program. Available as slide/tape show or transferred to 1/2" VHS video.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Urban Erosion and Sediment Control

Intended Audience General Public

Description Discusses the causes of, effects of, and solutions to urban erosion

Order From Minnesota Pollution Control Agency
Nonpoint Source Section
520 Lafayette Road
St. Paul, MN 55155
(612) 297-8218

Urban Project

Intended Audience Planners, General Public

Description Scripted slide presentation developed from portions of the National Urban Runoff Program. The slides illustrate various types of urban nonpoint source pollution and ways to avoid the problem.

Order From South Dakota Dept. of Agriculture
NPS Information and Education Program
445 East Capitol Avenue
Pierre, SD 57501-3185

Urban Water Quality

Intended Audience General Public

Description Shows possible sources of groundwater contamination from the average American home.

Order From Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, AK 99508-4143

The Value of Wetlands in Urban Areas

Intended Audience General Public

Description 45-minute slide show highlighting the value of wetlands in the achievement of water quality benefits in urban areas. Cannot be ordered, but the Council will respond to inquiries.

Order From West Michigan Environmental Action Council
1432 Wealthy, SE
Grand Rapids, MI 49506
(616) 451-3051

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R0036704

Water Quality Planning Guidance Manual

Intended Audience Local Government Officials

Description Slide show with detailed overview of the methods and procedures for prevention of watershed and aquifer nonpoint source pollution. Includes discussion of implementation plans for impacted or threatened waterbodies. Discusses high-technology best management practices.

Order From New York Soil and Water Conservation Comm.
1 Winners Circle, Capitol Plaza
Albany, NY 12235
(518) 457-3738

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33997

R0036705

R0036706

Acid Rain: A Sourcebook with Experiments for Advanced Students

Intended Audience Students, Grades 9 - 12; Teachers

Description Designed for students in grades 9-12 and adults. Written in nontechnical style. Covers acid rain sources, effects, controls, remediation, and citizen action. Includes text, graphics, and experiments to explain acid rain, acid fog, and acid deposition. A companion guide is available for grades 4 - 8.

Order From U.S. Environmental Protection Agency
Center for Environmental Research
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7562

Acid Rain: A Student's First Handbook

Intended Audience Students, Grades 4 - 8; Teachers

Description Designed for students in grades 4 - 8. Includes explanatory text with liberal amounts of explanatory information. Provides introductory experiments and activities to help students understand acidity and acid deposition. A companion guide is available for grades 9 - 12.

Order From U.S. Environmental Protection Agency
Center for Environmental Research
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7562

Adopt-A-Stream Teacher's Handbook

Intended Audience Teachers

Description 241-page handbook that includes chapters on how to adopt a waterway, field safety, sampling site selection, physical parameters, water chemistry, aquatic biology, microbiology, and evaluating results.

Order From Delta Laboratories, Inc.
34 Elton Street
Rochester, NY 14607
(716) 251-1531

Amazing Soil Stories — Adventure and Activity Book and Teachers Guide

Intended Audience Students, Grades 4 - 5

Description Presents information and hands-on activities for students in grades 4 and 5 about soil erosion in an 18-page comic/activity book. 35-page teacher's guide contains background information about each activity.

Order From National Association of Conservation Districts
408 East Main
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547
(Cost: $.65, teacher's guide $1.75)

Aquatic WILD

Intended Audience Teachers

Description 240-page lesson plan and activity book available upon the completion of the Aquatic WILD facilitated workshop.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

A-Way with Waste: A Waste Management Curriculum for Schools

Intended Audience Teachers, K-12

Description A 352-page teacher's guide that provides a classroom instruction outline on hazardous waste. Generally related to nonpoint source pollution.

Order From Washington State Department of Ecology
4250 150th Ave.
Redmond, WA 98052-5301
(206) 867-7000

VOL 12
3399
R0036707

Basic Water Environment Series, Member's Manual

Intended Audience Students, Upper Elementary

Description Booklet for 4-H and other outdoor groups. Activities teach students about water: characteristics, cycle, pollution, quality, etc. Objectives are to help youth to understand water and its importance in our lives, to appreciate the many uses for water, and to see the need for good-quality water.

Order From Michigan State University
Sea Grant College Program, Bulletin Office
Agricultural Hall, Room 10B
East Lansing, MI 48824-1039

Bay Walk-About

Intended Audience Students, Elementary through High School

Description Brochure guiding a tour through restored marsh habitat along Sarasota Bay, Florida. Question-and-answer insert encourages observation and interaction. Elementary, middle school, and high school versions.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Be Water Wise

By Kathy Sevebeck

Intended Audience Students, Grades 6-12

Description 48-page, cartoon-illustrated booklet. Includes activities on water conservation, water in the environment, and water and wastewater treatment. 32-page instructor's guide also available.

Order From Publications Services
Virginia Water Resources Research Center
617 N. Main Street
Blacksburg, VA 24060
(Cost: $1.25, instructor's guide $3)

Beneath the Shell

Intended Audience Teachers

Description Background information and activities on nonpoint source pollution and shellfish in New Jersey. 130 pages. Updated edition available in spring 1993.

Order From Office of Regulatory Policy
NJ Dept. of Envir. Protection and Energy
CN 423
Trenton, NJ 08625-0423
(609) 292-2113

Beyond Mudpies

Intended Audience Students, Grades 1-8

Description Educational activities in soil science, hydrology, and soil conservation for grades 1 through 8.

Order From Hillsborough County Conservation District
468 Route 13 South
Milford, NH 03055

California's Water Problems

Intended Audience Students, Grades 6-9

Description Cooperative learning exercises designed to give students first-hand experience at working out a solution to a real-life problem, the management of California's water. Lesson plan book, guides, and map included.

Order From Water Education Foundation
717 K Street, Suite 517
Sacramento, CA 95814
(916) 444-6240

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R0036708

The California Water Story

Intended Audience Teachers

Description Provides a multidisciplinary approach to teaching about one of California's most important resources. Lesson plans include worksheets, tests, and maps that integrate subject areas such as geography, history, science, math, and art.

Order From Water Education Foundation
717 K Street, Suite 517
Sacramento, CA 95814
(916) 444-6240

Charting Our Course: An Activity Guide for Grades 6-12 on Water Quality in Maine

Intended Audience Students, Grades 6 - 12

Description A 68-page booklet discussing water quality issues including nonpoint source pollution.

Order From Maine Coastal Program
State Plaza, Station 38
Augusta, ME 04333
(207) 289-3261

City Trees, Country Trees

Intended Audience Students, Middle School

Description Booklet of interdisciplinary activities focusing on trees and forests in the country and city.

Order From New York State Dept. of Envir. Conservation
Division of Lands and Forests
50 Wolf Road
Albany, NY 12233-4253

CLASS Project

Intended Audience Teachers

Description 134-page lesson plan and activity book available upon the completion of the CLASS Project facilitated workshop.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

Coloring Pages

Intended Audience Students, Preschool and Elementary

Description 11"x 17" coloring activity that features a manatee explaining how stormwater runoff damages the bay and its animals. Explains what children can do to help.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Conservation Education in Illinois — A Sourcebook for Educators

Intended Audience Teachers

Description A 65-page listing of conservation/environmental education materials available from Illinois state agencies.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

VOL 12
3401
R0036709

Conserving Soil

Intended Audience Students, Junior High

Description Background information, transparencies, activity sheets in folder format regarding soil properties and conservation practices.

Order From National Association of Conservation Districts
408 East Main Street
P.O. Box 885
League City, TX 77573
(800) 825-5547

Development and Implementation of Teacher Training in Water Quality Issues

APES #90-25

Intended Audience Teachers, School Officials

Description A teacher training workshop conducted in the summer of 1990. Information that was presented in classroom and laboratory exercises, guest lectures, and field trips. Topics include the water cycle, groundwater hydrology, water quality testing, nonpoint source pollution, and the role of humans in the natural environment.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

Discover Wetlands

Intended Audience Students, Grades 4 - 8

Description A curriculum guide that focuses on what wetlands are, why they are important, and how human actions affect them. Includes activities, reproducible graphics and activity sheets, and a thorough appendix directing teachers to additional wetlands resources.

Order From Washington State Department of Ecology
Publications Office
Mail Stop PV-11
Olympia, WA 98504-8711
(206) 438-7472

Earth Trek: Explore Your Environment

Intended Audience Students, Elementary

Description 25-page activity book on the environment, including nonpoint source pollution.

Order From U.S. Environmental Protection Agency
Office of Public Affairs
401 M. Street, SW
Washington, DC 20460

Educator's Earth Day Sourcebook — Grades 7 - 12

Intended Audience Students, Grades 7-12

Description 5-page booklet on Earth Day. Addresses nonpoint source pollution in general.

Order From U.S. Environmental Protection Agency
Office of the Administrator
401 M. Street, SW
Washington, DC 20460

Enjoy the Outdoors . . . While You Earn College Credit

Intended Audience Teachers

Description 8-panel brochure that provides information, tuition costs, and application forms for the Southeast Nebraska Environmental Education Seminar for Teachers. The camp is held in summer at Camp Jefferson near Fairbury, NE. The purpose of the three-credit (undergraduate or graduate) course is to provide teachers with background and basic skills in environmental education. Sponsored by several Natural Resource Districts in Nebraska.

Order From Lower Platte South Natural Resources Dist.
3125 Portia, P.O. Box 83581
Lincoln, NE 68501-3581
(402) 476-2729

VOL 12
3402
R0036710

Environmental Education for Teachers and Young People

Intended Audience Teachers, Students

Description A compendium of educational materials on environmental issues available from private and public sector organizations. Includes a section on workshops and other educational opportunities.

Order From U.S. Environmental Protection Agency
Office of Environmental Education
401 M Street, SW (A-107)
Washington, DC 20460
(202) 260-4484

Environmental Teaching Modules

APES # 92-11

Intended Audience Students, Grades K - 6

Description Model modular guide for 14 activities regarding estuarine and environmental health. A nontraditional, no-textbook approach using common and readily available materials. Encourages field trips, hands-on learning experiences for children, and community-level activities to raise environmental awareness.

Order From Albemarle-Pamlico Estuarine Study
P.O. Box 1507
1424 Carolina Ave.
Washington, NC 27889
(919) 946-6481

The Further Adventures of Captain Hydro

Intended Audience Students, Grades 7-9

Description A 16-page full-color comic book presenting Captain Hydro in his continuing battle with the Water Bandit. The teacher's guide includes eight reproducible worksheets and four time lines, and it incorporates the goals and objectives of the California Department of Education's recently adopted History-Social Science Framework.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523
(Workbook $.50, guide $2.00)

Go With The Flow — Understand Watersheds

Intended Audience Elementary Students

Description Five exercises to help school children understand watersheds. Includes a drainage basin map of New York State.

Order From New York State Dept. of Envir. Conservation
Division of Water Resources
50 Wolf Road, Room 310
Albany, NY 12233-3501
(518) 457-0669

Groundwater Protection Through Prevention: A Curriculum

Intended Audience Teachers

Description 15-page curriculum outline on groundwater protection. Addresses nonpoint source pollution in general.

Order From Iowa State University
Department of Agricultural Education
208 Davidson Hall
Ames IA, 50011-3080
(515) 294-6673

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34003
R0036711

Groundwater Study Guide

Intended Audience Teachers of Grade 6-9 Earth Science classes

Description Activities, study guide, poster, and booklet entitled *Groundwater Protecting Wisconsin's Buried Treasure.*

Order From Document Sales
P.O. Box 7840
Madison, WI 53707
(Cost: $10 + tax (5% or 5½%) unless exempt)

Groundwater: A Vital Resource, Student Activity

Intended Audience Students, Grades 4 -12

Description A 61-page activity guide including activities on the water cycle, water distribution in soils, and community impacts.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

Hands-on Nature: Information and Activities for Exploring the Environment with Children

Intended Audience Teachers

Description 235-page educational activity book on nature exploration. Addresses nonpoint source pollution in general.

Order From Vermont Institute of Natural Science
P.O. Box 86
Woodstock, VT 05091
(802) 457-2779

Healthy Water, Healthy World — Conservation Camp 1990

Intended Audience Students, Grades 5-7

Description 15-page teaching booklet on importance of healthy water. Addresses nonpoint source pollution of surface and ground water. Poses study questions. Contains a synopsis of environmental issues. Use alone or accompanying an outdoor field trip.

Order From Clinch-Powell Resource Cons. & Dev. Council
Route 2, Box 423
Rutledge, TN 37861
(615) 828-5927

Living with Wildlife

Intended Audience Students, Grades 6 - 8 (adaptable)

Description 48-page education supplement depicting interactions of humans with wildlife in urban and rural settings. Includes lesson plans and activities.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

Local Watershed Problem Studies: Middle and High School Curricula

Intended Audience Teachers

Description 328-page curricula guide book for teachers. Provides a classroom instruction outline on watersheds, with nonpoint source pollution-related topics.

Order From Cooperative Educational Service Agency 16
227 Maple Ave.
Waukesha, WI

VOL 12
3404
R0036712

The Magic of Water

Intended Audience Students, Elementary

Description 68-page activity book on water. Provides general educational material including nonpoint source pollution issues.

Order From California Department of Water Resources
1416 Ninth Street
Sacramento, CA 94236-0001
(916) 445-9248

More About Water: Where It Comes From; Where it Goes

Intended Audience Students, Grades 5-12

Description A fully illustrated booklet explaining where EBMUD gets its water and how it is treated, stored and delivered to customers. By the East Bay Municipal Utility District, Oakland, CA.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523

My World, My Water and Me

Intended Audience Teachers, Students

Description A 63-page teacher's guide to water pollution control with specific lesson plans, objectives, skills, and activities.

Order From NJ Dept. of Environmental Protection
Office of Communications and Public Education
401 East State Street
Trenton, NJ 08625
(609) 984-7478

Northern Illinois Wetlands Poster Education Guide

Intended Audience Students, General Public

Description 4-page educational guide to accompany the Northern Illinois Wetlands habitat poster produced by the Conservation Natural Heritage Division.

Order From Illinois Department of Conservation
Education Program
524 S. Second St.
Springfield, IL 62701-1787

The Official Captain Hydro Water Conservation Workbook

Intended Audience Students, Grades 5-8

Description A 40-page workbook that includes 10 pages of comics centered around Captain Hydro as he battles the Water Bandit. This 30-page workbook concentrates on units of science and social science. The readings, worksheets, and projects include sections on the water cycle, the uses of water, and water conservation and management. A Spanish-language version, *Capitan Tlaloc*, is also available.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523
(Workbook $.50, guide $2.00)

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34005
R0036713

One Green Tree

Intended Audience Students, Grades 4 - 5

Description Provides information in comic book format about the growing process for trees and benefits to wildlife, erosion control, and water quality.

Order From National Association of Conservation Districts
408 East Main
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547
(Cost: $.60)

The Pawcatuck Watershed Education Program

Intended Audience Students

Description This environmental education curriculum includes classroom and field instruction on watersheds, wetlands, cultural and agricultural resources, natural history, ecology, and point and nonpoint sources of pollution. When piloted in two schools during 1991-92, the program culminated in a mock hearing on a current environmental issue in the watershed, with students researching and representing the different interest groups involved with the issue.

Order From Department of Natural Resource Science
University of Rhode Island
Kingston, RI 02881
(401) 792-2138
Contact: Bonnie Lamb

Plant a Tree for Arbor Day

Intended Audience Students, Middle School

Description Booklet of teacher activities to use for tree planting activities for Arbor Day. Interdisciplinary.

Order From New York State Dept. of Envir. Conservation
Division of Lands and Forests
50 Wolf Road
Albany, NY 12233-4253

Plants: Improving Our Environment

Intended Audience Children

Description Helps children gather information about how humans depend on green plants for survival and how plants are used for pollution abatement, soil conservation, beautification, and building materials. Photosynthesis and various plant types are also explored.

Order From Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021
(800) THE-SOIL

Project Learning Tree

Intended Audience Teachers

Description 185 page (K-6) and 220-page (7-12) lesson plan and activity books available upon the completion of the Project Learning Tree facilitated workshop.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

Project Learning Tree Environmental Education Program

Intended Audience Teachers, K-12

Description Grass roots volunteer program working in conjunction with local school districts and state agencies. Education program is designed for teachers and other educators working with students in grades K-12. Includes interdisciplinary instructional activities.

Order From Project Learning Tree
1250 Connecticut Ave, NW, Suite 320
Washington, DC 20036

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34006
R0036714

Project WILD

Intended Audience Teachers

Description 386-page lesson plan and activity book available upon the completion of the Project WILD facilitated workshop.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

Protozoa Skits

Intended Audience Students, Junior High

Description Skits on protozoan life, including the effects of nonpoint source pollution.

Order From Belknap County Conservation District
719 N. Main Street, Room 203
Laconia, NH 032426
(603) 528-8713

Rouge River Watershed Teacher Education Program

Intended Audience Teachers

Description A variety of educational materials on the geology; hydrology; and biological, chemical, social, and political aspects of the Rouge River Watershed.

Order From Dr. Orin G. Gelderloos
University of Michigan-Dearborn
Department of Natural Sciences
Dearborn, MI 48128-1491

Sammy Soil Saver Puppet Kit

Intended Audience Teachers

Description Puppet and activity guide with three-ring notebook on soil conservation, including hints, scripts, activities, and puppets. Addresses nonpoint source pollution in general.

Order From National Association of Conservation Districts
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547

Sandcastle Moats and Petunia Bed Holes: A Book About Groundwater

Intended Audience Students, Grades 6 - 8

Description 32-page multicolored book containing information about the hydrologic cycle, Virginia's geology, and groundwater; class demonstrations and activities; and a glossary. 15-page instructor's guide also available.

Order From Virginia Water Resources Research Center
Publications Services
617 North Main Street
Blacksburg, VA 24060-3397

Show You Care

By Sister Anna Louise Wilson and Laura Noy

Intended Audience Students, K - 2

Description Material designed to promote the benefits of trees and encourage the wise use of forest resources. Other materials relating to the annual Soil and Water Stewardship Week are also available including interactive poster, bookmark, lessons for children and adults, reference book, placemat, and clip art.

Order From National Association of Conservation Districts
408 East Main
P.O. Box 885
League City, TX 77574-0855
(Coloring book $.10, sample kit $2.75)

VOL 12
34007
R0036715

Sleuth

Intended Audience Students, General Public

Description 160-page curriculum guide explores secondary- and intermediate-level activities for the identification of household hazardous wastes and their proper handling, use, and disposal.

Order From Washington State Office of Environmental Education
17011 Meridian Avenue N.
Seattle, WA 98133

A Soil Ecosystem Transparency

Intended Audience Teachers

Description Transparency with guide sheet showing the components of soil ecosystems. The guide sheet covers basic nutrient cycling involving plants, animals, and decomposers. Several school activities are suggested.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Soil and Water Stewardship Week

Intended Audience Students, General Public

Description Kit containing posters, program covers, slides, videos, booklets, placemats, and student activity books on soil and water stewardship. Provides general nonpoint source pollution educational information.

Order From National Association of Conservation Districts
408 East Main Street
P.O. Box 885
League City, TX 77573
(800) 825-5547

Southern Illinois Wetlands Poster Education Guide

Intended Audience General Public

Description 4-page educational guide to accompany the Southern Illinois Wetlands habitat poster produced by the Conservation Natural Heritage Division.

Order From Illinois Department of Conservation
Education Program
524 S. Second St.
Springfield, IL 62701-1787

The Story of Nutrient Enrichment of the Chesapeake Bay

Intended Audience Students, Elementary

Description 18-page activity booklet providing general information about the sources of nutrients and effects of nutrients on the bay.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

The Story of Soil Erosion Around the Chesapeake Bay

Intended Audience Elementary Students

Description 16-page activity booklet that provides general information concerning soil erosion to elementary school children.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

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34008
R0036716

A Stream Becomes an Ocean

Intended Audience Students, Junior High

Description 15-page activity book on surface water. Addresses nonpoint source pollution in general.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne St.
Blacksburg, VA 24061
(703) 961-6192

Tardy Twins Meet Polluto

Intended Audience Students, Grades 4-8

Description An 11-page comic book, with teacher's guide, featuring junior detectives who discover water pollution. They track the monster, Polluto, to the EBMUD Wastewater Treatment Plant and learn about the processes that prevent Polluto from entering San Francisco Bay. By the East Bay Municipal Utility District, Oakland, CA.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523
(Workbook $.50, guide $2.00)

Teacher/Student Water Quality Monitoring Network

Intended Audience Teachers, School Officials

Description Describes TVA's Teacher/Student Water Quality Monitoring Network including participant selection, training, responsibilities, and support. Includes names, addresses, and telephone numbers of key contacts.

Order From Environmental Education Section
Tennessee Valley Authority
Forestry Building
Ridgeway Road
Norris, TN 37828-2002
(615) 632-1599

A Teacher's Guide to Arbor Month

Intended Audience Elementary School Teachers

Description A collection of bulletin board ideas, tips, facts, activities, and reproducibles designed to help students in grades K-6 become tree-conscious all year long. 120 pages.

Order From Community Forestry Coordinator
North Dakota Forest Service
1511 East Interstate Avenue
Bismarck, ND 58501

Teaching Soil and Water Conservation: A Classroom and Field Guide

SCS Program Aid Number 341

Intended Audience Teachers

Description Includes several activities, experiments, and observations concerning soil properties and conservation including erosion and conservation.

Order From United States Department of Agriculture
Soil Conservation Service
(Contact local SCS)

Trees for Kids

Intended Audience Students

Description Comprehensive education kit about Illinois trees that is distributed to schools. Contains lesson plans, activities, color poster, videos, and audio tapes. Distributed to public and private schools; available for short-term loan.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

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Tualatin River Rangers

Intended Audience Students, Elementary

Description Elementary education program consisting of an interactive presentation and comic books on the water cycle and wastewater treatment. Addresses nonpoint source effects on surface water.

Order From Unified Sewerage Agency of Washington
155 N. First Avenue, Suite 270
Hillsboro, OR 97124
(503) 648-8621

TVA — A World of Resources

Intended Audience Students, Grades 6-8

Description 425-page school curriculum supplement discussing the relationships between natural resources and their management. Contains units on air, forestry, recreation, water, and wildlife resources. The water resources unit has hands-on activities on the hydrologic cycle, aquifers, artesian wells, weather, and water pollution.

Order From Tennessee Valley Authority
Environmental Education
Forestry Building
Norris, TN 37828-2002
(615) 632-1599

Water and Me

Intended Audience Students, K - 2

Description Material that provides information and activities about the use and importance of water. Includes a list of skills that students will learn and additional activities for parents and educators.

Order From National Association of Conservation Districts
408 East Main
P.O. Box 885
League City, TX 77574-0855
(800) 825-5547
(Cost: $.30 each)

Water Education for Teachers

By G. Morgan Powell and Emily Kling

Intended Audience Students, Grades 4 - 8

Description WET is a 4-H school enrichment program for teachers and volunteers to use with elementary and middle school students. The curriculum contains over 60 lessons in the areas of water cycle, water supply, water and waste water treatment, conservation, and pollution. Audio-visual resources and water education bibliography are included.

Order From 4-H and Youth Programs
Umberger Hall Room 201
Kansas State University
Manhattan, KS 66506
(Cost: $50)

Water Play

By the East Bay Municipal Utility District, Oakland, CA.

Intended Audience Students, K-3

Description A 16-page workbook with teacher's guide featuring coloring exercises, word puzzles, and fun activities, providing the K-3 teacher with the basis for a variety of lessons involving all aspects of water conservation.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523

Water Quality Monitoring: A Student Handbook

Intended Audience High School Students

Description 24-page handbook on water quality monitoring. Addresses nonpoint source pollution in general. Provides general educational information for high school students.

Order From Bureau of State Parks
Harrisburg, PA 17120

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Water, the Liquid of Life

Intended Audience Students

Description Activity packet designed to instruct students on life's dependence on water through the water cycle, drinking water, and wastewater treatment. Forms of water pollution and solutions to these problems are described.

Order From Illinois Environmental Protection Agency
Office of Public Information
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794-9276

Water: The Basis of Life

Intended Audience Elementary Students

Description 16-page cartoon booklet and 14-page teacher's guide exploring water quality and supply problems, the importance of a sustained supply of high-quality water, and how to prevent misuse and pollution of water resources. Includes problem-solving.

Order From Soil and Water Conservation Society
7515 N.E. Ankeny Road
Ankeny, IA 50021-9764
(800) THE-SOIL

Water: Where It Comes From; Where it Goes

By the East Bay Municipal Utility District, Oakland, CA.

Intended Audience Students, K-3

Description A fully illustrated booklet explaining where EBMUD gets its water and how it is treated, stored, and delivered to customers.

Order From Innovative Communications
ATTN: Grace Sanford
207 Coggins Drive
Pleasant Hill, CA 94523

WaterWays: Exploring Northwest Florida's Water Resources

Intended Audience Students, Middle School

Description An educational program that provides middle school students with a basic understanding of the importance of water resources for both human and environmental needs and the various management methods and individual actions necessary to preserve and protect both surface water and groundwater systems.

Order From Northwest Florida Water Management District
Route 1, Box 3100
Havana, FL 32333-9700

Wet and Wild: A Multidisciplinary Marine Education Teacher's Guide, Grades K - 6

Intended Audience Teachers

Description Unit I, Lakes, has 98 pages; Unit II, Bays, Estuaries and Near Coastal Waters, has 28 pages; Unit III, Research, has 68 pages. Available in both English and Spanish.

Order From University of Southern California
Sea Grant Program
University Park
Los Angeles, CA 90089-1231
(213) 740-1961

Wetlands Affect You and Me Member's Manual

Intended Audience Students, Grade 5

Description Outdoor activities that teach students about wetlands — what they are, why they are important, and how to preserve them. Objectives include helping students to understand wetlands and their value to humanity, to survey uses of wetlands, and to learn about wetland destruction and regulation.

Order From Michigan State University
Sea Grant College Program
Agriculture Hall, Room 10B
East Lansing, MI 48824-1039
(517) 355-0240

R0036719

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What Is an Ocean?

Intended Audience Students, Junior High

Description 15-page activity book on oceans; includes nonpoint source pollution effects.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne Street
Blacksburg, VA 24061
(703) 961-6192

What Is Water?

Intended Audience Students, Junior High

Description 15-page activity book on water; includes nonpoint source pollution effects.

Order From Virginia Tech Extension Distribution Center
1120 Landsdowne Street
Blacksburg, VA 24061
(703) 961-6192

Wild Mammals of Illinois

Intended Audience Students

Description Comprehensive education kit about Illinois mammals, distributed to schools. Contains lesson plans, activities, color poster, videos, and audio tapes. Distributed to public and private schools; available for short-term loan.

Order From Illinois Department of Conservation
Education Program
524 S. Second Street
Springfield, IL 62701-1787

WOW!: The Wonders of Wetlands — An Educator's Guide

By Brin Eckhardt Slattery

Intended Audience Teachers, K-12, Community Groups, Kids

Description A complete guide to wetlands learning activities, with more than 40 classroom and outdoor lessons. Includes a "restoration" and action guide offering ideas for projects to conserve, enhance, and restore wetlands in the local community. 160 pages.

Order From Environmental Concern, Inc.
Education Department
P.O. Box P
St. Michaels, MD 21663
(401) 745-9620
(Cost: $12, less in quantity)

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R0036720

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VIDEOS

R0036721

VIDEOS

Applying Pesticides Properly

Intended Audience General Public

Description Two officers of the fictitious Pest Police investigate the poisoning of fish in a small stream. While apprehending the killer, they explain the proper use, application, and storage of pesticides. Approximately 8 minutes.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Chesapeake Horizons

Intended Audience General Public

Description Video on Chesapeake Bay pollution. Addresses nonpoint source pollution in general.

Order From Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
(301) 268-8816

Clean Water, Clear Choices: The Challenge of Nonpoint Source Pollution

Intended Audience General Public

Description Video explaining the challenge of nonpoint source pollution and highlighting successful projects.

Order From National Association of Conservation Districts
509 Capitol Court, N.E.
Washington, DC 2002
(202) 547-6223

Construction Activities — Best Management Practices

Intended Audience Local Officials, Developers

Description Documents a construction BMP demonstration project in Louisiana and suggests statewide use of these BMPs.

Order From Louisiana Dept. of Environmental Quality
Office of Water Resources
Nonpoint Source Pollution Program
P.O. Box 82215
Baton Rouge, LA 70884-2215
(504) 765-0634

Coyote Creek Watershed Erosion Control Demonstration Project

Intended Audience General Public

Description Elizabeth Taylor narrates this local PBS video about erosion control on Coyote Creek, Arizona.

Order From Apache Resource Conservation District
P.O. Box 329
823 E Main St
Springerville, AZ 85938
(602) 233-5294

Earth Alert!

Intended Audience General Public

Description Ongoing series of 30-minute VHS documentary videos on subjects such as pollution on the California Coast, where it comes from, effects on life-forms, economy, and lifestyle of a region.

Order From Earth Alert!
P.O. Box 69193
West Hollywood, CA 90069
(213) 274-0954

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East Bay Wet Weather Program

Intended Audience General Public

Description 13-minute VHS video explaining East Bay (Oakland, CA, and surrounding communities) wet weather sewer overflow problems and coordinated community and regional "least cost" approach taken by the wet weather program for a solution.

Order From East Bay Municipal Utility District
Wet Weather Program
P.O. Box 24055
Oakland, CA 94623
(415) 465-3700

Educational Videotape Programs: Aquatic Plant Series

Intended Audience Teachers, Naturalists

Description Sheet listing of videos for secondary and college students, managers, and field personnel. Topics include lake ecology and aquatic plant management, and seven videos on Florida aquatic and wetland plant identification are available.

Order From IFAS Publications
IFAS Building 664
Gainesville, FL 32611-0001
($15 per tape; loan also available)

Erosion and Sediment Control: Procedures and Practices for Construction Sites

Intended Audience Local Officials, Builders

Description 15-minute video presenting procedures and practices for soil erosion and sediment control on construction sites. The video describes how effective control is achieved through site planning and design, soil stabilization, sediment controls, controls, and inspection and maintenance.

Order From Northeastern Illinois Planning Commission
400 West Madison Street, Room 200
Chicago, IL 60606
(312) 454-0400

Fabulous Wetlands

Intended Audience Students, Middle School.

Description Humorous 7-minute video featuring "The Science Guy" and the sinking parking lot. Basic introduction to the functions and values of wetlands, aimed at upper elementary and middle school students.

Order From Puget Sound Water Quality Authority
P.O. Box 40900
Olympia, WA 98504-0900
(206) 493-9300

Fertilizer: Vegetable Gardens / Fertilizer: Home Gardens

Intended Audience General Public

Description Two programs on responsible fertilization of gardens. Due to their short length, both of these programs are on the same videotape.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Fertilizer: Home Lawns

Intended Audience Homeowners

Description 6-minute VHS video on responsible fertilization of lawns.

Order From Virginia Dept. of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094
(804) 371-8884

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Forests for the Chesapeake Bay

Intended Audience Land Users, Farmers

Description 20-minute VHS video on effects of forestry on the Bay. Addresses nonpoint source pollution in general. Provides best management practices for land users.

Order From Virginia Department of Forestry
P.O. Box 3758
Charlottesville VA 22903
(804) 977-6555

From Curb to Stream: Cleaning Up Our Urban Waters

Intended Audience General Public

Description An 18-minute video from the "It All Adds Up" video series on nonpoint source pollution. This tape features urban nonpoint source pollution problems and solutions, including those related to construction sites and residential areas.

Order From Gary Korb
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

Great Lakes Video Series

Intended Audience General Public

Description 15-minute video designed to foster an awareness of the Great Lakes Region, its problems, and resources. Discusses the International Joint Commission, which is responsible for advising the U.S. and Canadian governments on matters of pollution control in the Great Lakes and other boundary waters.

Order From University of Michigan
Film and Video Library
400 Fourth Street
Ann Arbor, MI 48103
(313) 764-5360

Groundwater: The Unseen Resource

Intended Audience General Public

Description 19-minute videotape providing general introduction on the basics of groundwater hydrology. Provides general educational information to the public. Other videos in the series include "Groundwater and Your Family's Health" and "Agriculture and Groundwater."

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824
(517) 353-3742

Groundwater: Your Water At Risk

Intended Audience Public Interest Groups

Description MVRPC video program on groundwater and potable water quality. Addresses nonpoint source pollution in general. Provides educational information to public interest groups or organizations.

Order From Miami Valley Regional Planning Commission
40 West 4th Street, Suite 400
Dayton, OH 45402
(513) 223-6323

It All Adds Up: Taking Action for Cleaner Water

Intended Audience General Public

Description This 21-minute video from the "It All Adds Up" video series provides an overview of urban and rural nonpoint source pollution — what it is, the problems it causes, and how urban and rural residents can help reduce it.

Order From Gary Korb
1304 S. 70th Street
West Allis, WI 53214
(414) 475-2881

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James River Water Restoration Video

Intended Audience General Public

Description Video explaining South Dakota's James River water restoration project.

Order From James River Water Development District
P.O. Box 849, City Hall
Huron, SD 57350

Keeping Soil on Construction Sites: Best Management Practices

Intended Audience Construction Site Managers, Designers, Inspectors

Description Video training program for self-study program or workshop. Includes a 50-minute video and a 12-page workbook (10 copies included with instructor's manual) for a 2-hour course. The tape also includes a 26-minute version deleting technical implementation of practices.

Order From Ohio Department of Natural Resources
Division of Soil and Water Conservation
Fountain Square, E-2
Columbus, OH 43224

Lake Protection: Everyone Contributes

Intended Audience Lake Users

Description 10-minute VHS video on techniques that lakeshore property owners can adopt to minimize their impact on the lake on which they live.

Order From Beltrami Soil and Water Conservation
Federal Building, Room 403
Bemidji, MN 56601

Land Management Project Technical Conference Series

Intended Audience Resource Managers, Planners, Government Officials

Description Listing of available audio and video tapes from conferences. Subjects include planning for sustainable growth; issues in land and water management; water resource evaluation tools and protection strategies; design, function, and financing for stormwater controls.

Order From Rhode Island Dept. of Environmental Mgmt.
Land Management Project
83 Park Street
Providence, RI 02903-1037
(401) 277-3434

Mud

DNR Catalog Number 058

Intended Audience General Public

Description A film about erosion (how it can be prevented); sedimentation (how it can be prevented or, if necessary, corrected); urban development (how sensitive and smart builders and developers can take advantage of the known technology); storm drainage (how to minimize its destructive effect in urban areas); and people (how they must recognize that erosion is "the worst pollutant" and do something about it).

Order From Minnesota Dept. of Natural Resources
500 Lafayette Road
St Paul, MN 55155

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VIDEOS

Navesink: Restoration of a River

Intended Audience General Public

Description Describes the Navesink River Watershed in Monmouth County, NJ and the nonpoint source inputs which are contaminating the river. 35 minutes.

Order From Theodore B. Shelton, Ph.D.
Natural Resources Dept.
Cook College
P.O. Box 231
New Brunswick, NJ 08903
(Copy Charge: $35)

Nonpoint Source Series of Videos

Intended Audience Students, Grade K - 12 for Local, State and Nationwide Use

Description Project is incomplete. Estimated date of completion is June 1993.

Order From Ohio EPA
1800 WaterMark Drive
Columbus, Ohio 43215
Contact:

Partnership for Clean Water

Intended Audience General Public, CWP Project Sponsors

Description Video

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Pointless Pollution

Intended Audience General Public

Description 28-minute video describing how nonpoint source pollution has affected the lives of people in four regions of the United States. Focuses on the vanishing oyster industry in the Chesapeake bay, underground reservoir contamination in Minnesota, loss of hydropower potential due to reservoir siltation in the Tennessee Valley, and pollution of lakes and springs in Texas.

Order From Bullfrog Films, Inc.
Oley, PA 19547
(800) 543-3764

Priority Watersheds: Wisconsin's Approach to Mending the land and Its Waters

Intended Audience General Public

Description Detailed look at the components of WI's NPS program. 29 minutes.

Order From NPS Publications
WDNR-WR/2
P.O. Box 7921
Madison, WI 53707

Protect Your Lake — Start a Lake User's Association

Intended Audience Lake Users

Description 10-minute, 1/2" VHS video describing the benefits of forming a lake users' association. Tells what associations around the country have done and provides details for starting an association. Slide/tape transfer to video.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

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R0036726

Protecting Minnesota's Waters — The Land-Use Connection

Intended Audience General Public

Description Video on the protection of surface water in Minnesota.

Order From Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Reading and Understanding Pesticide Labels

Intended Audience Farmers, General Public

Description Discusses sections of pesticide labels and explains what each means. Uses a deck of playing cards to show in an entertaining manner that the failure to read and understand labels is gambling with the environment and health. Approximately 8 minutes.

Order From Virginia Polytechnic Inst. and State University
Office of Consumer Horticulture
407 Saunders Hall
Blacksburg, VA 24061-0327

Sarasota Bay: Reclaiming Paradise

Intended Audience General Public

Description 15-minute video relating the importance of Sarasota Bay to the community, problems facing the bay, and how the community is working to solve those problems.

Order From Sarasota Bay National Estuary Program
1500 Ken Thompson Parkway
Sarasota, FL 34236
(813) 361-6133

Stormwater Management Practices

Intended Audience Planners, Government Officials, General Public

Description 50-minute video on stormwater management practices. Addresses urban nonpoint source pollution. Provides high-technology best management practices for local governmental officials and planners.

Order From Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-4805

Streamside Protection: Finishing the Job for Clean Water

Intended Audience Urban and Rural Residents, Students (older grades), General Public

Description Illustrates water quality, wildlife, and aesthetic values of stream corridors; includes case studies of rural landowners who have adopted streambank protection. 14 minutes.

Order From NPS Publications
Wisconsin Department of Natural Resources
WR/2
P.O. Box 7921
Madison, WI 53707

Students Study Water Quality: A Networking Approach

Intended Audience General Public

Description A 15-minute show describing the TVA Teacher/Student Water Quality Monitoring Network Program. Available in slide/tape format or as 1/2" VHS video.

Order From Water Quality Department Library
Tennessee Valley Authority
Haney Building 2C
1101 Market Street
Chattanooga, TN 37402-2801
(615) 751-7338

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3419
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Superior Today

Intended Audience General Public

Description 29-minute VHS video exploring Lake Superior's dimensions, formation and history, climate and weather, and animal and marine life. Describes the way Lake Superior is used and abused and the issues that surround it and its future.

Order From Northern Michigan University
WNMU-TV
Elizabeth Harden Circle
Marquette, MI 49855
(906) 227-1300

Toxic Turmoil: The Silicon Valley Story

Intended Audience General Public

Description 27-minute video focusing on groundwater contamination from industrial chemicals, particularly from Silicon Valley electronics firms. Discusses what industry is doing to clean up and prevent contamination.

Order From Modern Talking Picture Service
149 New Montgomery Street
San Francisco, CA 94105
(415) 777-3995

The Trouble With Toxics

Intended Audience General Public

Description 29-minute, 1\2" VHS documentary video describing the sources of toxic substances, their chronic effects, fate and control of contaminants, management of freshwater fisheries, public policy issues, and prevention strategies. Topics are discussed from a Great Lakes perspective.

Order From Michigan State University
Michigan Sea Grant Program
334 Natural Resources Building
East Lansing, MI 48824-1222
(517) 353-9568

Understanding Stormwater Detention Ponds

Intended Audience Local Officials, Planners

Description 15-minute video that describes the impacts of urbanization on water quality and stream hydrology and explains how wet detention ponds can reduce these impacts. It also presents design considerations for safety, aesthetics, and wildlife.

Order From Steve Bennett
CES-317, UW-Green Bay
Green Bay, WI 54313-7001
(414) 465-2317

Urban Construction NPS Pollution

Intended Audience Local Officials

Description 17-minute video directed toward local officials from cities, counties, and towns. Focuses on nonpoint source runoff problems associated with urban construction activities.

Order From Denver Regional Council of Governments
2480 W. 26th Ave., Suite 200-B
Denver, CO 80211

Urban Stormwater Runoff: Nonpoint Source Pollution to Delaware's Inland Bays

Intended Audience General Public

Description 17-minute slide/video presentation discussing urban runoff pollution to Delaware's inland bays.

Order From Delaware Department of Natural Resources
Division of Soil and Water Conservation
89 Kings Highway
P.O. Box 1401
Dover, DE 19903
(302) 736-3689

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34220
R0036728

VIDEOS

Using Pesticides Safely

Intended Audience Farmers, Landscape Professionals

Description Six-part video series compiled by the Maryland Cooperative Extension Service to educate applicators with essential information and standards on pesticide safety. Pesticide laws and regulations, labeling, human health, handling, environmental issues, and Integrated Pest Management are among the topics discussed.

Order From University of Maryland
c/o Video Resource Center
0120 Symons Hall
College Park, MD 20742

Water Conservation Video

Intended Audience General Public

Description 33-minute, 1/2" VHS video that takes the viewer through the house and yard, giving simple practical ways to save water. Information about California's water problem is also featured.

Order From Water Education Foundation
717 K Street, Suite 517
Sacramento, CA 95814
(916) 444-6240

Water Environment Curriculum Series

Intended Audience Students

Description Four videos designed to be used as a water quality program or separately. Provides information on how to protect water resources and the importance of maintaining water quality. Teacher and student guides accompany each video.

Order From Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

Water Quality Monitoring Videotapes

Intended Audience Field Technicians, Students, Citizen Groups

Description A set of eight videos, 5 - 12 minutes in length, for teaching the skills of water quality monitoring for dissolved oxygen, BOD, pH, nitrates, phosphates, total solids, fecal coliform, temperature, and turbidity. The tapes correlate with the book *A Water Quality Monitoring Manual* by Mark Mitchell and William Stapp.

Order From Dr. Orin G. Gelderloos
University of Michigan-Dearborn
Department of Natural Sciences
Dearborn, MI 48128-1491

Wetlands and Stormwater

Intended Audience General Public

Description Video addressing the effects of stormwater pollution on natural wetlands in the Puget Sound area. Available for loan only.

Order From King County Resource Planning
3600 136th Place S.E.
Bellvue, WA 98006-1400
(206)296-6602
(Cost: $2.50 for handling and mailing)

Where the River Flows Clean

Intended Audience General Public

Description 12-minute, 1/2" video describing the role of rivers in the hydrologic cycle, how land use affects river water quality, and how pollutants degrade water. Also examines physical, chemical, and biological measurements for determining the water quality of rivers.

Order From Michigan State University
Inst. of Water Research, GEM Program
334 Natural Resources
East Lansing, MI 48824

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Whetstone Watershed

Intended Audience General Public

Description 9-minute video on best management practices. (BMPs).

Order From U.S. Department of Agriculture
Soil Conservation Service
201 Rublein Street
Marquette, MI 49855
(906) 226-8871

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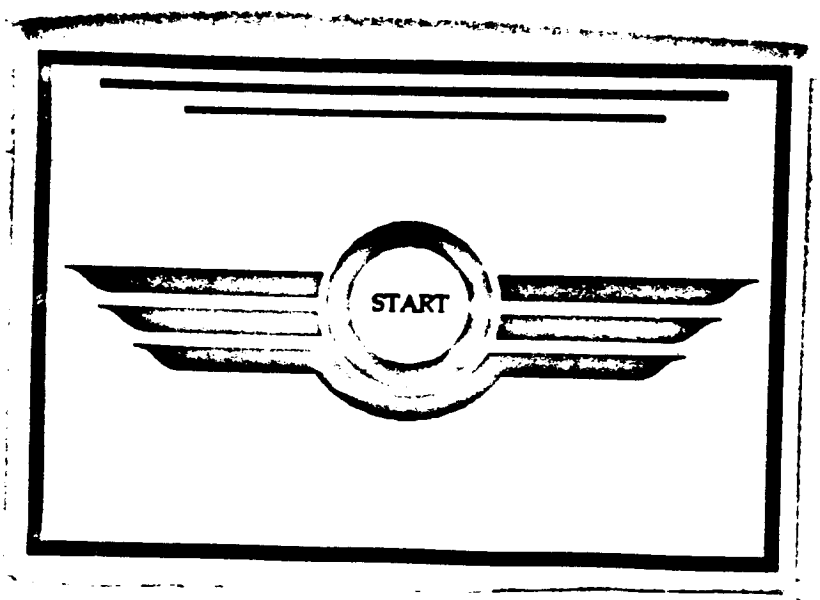
WATER: THE CHALLENGE OF CLEANSING RIVERS & OCEANS



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Pollution Program Affiliates, Inc.

Specializing in Inter-Disciplinary approaches to control of non-point source pollution

PROGRAM

April 7, 1994 - at EcoExpo, Los Angeles Convention Center

WATER: THE CHALLENGE OF CLEANSING RIVERS & OCEANS

The challenge of water quality- the "carrot and the stick". Responses and responsibilities for control of non-point source pollutants. Cleaning the nation's waterways is the most important work of the '90s. Is your industry permitted? Is your City prepared? Produced by PPA.

Topics & Speakers:

Communication and working together - community efforts, watershed management and the goals of water quality. Responsibilities and mandated activities for government, industry, and construction. Creating public acceptance for local action.
Lesley Devine, Councilmember, City of Calabasas and President, Pollution Program Affiliates, Inc.

Funding - "the carrot!" Cities and counties have major responsibility for control of non-point source pollutants. How are they going to pay for this new work? Accessing existing funding and strategies for creating funds.
Carlos Urrunaga, Coordinator, LA County Municipal Permits, LA Regional Water Quality Control Board.

Law suits - "the stick!" Cal Trans and a few select cities have been sued by NRDC for lack of compliance with non-point source pollution prevention regulations. Learn why and how to prevent the same from happening to your city or industrial site.
Everett DeLano, Staff Attorney, National Resources Defense Council [NRDC]

Using BMPs in an urban setting. Explore natural science and practical solutions to water quality problems.
Bill Roley, Phd. Bioengineer, PPA and Permaculture Institute.

"EPA's favorite indicator species - the surfer!" A view from the sea. Dispersion of urban runoff in near shore waters. See *Keepers of the Coast*. How safe is it to swim at your local beach? What is a safe distance to swim from a storm drain outfall? Pierce Flynn, Phd. Professor of Sociology, Cal. State San Marcos and National Communications Director, Surfrider Foundation.

PPA -
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The Law

Regulation overview for control of non-point source pollution

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NPDES LEGISLATION OVERVIEW

POLLUTION CONTROL OF STORM WATER DRAINAGE

THE FEDERAL LAWS AND REGULATIONS

The NPDES regulations, which include "point" and "non-point" sources of pollution, are aimed at eliminating pollutants from entering the nations waterways. The Environmental Protection Agency (EPA) has concluded that fifty to sixty percent of all pollutants come from "non-point" sources. Further, EPA concludes, the only way to decrease or eliminate these pollutants is to stop or minimize their discharge from each site.

The United States government has focused on the need for clean water for two decades:

WATER POLLUTION CONTROL ACT OF 1972
as amended by the
CLEAN WATER ACT OF 1977

Seeks to restore the chemical, physical and biological integrity of the navigable waters of the United States.

NRDC v. EPA, 3rd US Circuit Court of Appeal, 1986

Held that EPA was in violation of the Clean Water Act for failing to address the problem of "extremely detrimental" discharge of untreated and unpermitted storm water runoff into the national waters.

WATER QUALITY ACT OF 1987

Required the EPA, within 2 years, to establish regulations for NPDES permit application requirements for storm water discharges.

NPDES STORM WATER REGULATIONS, NOV. 16, 1990

EPA created a two part application process:
In California, the primary Permit process is administered by the State Water Resources Control Board, with additional authority maintained in selected areas by the State Coastal Commission.

The EPA focus is on regulating non-point sources of pollution, from both industrial sites and from entire cities and counties.

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NPDES STORM WATER REGULATIONS, NOV. 16, 1990 (continued)

NRDC v. EPA, 9th US Circuit Court of Appeal, 1992

9th US Circuit Court of Appeal ruled that certain industrial sites and construction sites under 5 acres should not be exempt from the regulations. EPA was ordered to re-write guidelines for the States affected. (s.a. California) New guidelines were to have been be issued by October 1, 1992, but to date have not been issued. It is expected that NRDC will bring another court action shortly.

WHO IS AFFECTED BY CURRENT REGULATIONS:

- Cities over 100,000 in population and those using a metropolitan storm water system.
- Construction sites over five acres in size.
- The majority of California's industrial facilities.
- It is the responsibility of each locations owner to determine if they are required to obtain an NPDES Permit.
- If needed, a Notice of Intent (NOI) should have been filed.

PART 1 of the NPDES PERMIT REQUIRES:

- Description of existing authority & revenue sources.
- Identification of
  - Outfalls;
  - Existing management programs and regulatory controls;
  - Monitoring plan

There is a benefit to those companies that do enter this process at the early stages. It is that you can virtually write your own plan that will fit the needs of your particular business. If a company waits until full enforcement is in place, the procedures may be more stringent and costly. Our discussions with the State regulators have convinced us that the best way for private concerns to approach these EPA regulations is to move directly to preventing pollution.

PART 2 — REQUIRES A "MANAGEMENT PROGRAM"

EPA is looking for creative solutions to eliminate the discharge of pollutants from each site. They want, at this stage, an implemented monitoring plan plus the design of a site specific *Storm Water Pollution Prevention Plan.*

PPA recognizes that answers to the problems of lowered water quality from non-point source pollutants will be found by comprehensive team approaches. Our teams emphasize the contribution of the natural science disciplines, such as biology, bio-chemistry, geology, etc., augmented by the social sciences, such as governmental relations, sociology and adult education to help motivate solutions.

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Compliance responsibility

Government	Agency
Federal	Environmental Protection Agency (EPA)
State	State Water Resources Control Board
Regional	Regional Water Quality Control Board
Local	City of _____ (and/or county)

Private Entities

- Agricultural
- Industrial
- Construction

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MUNICIPAL NPDES PROGRAM

Municipalities with a population over 100,000 or those that have been determined to be a significant contributor of pollutants are also required to obtain a NPDES storm water permit. The November 16, 1990 regulations detailed the information required by the municipality to prepare a NPDES permit application. The application is divided into two parts. Part 1, basically, requires the discharger to collect existing information regarding storm water discharges, receiving waters, management programs, fiscal resources, and associated elements. In Part 2, the municipality is then expected to take this information and formulate a storm water management program designed to reduce the discharge of pollutants to the maximum extent practicable.

As part of its storm water management program, the municipality is required to develop a program to monitor and control pollutants in storm water discharges from its municipal system. Such control may include regulating storm water discharges from industrial facilities that the municipality determines are contributing pollutants to the municipal storm drain system. Thus it is important for the industries located within such municipalities to realize that there may be municipal requirements on storm water discharges from their industrial facilities. It is imperative that the industry check with its local authority responsible for storm water management.

OTHER FEDERAL AND STATE PROGRAMS

California Coastal Nonpoint Pollution Control Program

The Coastal Zone Act Reauthorization Amendments of 1990 require states with approved coastal zone management programs to develop and submit a Coastal Nonpoint Pollution Control Program to USEPA and National Oceanographic and Atmospheric Administration (NOAA) for approval. The purpose of the program is to work closely with other state and local authorities to develop and implement management measures for nonpoint source pollution including urban runoff to restore and protect coastal waters. Coastal storm water control programs are not intended to supplant existing coastal zone management programs or nonpoint source management programs. Rather, they are to serve as an update and expansion of existing nonpoint source management programs and are to be coordinated closely with the existing nonpoint source management programs (USEPA, 1991). In California, the Coastal Commission and Water Quality Control Board are responsible for the development and implementation of this program.

National Estuary Program

USEPA administers the National Estuary Program under Section 320 of the Clean Water Act. This program focuses on all pollutant sources in geographically targeted, high priority estuarine waters. In this program, USEPA assists state, regional, and local governments to develop comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters (USEPA, 1991). The USEPA (Region 9), SWRCB, and RWQCBs are responsible for administering the California program.

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Cities

Elements of a Storm Water Management Plan

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Pollution Program Division

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A jurisdictions
STORM WATER MANAGEMENT PLAN

Assessment of existing conditions

- ☐ Watershed[s] within the jurisdiction - their characteristics which affect storm water pollution and current management.

- ☐ Community characteristics which influence storm water priorities.

- ☐ Information on hand - such as conditions of stormwater. outfall locations. storm water monitoring information. ambient water quality conditions. any industrial or construction impacts.

- ☐ Existing programs - activities that also apply to storm water management such as erosion control measures. household hazardous waste "roundups" and public education.

Comprehensive Planning

- ☐ Program goals on watershed wide basis. throughout the jurisdiction. Which types of pollutants could be most prevalent and from what sources.

- ☐ Priorities for choosing the focus of your program. Such as a heavily industrial area concentration on chemical pollutants. a residential area concentration on roadway pollutants. a mountain areas concentration on soil erosion and other jurisdiction specific priorities.

- ☐ Public participation goals for active participation and awareness. Should efforts go toward education for school children. homeowners. industry leaders. etc.?

- ☐ BMPs should be chosen based on applicability to jurisdictions specific goals and priorities for reducing pollutants in storm water.

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Responsible Parties

- ☐ Specify city staff and officials responsible for program.
- ☐ Determine how elements of storm water program overlap and need coordination with other city environmental programs.
- ☐ Determine how various departments can integrate the plan into existing responsibilities.
- ☐ Identify other government agencies involved in your watersheds.
- ☐ Decide the best ways to coordinate efforts and storm water programs with adjoining cities, counties and/or jurisdictions such as water agencies.

Legal Authority

- ☐ Ordinances that enable your program should be reviewed and brought before the public and council as needed to authorize your program.
- ☐ Regulations that backup your program should be collated under a unified storm water program system and updated as needed.

Checks for effectiveness

- ☐ Inspections, reporting and review procedures help determine effectiveness of program. Plan for them.
- ☐ Monitoring is your documentation of improvements. It is THE KEY to a well done, approved program.

Maintenance and outreach

- ☐ Plan for continuation of public outreach to citizens and businesses.
- ☐ Maintain a high level of staff training and awareness.

Funding - costs and sources, plan and specify.

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MULTI ASPECTS OF NATURAL SYSTEMS

Planning for NPDES must be site specific

Assess your City's variables:

General Considerations -
- + Amount and density of urbanization
  - Are you mainly residential, industrial, have open space?
- + Storm drain system.
  - Is it independent or part of a regional system?
- + Location within the watershed
  - Are you at the head, a tributary, at the ocean?

Unique situations -
- + Sensitive environmental considerations
- + Unusual history of practices or perspective

Understand monitoring data

Assess presently available background information.
Recognize the lack of present monitoring data.
"Common wisdom" may be wrong -
Example: The "first flush" data debate.

Explore options to take advantage of the unique situation.

Some examples:
Using compost and mulch to build soil sturcture for better infiltration.
Catchment control to build sub soil moture.
Dry wells for percolation of stormwater to sub soil.
Using landscape practices to focus water flows.
Nautual swales for drainage instead of paved channels.

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Examples of City responsibilities

Residential/Commercial Activities

- ❒ Roadway and drainage facility operations and maintenance.
- ❒ New development and redevelopment projects BMPs.
- ❒ Retrofitting existing or proposed flood control projects.
- ❒ Municipal waste handling and disposal operations.
- ❒ Pesticide, herbicide and fertilizer use controls and education.

Improper Discharge Activities

- ❒ Prevention, detection and removal program for illegal storm drain connections.
- ❒ Hazmat spill prevention, containment and response program. Program for proper use and disposal of toxic materials.
- ❒ Reduce cross contamination between storm drain and sewer systems.

Industrial Activities

- ❒ Prioritize inspection and control procedures.
- ❒ Monitor significant outfalls of industrial discharges

Construction and Land Development Activities

- ❒ Training for developers and contractors.
- ❒ Water quality assessments during site planning.
- ❒ Goal of minimum added pollutants for final projects future.
- ❒ Site inspection and enforcement procedures during and after construction.

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TABLE 1.2 COMMON SOURCES OF POLLUTANTS IN URBAN RUNOFF

Pollutant	Automobile/ Atmospheric Deposit	Urban Housekeeping/ Landscaping Practices	Industrial Activities	Construction Activities	Non-Storm Water Connections	Accidental Spills & Illegal Dumping
SEDIMENTS	X	X	X	X		
NUTRIENTS	X	X	X	X	X	X
BACTERIA AND VIRUSES		X		X	X	X
OXYGEN DEMANDING SUBSTANCES		X	X	X	X	X
OIL AND GREASE	X	X	X	X	X	X
Anti-Freeze	X	X		X	X	X
Hydraulic Fluids	X	X	X	X	X	X
Cleaners and Solvents	X	X		X	X	X
HEAVY METALS						
Chromium	X	X	X	X	X	X
Copper	X	X	X			
Lead	X	X	X			
Zinc	X	X	X			
Iron	X	X	X			
Cadmium	X		X			
Nickel	X		X			
Manganese	X		X			
Paint	X		X			
Wood Preservatives		X X		X X	X X	X X
TOXIC MATERIALS						
Fuels	X					
PCBs	X		X	X	X	X
Pesticides	X				X	X
Herbicides	X	X	X X	X X	X X	X X
FLOATABLES		X	X	X		X

References: Minnesota PCA (1989); Berman, L., et al. (1991); Woodward-Clyde (1990); USEPA (1991); Schueler (1987); Beaton, J., et al. (1972); and Oberts, G. (1986).

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floatables. These pollut[illegible] and their impacts on water quality and aquatic habitat are described as follows:

- *Sediment* is a common component of storm water, and is a pollutant in its own right. Excessive sediment can be detrimental to aquatic life (primary producers, benthnic invertebrates and fish) by interfering with photosynthesis, respiration, growth, and reproduction. In addition, the sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons (APWA, 1981).

- *Nutrients* including nitrogen and phosphorous are found in storm water. These nutrients can result in excessive or accelerated growth of vegetation or algae resulting in impaired use of water in lakes and other sources of water supply. For example, nutrients have led to a loss of water clarity in Lake Tahoe. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish.

- *Bacteria and viruses* are common contaminants of storm water. For separate storm drain systems, main sources of these contaminants are animal excrement and sanitary sewer overflows. High levels of coliform bacteria in storm water have led to the closure of waterways such as the beaches in Santa Monica Bay (Gold, et al., 1992).

- *Oxygen demanding substances* including plant debris (such as leaves and lawn-clippings), animal excrement, street litter, and organic matter are commonly found in storm water (USEPA, 1992; Woodward-Clyde, 1990). Such substances depress the dissolved oxygen levels in streams, lakes, and estuaries.

- *Oil and grease* contain a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations (Woodward-Clyde, 1990). The main sources of oil and grease are leakage from engines, spills at fueling stations, overfilled tanks, restaurant grease traps, and waste oil disposal (Berman, L., et al, 1991).

- *Lead, zinc, cadmium, and copper* are the heavy metals found most commonly in storm water. Chromium and nickel are also frequently present (USEPA, 1983). Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies (see Table 1.1). Storm water runoff is considered a major source of metals that have accumulated in the sediment of South San Francisco Bay. This accumulation has resulted in restricted water uses and impaired aquatic habitat.

Table 1.1 Runoff Concentrations and Freshwater Water Quality Objectives (ug/l) of Various Metals from Three Land Use Categories

Metals	Water Quality Obj. (a)	Land Use Category(b)		
		Resid/ Comm.	Indust. Sites	Open Space
Cadmium	0.66 (c)	1.3	5.5	0.5
Chromium (d)	11	14	33	8
Copper	6.5 (c)	31	49	6
Lead	1.3 (c)	37	121	2
Nickel	88 (c)	25	48	8
Zinc	59 (c)	200	1324	7

(a) Freshwater aquatic life 4-day average objective from California Inland Surface Waters Plan. Objectives are written in terms of total recoverable concentrations. Runoff concentrations are total concentrations.
(b) Concentrations reported as median values (Woodward-Clyde, 1989).
(c) Objective is calculated based on an assumed hardness in the receiving water of 50 mg/L as $CaCo_3$
(d) Objective is for hexavalent chromium.

- *Other toxic materials* (priority pollutants) may be found in storm water in low concentrations. Pesticides, phenols, and polynuclear or polycyclic aromatic hydrocarbons (PAHs) are the organics most frequently found in storm water (City of Seattle, 1989).
- *Floatables* in storm water are pollutants that may contain significant amounts of heavy

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ANNUAL INSPECTION CHECKLIST
and Summary of Activities

Storm Water Pollution Prevention Plan (SWPPP)

The following procedures have been properly implemented.

_____ Hazardous waste area

_____ Spill Prevention and Response

_____ Good housekeeping practices

_____ Preventative maintenance of equipment

_____ Storm water best management practices
(such as berming, bio-remediation)

_____ Employee training

_____ Inspections

_____ Non-storm water discharges

_____ Record keeping

Monitoring Plan

☐ Dry season observations were made and recorded.

☐ Wet season observations were made and recorded.

☐ Sample collections made according to instructions and recorded.

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TABLE 1.3 EXISTING REGULATIONS FOR STORM WATER POLLUTION CONTROL

REGULATION	ACTIVITY	POTENTIAL
General Plan Law	Municipal development objectives Adoption of ordinances	Storm water management controls, e.g., pollutants control, watershed protection
California Environmental Quality Act (CEQA)	Environmental review of projects	Mitigation measures for reduction of pollutants
Subdivision Map Act	Adoption of ordinances	Standard/Regulations for grading, erosion protection, detention/retention design, and dust control
Flood Plain Management & Drainage Ordinances	Control of velocity	Control of erosion
	Detention/retention	Control of sediment, pollutants, and quantity
	Bank stabilization and outlet controls	Erosion and Sediment controls
Clean Water Act 401 and 404 Permits	Permits dredging and filling in "waters of the United States"	Erosion control, sediment control, long-term sediment balance & minimize pollutants
		Vegetative controls to preserve riparian areas
Zoning Ordinances	Cluster development	Minimize runoff & impervious areas
	Hillside development	Slope & erosion restriction. May include revegetation or stabilization.
	Landscape/open space	Vegetative BMPs perimeter controls reduction of runoff
Sewer Use Ordinance	Control of illicit connections	Pollutant controls
Uniform Building Code	Chapter 70 - Excavating & Grading	Minimize erosion & sedimentation
		Standards for stable cut & fill slopes
Uniform Plumbing Code	Prevention of illicit connection	Pollutant controls
	Various chapters on materials & application/use	Pollutant controls
Fire Code	Storage of materials	Pollutant controls
Air Quality Management Plans	Emission	Sediment & dust controls
1601 and 1603 Stream Bed Alternation Agreements	Alternations to creek and stream beds	Pollutant controls and prevent loss of habitat
Coastal Zone Act	Regulation of non-point pollution to the ocean	Pollutant controls

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Industry

Who needs the General Industrial Storm Water Permit

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Industrial Facilities
required to have a
General Industrial Storm Water Permit
and site specific plan for
management and monitoring.

- ☐ "Heavy" manufacturing facilities as defined by the SIC Codes.
- ☐ Manufacturing facilities with outdoor activities or materials exposed to storm water.
- ☐ Recycling facilities.
- ☐ Transportation facilities*
- ☐ Active and inactive mining and oil & gas facilities.
- ☐ Facilities subject to requirements of 40CFR. subchapter N.
- ☐ Hazardous waste treatment. storage or disposal facilities. landfills and open dumps.*
- ☐ Steam electric generating plants*.
- ☐ Wastewater treatment plants with design flows greater than 1 million gallons a day.*

* = Facilities that could be public or private.

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The California Administration
of the Federally mandated
General Industrial Storm Water Permit

Federal EPA Regulations (40CFR Ch.I, Part 122, Nov. 16, 1990) "designate" each State to administer the Federal mandates. In California that designation has been primarily placed under the California Water Resources Control Board, with some sections of the Federal regulations being overseen in coastal areas by the California Coastal Commission.

The State Water Resources Control Board adopted specific regulations on Nov. 19, 1991, to provide for a mandated *General Industrial Storm Water Permit*. In summary, industrial dischargers must:

- Eliminate non-storm water discharges to storm water systems.
- Develop and implement a *Storm Water Pollution Prevention Plan*
- Monitor discharges to storm water systems.

Who needs the Permit? Facilities which must apply include industrial, manufacturing, transportation and recycling operations with *Standard Industrial Classifications*(SICs) beginning with the following numbers: 24 (Except 2411 & 2434), 26 (except 265 & 267), 28, 29, 311, 32, 33, 3441, 3648, 3652, 3679, 373, 40 through 45, 5015, 5093 and 5171. [Note that, originally SICs 20, 21, 22, 23,25,27,30,35, 38, 39, and 4221-4225 were exempt unless materials were exposed to storm water, however, recent 9th District, U.S. Court of Appeals rulings 91-0200 and 90-7061 disallowed all exemptions. Therefore, any California site classified with these SIC numbers will soon be required to also obtain the General Industrial Storm Water Permit.]

Notice of Intent (NOI) to be covered by the California Permit was required by March 30, 1992. An individual site NOI must be submitted to the appropriate Regional Board and should be filed ASAP.

Storm Water Pollution Prevention Plan (SWPPP) must be developed and implemented for each location. Specific elements of the SWPPP, consistent with the Federal mandates, are detailed in the state regulations.

The Monitoring Program provision was to be implemented by January 1, 1993 per the 9/17/92 revised standards. This includes identifying monitoring locations and elements for a storm event sampling. Samples must include pH, TSS, specific conductance and TOC. Additional tests for toxic chemical and other pollutants such as metals, oils, acids, chlorinated hydrocarbons and hazardous materials listed in Code of Federal Regulations (40CFR372, 110, 117, OR 302) may also be required at specific sites.

Risks of non-compliance are high. The law allows assessment of fines of up to $25,000 per day against facilities that do not file the NOI and implement a SWPPP. Such fines may be retroactive and cumulative for the months or years prior to enforcement.

Prepared by
Pollution Program Affiliates

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WORKSHEET #5
CHECKLIST FOR CONSIDERATION OF MINIMUM BMPs

Check which of the following describe your facility.

Name of Reviewer:	Date:

Yes	No	N/A	
☐	☐	☐	Are outside areas kept neat and clean?
☐	☐	☐	Is the facility orderly and neat?
☐	☐	☐	Is process debris removed regularly?
☐	☐	☐	Is the area clear of excessive dust from industrial operations?
☐	☐	☐	Is there no evidence of leaks and drips from equipment and machinery?
☐	☐	☐	Are employees regularly informed of the importance of good housekeeping?
☐	☐	☐	Are catch basins, storm conveyance pipes, and storm water treatment facilities cleaned at the appropriate intervals (see Chapter 5)?
☐	☐	☐	Are good housekeeping procedures and reminders posted in appropriate locations?
☐	☐	☐	Are vehicle maintenance activities kept indoors and kept from "creeping" out the front door of the maintenance shop?
☐	☐	☐	Are containers for chemical substances and for temporary storage of wastes labeled?
☐	☐	☐	Is vehicle and equipment washing done in a designated area so that the wash water can be discharged to the sanitary or process wastewater sewer?
☐	☐	☐	Are regular housekeeping practices carried out?
☐	☐	☐	Is there a spill prevention and response team?
☐	☐	☐	Are appropriate spill containment and cleanup materials kept on-site and in convenient locations?
☐	☐	☐	Are cleanup procedures for spills followed regularly and correctly?
☐	☐	☐	Are used absorbent materials removed and disposed in a timely manner?
☐	☐	☐	Are personnel regularly trained in the use of spill control materials?
☐	☐	☐	Is exposed piping and process equipment regularly inspected and/or tested to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters?
☐	☐	☐	Are drainage ditches or the areas around the outfall(s) free of erosion?
☐	☐	☐	Are unpaved outdoor areas protected from water or wind erosion?

Any items checked "No" require consideration in the selection of BMPs.
N/A = Not Applicable.

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Construction

Planning for pollutant controls during construction and as part of the final project

3446

Pollution Prevention Alliance

R0036754

Construction Sites

of over 5 acres* require
storm water pollution prevention
both during construction and
as feature of the final project.

[*Note: Per 1992 9th US Circuit Court of Appeal ruling, 5 acre rule may soon change to all construction projects.]

Planning Phase

- ☐ Assessment of site conditions.
- ☐ Development of site base map including slope directions and where storm water will leave the site.
- ☐ Identify controls for during construction.
- ☐ Select Post construction BMPs for future control of pollutants.
- ☐ Establish maintenance agreements for final BMPs.

Design Phase

- ☐ Prepare project site plan.
- ☐ Define BMP objectives.
- ☐ Design post construction BMPs.

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Construction Phase

- Initial steps -
  - Prepare and submit the *Notice of Intent.*
  - Select appropriate BMPs.
  - Complete the *Storm Water Pollution Prevention Plan* (SWPPP).
- Construction operations -
  - Inspect and maintain BMPs for construction activities.
  - Construct Post-construction BMPs
  - Revise the SWPPP as construction evolves or property is sold.
- Completed construction -
  - Permanent site stabilization
  - Maintenance plan and agreement for post-construction BMPs.

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Final Project

- Typical post-construction BMPs -

  - Site stabilized by final land grades, contours and drainage patterns.

  - Volume, flow and/or velocity of storm water runoff controled by such means as detention/retention basins, porous pavement, dry wells, debris basins, etc.

  - Channel stabilization, energy dissipators, or other drainage structures.

  - Soils or slopes stabilized by permanent landscaping, rock rip rap, vegetation and other permanent ground covers.

- Urban alternative BMPs -

  - Parking lot pollutants mitigated by porous pavement and underground filtrations.

  - Filtration systems prior to project drainage leaving site.

  - Reduce flow from site by landscape design in order to percolate runoff into ground.

  - Reduce and reuse rainwater by such uses as rooftop gardens.

* * *

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TABLE 1.1 CONSTRUCTION SITE POLLUTANTS

CATEGORY	PRODUCT	POLLUTANTS
Adhesives	Adhesives, Glues Resins, Epoxy Synthetics Calks, Sealers, Putty, Sealing Agents Coal Tars (Naptha, Pitch)	Phenolics, Formaldehydes Phenolics, Formaldehydes Asbestos, Phenolics, Formaldehydes Benzene, Phenols, Naphthalene
Cleaners	Polishes, (Metal, Ceramic, Tile) Etching Agents Cleaners, Ammonia, Lye, Caustic Sodas Bleaching Agents Chromate Salts	Metals Metals Acidity/Alkalinity Acidity/Alkalinity Chromium
Plumbing	Solder (Lead, Tin), Flux (Zinc Chloride) Pipe Fitting (Cut Shavings) Galvanized Metals (Nails, Fences) Electric Wiring	Lead, Copper, Zinc, Tin Copper Zinc Copper, Lead
Painting	Paint Thinner, Acetone, MEK, Stripper Paints, Lacquers, Varnish, Enamels Turpentine, Gum Spirit, Solvents Sanding, Stripping Paints (Pigments), Dyes	VOC's Metals, Phenolics, Mineral Spirits VOC's Metals Metals
Woods	Sawdust Particle Board Dusts (Formaldehyde) Treated Woods	BOD Formaldehyde Copper, Creosote
Masonry & Concrete	Dusts (Brick, Cement) Colored Chalks (Pigments Concrete Curing Compounds Glazing Compounds Cleaning Surfaces	Acidity, Sediments Metals Asbestos Acidity
Floors & Walls	Flashing Drywall Tile Cutting (Ceramic Dusts) Adhesives*	Copper, Aluminum Dusts Minerals
Remodeling & Demolition	Insulation Venting Systems Brick, Cement, Saw, Drywall	Asbestos Aluminum, Zinc Dusts
Air Conditioning & Heating	Insulting Coolant Reservoirs Adhesives*	Asbestos Freon
Yard O&M	Vehicle and Machinery Maintenance Gasoline, Oils, Additives Marking Paints (Sprays) Grading, Earth Moving Portable Toilets Fire Hazard Control (Herbicides) Health and Safety Wash Waters (Herbicides, Concrete, Oils, Greases)	Oils and Grease, Coolants Benzene & Derivatives, Oils & Grease Vinyl Chloride, Metals Erosion (Sediments) BOD, Disinfectants (Spills) Sodium Arsenite, Dinitro Compounds Rodenticides, Insecticides
Landscaping & Earthmoving	Planting, Plant Maintenance Excavation, Tilling Masonry & Concrete* Solid Wastes (Trees, Shrubs) Exposing Natural Lime or Other Mineral Deposits Soils Additives Revegetation of Graded Areas	Pesticides, Herbicides, Nutrients Erosion (Sediments) BOD Acidity/Alkalinity, Metals Aluminum Sulfate, Sulfur Fertilizers
Materials Storage	Waste Storage (Used Oils, Solvents, Etc.) Hazardous Waste Containment Raw Material Piles	Spills, Leaks, Polluted discharge Spills, Leaks, Polluted discharge Dusts, Sediments, Polluted discharg

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Monitoring

Objectives of monitoring and overview of common urban pollutants

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STORM WATER MONITORING

OBJECTIVES OF A *MONITORING PLAN*

- ☐ Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in the Storm Water Permit.

- ☐ Ensure that pollution control practices are evaluated and revised to meet changing conditions.

- ☐ Aid in the implementation of the Storm Water Pollution Prevention Plan required by the Storm Water Permit.

- ☐ Measure the effectiveness of best management practices (BMP's) in removing pollutants in storm water discharges.

Benefits of Monitoring:

- ★ To demonstrate effectiveness of Storm Water Prevention Plan.
- ★ To illustrate whether or not continued monitoring is needed.
- ★ To ensure worker safety by showing site to beclean and toxic free.

★ *Clean sites should be publicized to your public* ★

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R0036760

Highway Runoff Constituents and Their Primary Sources

Constituents	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer applications
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material, lubricating oil and grease, bearing wear)
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails, etc.), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticake compound (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate
PCB	Spraying of highway rights-of-way, background atmospheric deposition, PCB catalyst in synthetic tires

Source: U.S. DOT, FHWA, Report No. FHWA/RD-84/057-060, June 1987.

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Potential Sources of Toxic and Hazardous Substances in Urban Runoff

	Automobile Use	Pesticide Use	Industrial/Other Use
Heavy Metals			
Copper	metal corrosion	algicide	paint, wood preservative electroplating
Lead	gasoline, batteries		paint
Zinc	metal corrosion tires, road salt	wood preservative	paint, metal corrosion
Chromium	metal corrosion		paint, metal corrosion, electroplating
Halogenated Aliphatics			
Methylene chloride		fumigant	plastics, paint remover solvent
Methyl chloride	gasoline	fumigant	refrigerant, solvent
Phthalate Esters			
Bis (2-ethylhexyl) phthalate			plasticizer
Butylbenzyl phthalate			plasticizer
Di-N-butyl phthalate		insecticide	plasticizer, printing inks, paper, resin, adhesive
Polycyclic Aromatic Hydrocarbons			
Chrysene	gasoline, oil, grease		
Phenanthrene	gasoline		wood/coal combustion
Pyrene	gasoline, oil, asphalt	wood preservative	wood/coal combustion
Other Volatiles			
Benzene	gasoline		solvent
Chloroform	formed from salt, gasoline & asphalt	insecticide	solvent, formed from chlorination
Toluene	gasoline, asphalt		solvent
Pesticides and Phenols			
Lindane (gamma-BHC)		mosquito control seed pretreatment	
Chlordane		termite control	
Dieldrin		insecticide	
Pentachlorophenol		wood preservative	wood processing
PCBs			paint electrical, insulation

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CHECKLIST FOR CONDUCTING DRY WEATHER EVALUATIONS

1. Date of inspection:
2. Facility name and address:
3. Date of last rain event:
4. Inspector name:
5. Type of outfall: Concrete __Pipe __Grassed __Rock __Other
6. Is there visible flow from the pipe? Yes No
   If yes, check all that apply. If no, go to number 7.

   __Colored water (describe) _____
   __Floating objects (describe) _____
   __Scum
   __Sludge present
   __Murky
   __Clear Water
   __Oily sheen
   __Stains on conveyance
   __Absence of plant life surrounding conveyance
   __Notable difference in plant life surrounding conveyance
   __Odor* (circle below)
   __Soda. Other:
   *e.g., rotten eggs, earthy, chemical, chlorine, soap, petroleum, gasoline, musty, other.

Estimate the flow either visually or by describing the width, height, and shape of the conveyance and the approximate percentage of the conveyance where flow is present or the approximate depth of the flow.

Describe your estimate. _____

7. Is there standing water present? Yes No
   If yes, check all that apply. If no, go the number 8.

   __Colored water (describe) _____
   __Floating objects (describe) _____
   __Scum
   __Sludge present
   __Murky
   __Clear Water
   __Oily sheen
   __Stains on conveyance
   __Absence of plant life surrounding conveyance
   __Notable difference in plant life surrounding conveyance
   __Odor* (circle below)
   __Soda. Other:
   *e.g., rotten eggs, earthy, chemical, chlorine, soap, petroleum, gasoline, musty, other.

form prepared by pPA

8. From the inspection locations, can you see any unusual piping or ditches that drain to the storm water conveyance? Yes ___ No ___
9. Is there any overland flow visible from the discharge location? Yes___ No___
10. Are there dead animals present? Yes ___ No ___

Signature: _____

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BMPs

Types of Best Management Practices

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Pollution Program Affiliates

R0036764

Adapting BMPs to urban problems

BMPs have been traditional practices for agricultural uses. These methods are designed to work with the land and the specific site to mitigate problems with the goal of preserving and enhancing useful land.

Pollutants and soil erosion harm the land and reduce productivity of a site. This is true whether it is farmland or urban locations. Not all techniques can be useful to particular sites. Adapting traditional methods must be used creatively and site specifically.

Some examples of urban adaption:

* Engineered - swales, gabions

  Manufacturing sites -
  swales placed to direct potentially polluted stormwater into clarifiers.
  Construction sites -
  swales to mitigate soil erosion during construction;
  gabions to permanently stabilize adjacent stream beds as a feature of the finished development.
  Municipalities -
  gabions to prevent bank erosion along sensitive creeks;

* Natural systems - ponds, urban forests

  Manufacturing sites -
  Infiltration trenches to collect oil and grease from parking lots;
  Construction sites -
  Vegetative practices to control soil erosion
  Infiltration ponds placed to collect and filter pollutants before entering storm drains as a feature of final development
  Municipalities -
  Urban forest practices to hold soils and prevent sedimentation.

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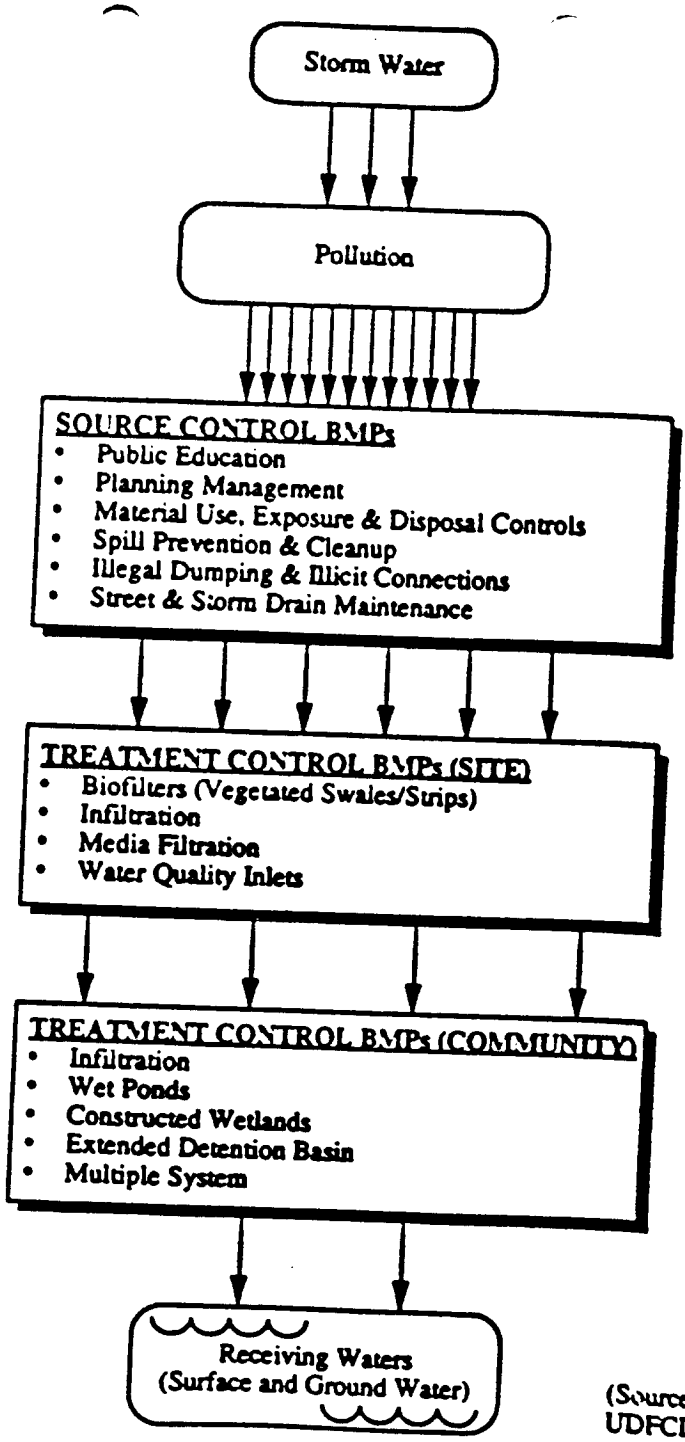

(Source: Modified from UDFCD, 1992)

FIGURE 3.1 MULTI-LEVEL STRATEGY FOR STORM WATER MANAGEMENT PROGRAM

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United States
Environmental Protection
Agency

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Handbook

Urban Runoff Pollution Prevention and Control Planning

Item 18
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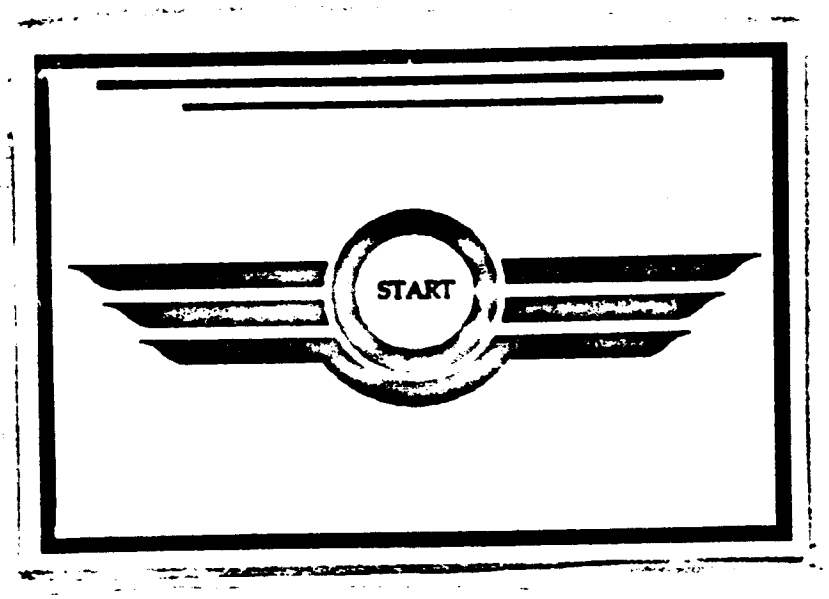

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Chapter 1
Introduction

Purpose of Handbook

Urban runoff pollution sources, including storm water, combined sewer overflows, and diffuse or nonpoint sources of water pollution, are formidable obstacles to achieving water resource goals in many municipalities. Because these types of pollution sources are best addressed locally, the U.S. Environmental Protection Agency (EPA) has prepared this handbook to provide local officials with a practical planning approach for developing and implementing urban runoff pollution prevention and control plans in urban settings.

This handbook is designed to serve as an overall reference. Other references and guidance manuals have addressed specific aspects of storm water and urban nonpoint source (NPS) control, such as best management practice (BMP) design (Schueler, 1987; Tourbier and Westmacott, 1981), monitoring (U.S. EPA, 1988), and regulatory compliance (U.S. EPA, 1991, 1992a,b,c). This handbook, however, presents a step-by-step planning approach that municipal officials can use to develop technically feasible, targeted, affordable, and comprehensive urban runoff pollution prevention and control plans. Based on information from numerous references, this handbook is both an information source for urban runoff pollution issues and a guide to the planning and implementation of effective pollution prevention measures and controls. It will also help municipalities comply with evolving environmental regulations related to urban runoff management and control.

The handbook is divided into chapters that outline a step-by-step planning process. The planning process emphasizes and addresses the following considerations:

- A multitude of diffuse pollution sources exist (e.g., combined sewer overflows (CSOs), storm water, and NPS), and each type of source often has specific regulatory requirements. The planning approach is designed to be flexible enough to address these numerous sources (including point sources) and regulations or to focus on specific sources or regulations.
- While a high level of complexity and uncertainty is unavoidable in urban runoff control planning, this handbook is designed to minimize such difficulties by identifying a clear series of logical steps for the analysis. These steps are founded on what various regulations require, what is described in the technical literature, and what is standard practice for planning. Each chapter in the handbook describes one of these steps.
- Municipalities need a flexible approach based on the problems to be solved and available resources. The handbook, therefore, presents a range of options (from simple to complex) for the major steps in the planning process. Examples of these options are provided and case study descriptions are included to demonstrate their use.
- Numerous published resources address particular aspects of or steps in the planning process. Rather than repeat this literature, this handbook refers to the best sources and shows where and how to apply them in the planning process.
- It is more cost effective to prevent potential urban runoff pollution problems and protect existing resources than to implement pollution controls once a problem exists. Therefore, this handbook emphasizes pollution prevention and the implementation of regulatory controls designed to protect existing resources.

This chapter provides an overview of urban runoff pollution issues including types of pollutants, their origins and modes of transport, and their effects on receiving waters. Chapter 2 discusses the regulatory framework and the agencies and programs that deal with urban runoff pollution prevention and control. Chapter 3 describes the planning process set forth in this document. It stresses the iterative nature of storm water and urban NPS pollution prevention and control planning, and the need to set goals that can be reassessed and refined as efforts progress. Subsequent chapters discuss each step in the planning process for the development of an urban runoff pollution prevention and control plan. The process includes

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assessment of existing conditions using available data (Chapter 4), collection and analysis of supplemental data (Chapter 5), problem assessment and ranking (Chapter 6), screening (Chapter 7) and selection (Chapter 8) of pollution prevention and control strategies, and definition of the selected plan (Chapter 9).

Target Audience of the Handbook

This handbook has been prepared for municipalities seeking to comply with evolving urban runoff regulatory requirements and to improve or protect water resources and their uses through efficient and cost-effective pollution prevention and control strategies. The information in this handbook is primarily oriented to urban and suburban communities with residential, commercial, and industrial areas. Rural communities with extensive agricultural areas are not directly addressed, although some techniques discussed in the handbook are applicable. This document can also be used by state agencies, local environmental groups, and other entities responsible for or interested in protecting water resources. The handbook can be a resource to persons of diverse backgrounds implementing an urban runoff pollution prevention and control project. For example, it can be used by a multidisciplinary team (from city or county governments) that might include engineers, biologists, planners, chemists, political officials, environmental group members, and residents, all contributing their expertise and resources to the project.

Overview of Urban Runoff Pollution

Urban runoff pollution results from numerous sources. It is the result of rainfall and snow melt that becomes contaminated as it travels through the atmosphere, along the land surface, and makes its way to a water body. Urban runoff can enter a water body from an identifiable point source, such as a separate storm sewer outfall or a combined sewer overflow. It can also flow directly into a water body without an easily identified point of entry. Regardless of the point of entry, urban runoff has diffuse origins and, therefore, is difficult to manage and control.

EPA regulates certain point source discharges of urban runoff through the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES permit requirements currently apply to urban runoff discharges from separate storm sewer systems of many large municipalities and urban counties across the country; to urban runoff discharged through a combined sewer overflow; and to urban runoff discharges from separate storm sewer outfalls that violate state water quality standards.

Since urban runoff that enters water bodies from diffuse or unidentifiable locations and sources can cause significant water quality degradation, it certainly should be addressed as part of a municipality's overall urban runoff pollution prevention and control program.

To benefit fully from the nation's urban water resources, widespread implementation of urban runoff pollution prevention measures and controls is necessary. Unlike point source control, however, institutional frameworks and funding sources to deal with urban runoff pollution are usually not well established, especially in smaller communities.

Urban runoff pollution prevention and control programs present unique challenges. Management and control programs must often be developed and implemented at the municipal level by local officials who might not be familiar with the technical and regulatory issues surrounding urban runoff pollution. The development of an urban runoff pollution prevention and control plan typically requires dealing with an extraordinary amount of ambiguity. To illustrate this complexity, Table 1-1 compares various types of water resource improvement projects. Municipal wastewater treatment projects are driven by regulations and the NPDES program requirements to control point sources with large, typically end-of-pipe methods (biological or chemical wastewater treatment), which generally do not call for land use control or involvement of multiple agencies. At the other end of the spectrum, urban runoff and nonpoint sources are inherently difficult to address because of the large number and types of diffuse discharges, the quantity and effects of which are difficult to assess. Control of such sources can require structural BMPs, stricter regulations, more comprehensive municipal maintenance programs, and environmental education for homeowners and businesses. (BMPs as used in this handbook can indicate any type of pollution control measure, including structural, regulatory, maintenance, education, or others.) A successful local urban runoff pollution prevention and control program depends on the involvement and support of multiple entities including federal agencies, state agencies, local government departments, watershed protection groups, and private citizens. Each of these groups has a stake in the program's outcome and could have significant resources to contribute.

The promulgation of EPA's storm water regulations and the evolution and strengthening of other programs, such as those dealing with nonpoint source pollution (see Chapter 2), reflect a trend—municipalities are being required to address diffuse sources of pollution to greater and greater degrees. These programs typically emphasize management, rather than treatment, and rely heavily on local control measures. Given the complexity of urban runoff pollution control and the typical scarcity of resources, municipal departments

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Table 1-1. Comparison of Water Quality Planning Projects

Project Type	Engineering Facilities	CSO Facilities	Storm Water Management	Nonpoint Source Control	Lake Restoration	Watershed Management
Regulatory basis	National Environmental Policy Act; State Construction Grant Program	EPA National Strategy; State CSO policies	Storm Water Permit Rule, 40 CFR Part 122	CWA, Section 319	CWA, Section 314	SDWA, Surface Water Treatment Rule
Type and number of pollutant sources	One or few point source(s)	Few to multiple point sources	Few to multiple piped and direct discharges	Multiple nonpoint sources	Multiple point and nonpoint sources	Multiple point and nonpoint sources
Reliability of predicting pollutant loads and impacts	High	High	Moderate	Low to moderate	Moderate	Low to moderate
Type of alternatives	Engineering	Engineering with some BMPs	BMPs and engineering	BMPs with some engineering	BMPs and in-lake	Engineering, BMPs, and in-lake
Emphasis on regulatory/land use control	Limited	Limited	High	High	High	High
Agencies needed for implementation	Few	Few	Some	Many	Some	Many

must share responsibilities, and state and federal agencies, as well as local groups, ideally should network and build coalitions. Successful control efforts require effective planning and decision-making to make the best use of available resources. Identification of high-priority problem areas and development of effective pollution prevention and control strategies are critical to a successful program.

Land development and intensive land use lead directly to many of the pollution problems associated with urban runoff. These problems can be divided into two basic categories: hydrologic impacts and pollution.

Hydrologic Impacts of Urbanization

When precipitation contacts the ground surface, it can take several paths. These include returning to the atmosphere by evaporation; evapotranspiration, which includes direct evaporation and transpiration from plant surfaces; infiltration into the ground surface; retention on the ground surface (ponding); and traveling over the ground surface (runoff). Altering the surface that precipitation contacts alters the fate and transport of the runoff. Urbanization replaces permeable surfaces with impervious surfaces (e.g., roof tops, roads, sidewalks, and parking lots), which typically are designed to remove rainfall as quickly as possible. As seen in Figure 1-1, increasing the proportion of paved areas decreases the infiltration and evapotranspiration paths of precipitation, thus increasing the amount of precipitation leaving an area as runoff.

In addition to magnifying the volume of runoff, urban development increases the peak runoff rate and decreases travel time of the runoff. When mechanisms that delay entry of runoff into receiving waters (i.e., vegetation) are replaced with systems designed to remove and convey storm water from the surface, the storm water's travel time to the receiving waters is greatly reduced, as is the time required to discharge the storm water generated by a storm. Figure 1-2 shows an urban area's typical predevelopment and postdevelopment discharge rates over time.

The following changes to hydrology might be expected for a developing watershed:

- Increased peak discharges (by a factor of 2 to 5).
- Increased volume of storm runoff.
- Decreased time for runoff to reach stream.
- Increased frequency and severity of flooding.
- Reduced streamflow during periods of prolonged dry weather (loss of base flow).
- Greater runoff and stream velocity during storm events.

Each of these hydrologic changes can lead to increased pollutant transport and loading to receiving waters. As peak discharge rates increase, erosion and channel scouring become greater problems. Eroded sediments carry nutrients, metals, and other pollutants. In addition, increases in runoff volume result in greater discharges of pollutants. Pollution problems, therefore, multiply with increased urbanization.

Changes in hydrology affect receiving waters through channel widening and subsequent streambank erosion

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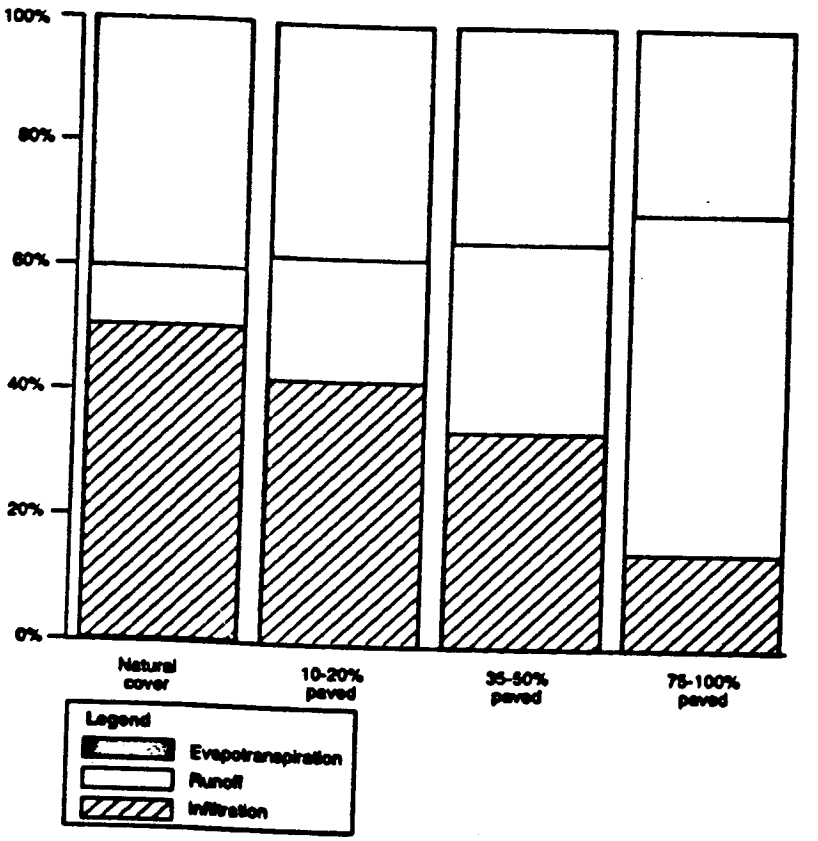

Figure 1-1. Typical changes in runoff flow resulting from paved surfaces (MPCA, 1989).

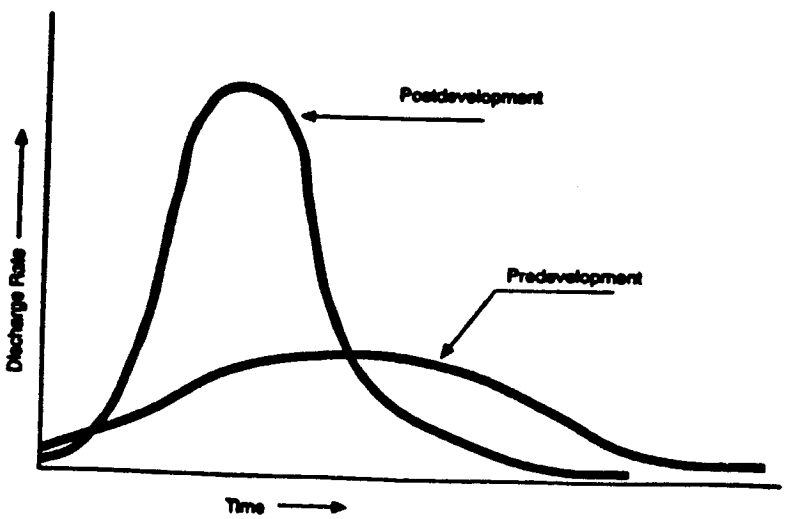

Figure 1-2. Pre- and postdevelopment hydraulics (MPCA, 1989).

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and deposition, increased stream elevation due to greater discharge rates, and an increased amount of sedimentary material within a stream due to streambank erosion. The decrease in the ground surface's infiltration capacity and loss of buffering vegetation undermines a significant mechanism for pollutant removal, thereby increasing the load entering the receiving waters. Hydrologic changes can result in more subtle but equally important impacts. Removal or loss of riparian vegetation due to erosion, for example, can increase stream temperature as levels of direct sunlight increase, which can in turn change the biological community structure. With increased sunlight, algae in nutrient-rich receiving waters grow faster and the dominant species changes, which affects the composition of higher organisms. Increased imperviousness and loss of ground-water resupply can lead to more frequent low-flow conditions in perennial streams. The effects of hydrologic changes due to urbanization therefore should be prevented or mitigated to minimize urban runoff pollution.

Further discussion of urban runoff hydrologic analysis is presented in Chapter 6. Appendix A lists sources of additional, more detailed information on the effects of urbanization on runoff and stream hydrology.

Urban Runoff Pollution

Prevention and control of urban runoff pollution requires an understanding of pollutant categories, of the major urban sources of these pollutants, and of the pollutants' effects. Table 1-2 lists the primary categories of urban runoff pollutants, pollutants associated with each category, typical urban runoff pollutant sources, and potential effects. Table 1-3 summarizes the relative contribution of predominant NPS pollution sources to the degradation of U.S. rivers, lakes, and estuaries. Additional pollutant sources often included in these categories are shown in Table 1-2. For municipalities, urban storm-generated runoff and construction are the most prevalent sources; outlying agricultural activities also can play a significant role in many urban areas.

The effects of urban runoff pollutants vary for different water resource types. A given municipality's pollutants of concern, therefore, depend on the types of water resources in and downstream of the community, and

Table 1-2. Summary of Urban Runoff Pollutants

Category	Parameters	Possible Sources	Effects
Sediments	Organic and inorganic Total suspended solids (TSS) Turbidity Dissolved solids	Construction sites Urban/agricultural runoff CSOs Landfills, septic fields	Turbidity Habitat alteration Recreational and aesthetic loss Contaminant transport Navigation/hydrology Bank erosion
Nutrients	Nitrate Nitrite Ammonia Organic nitrogen Phosphate Total phosphorus	Urban/agricultural runoff Landfills, septic fields Atmospheric deposition Erosion	Surface waters Algal blooms Ammonia toxicity Ground water Nitrate toxicity
Pathogens	Total coliforms Fecal coliforms Fecal streptococci Viruses *E. Coli* Enterococcus	Urban/agricultural runoff Septic systems Illicit sanitary connections CSOs Boat discharges Domestic/wild animals	Ear/intestinal infections Shellfish bed closure Recreational/aesthetic loss
Organic enrichment	Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Total organic carbon (TOC) Dissolved oxygen	Urban/agricultural runoff CSOs Landfills, septic systems	Dissolved oxygen depletion Odors Fish kills
Toxic pollutants	Toxic trace metals Toxic organics	Urban/agricultural runoff Pesticides/herbicides Underground storage tanks Hazardous waste sites Landfills Illegal oil disposal Industrial discharges	Bioaccumulation in food chain organisms and potential toxicity to humans and other organisms
Salts	Sodium chloride	Urban runoff Snowmelt	Vehicular corrosion Contamination of drinking water Harmful to salt-intolerant plants

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Table 1-3. Relative Contribution of Nonpoint Source Loading (U.S. EPA, 1990a)

Source	Relative Impacts, %		
	Rivers	Lakes	Estuaries
Agriculture	55.2	58.2	18.6
Storm sewers/urban runoff*	12.5	26.0	36.8
Hydrological modification	12.9	33.1	4.8
Land disposal	4.4	26.5	27.4
Resource extraction	13.0	4.2	43.2
Construction	6.3	3.3	12.5
Silviculture	6.6	0.9	1.6

* Includes combined sewer overflows.

their desired uses. While conditions are very site specific, the water resources generally most affected by certain pollutants are discussed in the following sections.

Sediments

Sediment is made up of particulate matter that settles and falls in the bottoms of ditches, streams, lakes, rivers, and wetlands. Sediment loading occurs primarily from soil erosion and runoff from construction sites, urban land, agricultural areas, and streambanks. While some sedimentation is natural, construction, farming, and urbanization accelerate the process by increasing the rates of storm water runoff, by removing cover vegetation, and by changing slopes and affecting soil stability. Increased runoff from developed areas transports solids from various sources, including deposition from erosion, litter (both manmade and naturally produced), and road sanding. These solids also carry nutrients, metals, and other substances that can affect water resources adversely.

Sedimentation can have substantial biological, chemical, and physical effects in receiving waters. Solids can either remain in suspension and settle slowly, or settle quickly to the bottom. Suspended solids can make water look cloudy or turbid, diminishing a water body's aesthetic and recreational qualities. Decreased light penetration into the water column due to increased turbidity reduces the growth of microscopic algae and submerged aquatic vegetation. Suspended solids can also threaten the survival of filter-feeding organisms (e.g., shellfish and small aquatic invertebrates), which could stop feeding or feed less efficiently. Sight-feeding predators (e.g., game fish and microscopic predatory feeders) have trouble locating prey in turbid waters and, as a result, can suffer from increased stress and decreased survival.

Deposited sediments that change the physical nature of the bottom can greatly alter hydrology and habitat and affect navigation. Sedentary, bottom-dwelling species can be smothered by accumulating sediment, and the habitat change can threaten many species that use the bottom habitat to feed, spawn, or live. Depositional sediments are also a sink for adsorbed pollutants, such as nutrients, toxic metals, and organics, which can affect both water-column and bottom-dwelling organisms. These toxic pollutants can be remobilized if sediments are disturbed and can pose a health hazard to humans through the consumption of fish and shellfish. Solids can cause problems in either the suspended or the deposited state. While less of an issue for ground water, solids can affect all surface water resource types.

Nutrients

Runoff can contain high concentrations of nitrogen and phosphorus, the nutrients of primary concern to water quality. Nutrients are associated with agricultural and urban runoff, atmospheric deposition, leachate from landfills and septic systems, and erosion. Nutrient additions can cause eutrophication, or over-enrichment, of receiving waters, stimulating algal growth. In many cases, nutrients from urban runoff originate from chemical fertilizers and thus are in a dissolved form which algae in the receiving waters can readily utilize. Traditionally, phosphorus is considered the growth-limiting nutrient in freshwater systems, while nitrogen is considered growth-limiting in marine systems. According to research in estuarine systems, however, seasonal shifts can occur between nitrogen and phosphorus enhancement of algal growth (D'Elia et al., 1986a,b).

Nutrient enrichment can result in severe algal blooms, either in the water column or in stream and lake beds (by attached forms of algae). Blooms in the water column can occur either as surface scums of blue-green algae (e.g., *Anacystis* or *Oscillatoria* blooms) or throughout the water column by numerous species of floating algae. In all cases, blooms can be transported by wind and currents, and are often concentrated along the downwind shoreline; these blooms can cause unpleasant odors and otherwise detract from the aesthetic value of the water resource. High densities of certain algal species can create taste and odor problems in drinking water from reservoirs. Some marine algal species potentially stimulated by eutrophication of coastal waters contain toxins that can be harmful to humans consuming affected fish or shellfish. In addition to increased algal densities, nutrient enrichment can lead to shifts in species composition that can profoundly affect the transfer of carbon through the food web (Sanders et al., 1987; Duguay et al., 1989).

One of the most profound effects of eutrophication is the depletion of dissolved oxygen in the water column.

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Algal cells from blooms and aquatic plants not utilized as food by fish or other aquatic species eventually settle to the bottom sediments. Bacterial decomposition of this material consumes oxygen and can lead to anoxic conditions (little or no dissolved oxygen) in the near-bottom waters. These conditions can persist for months during the summer, damaging fish habitat, creating odors, and releasing more nutrients from the sediments. This phenomenon can occur on a small scale, such as in a pond, small lake, or the quiescent embayments of lakes and rivers used for spawning, or on a very large scale such as in the Chesapeake Bay. While mobile organisms, such as many species of fish, can frequently move away from oxygen-stressed waters, sessile organisms, such as shellfish, or fish species that require high levels of oxygen, such as trout, are at much higher risk. In highly nutrient-enriched waters, a diurnal variation in dissolved oxygen concentration might occur. During daylight hours, algae produce oxygen through photosynthesis; then at night, algae consume dissolved oxygen through endogenous respiration.

Generally, nutrients cause problems that allow for the development of algal blooms in slow-moving waters, such as lakes, coastal areas, large rivers, and wetlands. Nutrients are not considered a significant problem in fast-moving urban streams, except when such streams contribute nutrient loading to other water resources.

Pathogens

Pathogens are bacteria, protozoa, and viruses that can cause disease in humans. Although not pathogenic themselves, the presence of bacteria such as fecal coliform or fecal enterococci are used as indicators of pathogens and of potential risk to human health. While detecting these indicator organisms in runoff does not conclusively prove the presence of pathogens, no more reliable system has been developed.

According to data from the Nationwide Urban Runoff Program (NURP) study (U.S. EPA, 1983), urban runoff typically contains fecal coliform densities of 10,000 (10^4) to 100,000 (10^5) organisms per 100 milliliters. While these high densities of indicator organisms do not necessarily indicate the presence of pathogens, potential health risks are associated with primary contact recreation, such as swimming; with secondary contact recreation, such as boating; and with consumption of contaminated fish and shellfish in areas affected by urban runoff.

The primary sources of bacterial and viral pathogens are runoff from livestock in agricultural areas and runoff from pet wastes and other contaminants in urban areas (ASIWPCA, 1985). Other sources of these disease-causing organisms include failed septic systems, landfills, bathers, combined sewer overflows, and unauthorized sanitary sewer connections to storm drains.

Pathogens generally cause water quality degradation in slow-moving waterways and water resources used by humans for primary and secondary contact recreation or shellfishing. Pathogens are considered pollutants of concern in drinking-water sources, slow-moving rivers, lakes, and estuaries. Pathogen-contaminated discharges to wetlands or to fast-moving urban streams are typically less of a concern because of the lack of recreational use and fishing in such waters.

Oxygen-Demanding Matter

As microorganisms consume organic matter deposited in water bodies via storm-water runoff, oxygen is depleted from the water. Organic enrichment can arise from agricultural and urban runoff, combined sewer overflows (CSOs), and leachate from septic tanks and landfills. A sudden release of oxygen-demanding substances into a water body during a storm can result in total oxygen depletion and fish kills. Organic enrichment can also have long-term effects on sediment quality, increasing organic content and the tendency of sediments to deplete surface waters and benthos of oxygen, referred to as sediment oxygen demand (SOD). The solid and dissolved organic content of water and its potential to deplete oxygen is measured by its biochemical oxygen demand (BOD).

Oxygen-demanding matter is primarily a concern in water bodies that support aquatic life, such as rivers, lakes, and estuaries. While generally a less important consideration for fast-moving urban streams and wetlands, high organic loads have been shown to cause oxygen depletion in some urban streams.

Toxic Pollutants

Toxic pollutants include metals and organic chemicals. Heavy metals in urban runoff result from sources such as the breakdown of galvanized and chrome-plated products (e.g., trash cans and car bumpers), vehicular exhaust residue, and deicing agents. Potential sources of toxic organic pollutants include vehicular residues, industrial areas, landfills, hazardous waste sites, leaking underground and aboveground fuel storage tanks, and fertilizers and pesticides. In the NURP studies (U.S. EPA, 1983), copper, lead, and zinc were detected in more than 90 percent of storm water samples from residential, commercial, and light industrial sites; 14 toxic organic compounds were detected in more than 10 percent of samples.

Potentially toxic compounds in urban runoff pollution include oil and grease products from vehicles and construction equipment. These products enter waterways in runoff from roads, parking lots, service

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areas, and construction sites, and can be constituents of landfill leachate. Such hydrocarbons frequently become adsorbed to sediment particles and are deposited in bottom sediments. These compounds are toxic to aquatic organisms and can bioaccumulate in fish and shellfish, potentially resulting in toxic effects to humans consuming this tainted food. Because of the potentially acute and chronic effects of toxic pollutants, their discharge to all water resource types should be limited.

Sodium and Chloride

Discharges of sodium and chloride to surface waters result primarily from road salting during the winter, and snowmelt during the early spring thaws. These discharges can affect the taste of drinking water, can harm people who require low sodium diets, and can result in corrosion. Also affected are salt-intolerant plant species. Sodium and chloride concentrations in runoff are typically small enough to not cause serious problems in water resources with continuous flushing (e.g., in rivers and streams). Sodium and chloride discharges are more of a concern in drinking-water supplies and water resources that are not well flushed (e.g., lakes and ground water).

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National Technical Information Service
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Springfield, VA 22161
703-487-4650

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Chapter 2
Regulatory Framework

The structure of urban runoff regulations includes all levels of government. Responsibility for enforcement and oversight of these regulations can be held by federal, state, local, or in some cases regional agencies. Despite this array of programs and regulations, the primary responsibility for developing approaches to solve urban runoff pollution problems generally resides with municipalities. Such pollution problems are considered to be best handled locally because of the site-specific nature of pollution sources and of potential pollution prevention and control activities.

The major direction for prevention and control of urban runoff pollution has come from the federal government through the 1972 Clean Water Act (CWA) and its amendments. Several sections of the Act deal with diffuse source pollution. Additional federal statutes that address urban runoff pollution include the Pollution Prevention Act, the Safe Drinking Water Act (SDWA), and the Coastal Zone Management Act (CZMA).

This chapter discusses the major federal regulations, policies, and programs related to urban runoff pollution prevention and control. Given the national scope of this handbook and the site-specific nature of state, regional, and local regulations, this chapter focuses on regulations and programs at the federal level. Currently, the major federal statutes, regulations, and programs that provide a framework for storm water runoff and NPS pollution prevention and control are:

- Storm Water NPDES Permit Program
- Combined Sewer Overflow Strategy
- Pollution Prevention Act
- Safe Drinking Water Act
- Nonpoint Source Management Program
- Coastal Zone Nonpoint Source Pollution Control
- Clean Lakes Program
- National Estuary Program
- Agricultural Nonpoint Source Programs

This chapter includes a general discussion of each of these statutes, regulations, and programs and of how they relate to urban runoff pollution control at the municipal level. Because of the dynamic, evolving nature of most of these regulations and programs, municipalities must keep up to date on specific schedules and requirements. In addition, local officials need to be familiar with urban runoff pollution prevention and control programs initiated and overseen by state, county, and local entities. These programs might stem from federal regulatory authority but will be more tailored and directly applicable to local issues and needs.

Storm Water NPDES Permit Program

Under Section 402 of the 1972 CWA, point source discharges of pollutants to navigable waters are prohibited unless authorized by an NPDES permit. Initially, the focus of the permit program was on point source discharges of industrial and municipal wastewaters. As controls for point source discharges were implemented, however, it became apparent that to achieve the water quality goals of the CWA, more diffuse sources of pollutants, including urban and agricultural runoff, also would have to be addressed.

In the 1987 amendments to the CWA, Congress introduced new provisions and reauthorized existing programs that address diffuse sources. The development of a workable program to regulate storm water discharges was challenging given the number of individual discharges, the diffuse nature of the sources and related water quality effects, and limited state and federal resources. After extended development and review, EPA promulgated the NPDES storm water regulations in November 1990. These regulations represent the most comprehensive program to date for controlling urban and industrial storm water runoff pollution. The storm water regulations apply to municipal separate storm sewer systems that serve either incorporated populations greater than 100,000 or unincorporated, urbanized populations greater than 100,000 based on the 1980 decennial census. In addition, EPA defined a discharge associated with industrial activity; activities that fall within 11 industrial categories are required to obtain a NPDES storm water permit (U.S. EPA, 1990a).

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The 1990 NPDES storm water permit regulations directly affect approximately 200 municipalities and 47 counties across the country, as well as an estimated 125,000 industries and 10,000 construction sites annually. Under this extensive program, affected municipalities and industries must conduct storm water runoff sampling and collect site characterization information for each permit application. The municipal permit application requirements include:

- Proof of the municipality's legal authority to enforce the regulations.
- Characterization of the municipality's storm water runoff through wet-weather sampling.
- Location of illicit storm drain connections and development of a plan to eliminate those connections.
- Description of existing urban runoff control programs and development of a proposed storm water management program.
- Analysis of the municipality's fiscal resources to implement the program.

Once a permit application is filed and a permit issued, both municipalities and industries are required to comply with permit conditions as specified by EPA or the responsible state permitting authority. EPA has developed general permits designed to cover many industrial storm water discharges. These general permits require the elimination of non-storm water discharges from drainage systems and the development of a storm water pollution prevention plan, including:

- Development of a pollution prevention team.
- Description of sources expected to add pollution to runoff.
- Implementation of source control practices, such as:
  - good housekeeping,
  - preventive maintenance,
  - spill prevention and response procedures,
  - equipment inspections,
  - employee training,
  - recording and internal reporting procedures,
  - removal of non-storm water discharges,
  - sediment and erosion control, and
  - management of runoff.
- Implementation of annual site-compliance evaluations.

Most municipalities in the United States have populations under 100,000 and therefore are not currently required to file municipal storm water permit applications. EPA is considering regulations to address storm water runoff pollution from smaller communities (CWA Section 402), which could be required to develop storm water management plans. In addition, existing NPDES regulations allow EPA or a responsible state permitting authority to require permits for any storm water discharges that cause violations of water quality standards.

Combined Sewer Overflow Strategy

Combined sewer overflows (CSOs) are discharges from sewer systems that are designed to carry storm water rainfall and snowmelt runoff, along with sanitary sewage, pretreated industrial wastewater, and a certain quantity of flow from storm and ground-water infiltration. Combined systems were constructed in more than 1,200 municipalities throughout the United States, particularly in the Northeast, East, and Midwest. Combined sewer systems have overflow points designed to discharge wet-weather flows that exceed the carrying capacity of the system (usually designed to carry peak dry-weather flow). Such combined sewer discharges, if not treated before overflowing into receiving waters, can significantly affect water resources and threaten human health.

Many municipalities have begun to address these pollution sources through various means, such as storing and treating the discharges, implementing low-cost BMPs, and replacing combined sewers with separate sanitary and storm sewer systems. Separating combined systems can be a long and relatively expensive process and results in a separate storm drainage system that could eventually require an NPDES permit.

To address CSO discharges, EPA developed a national strategy (Federal Register, 1989), which sets forth three major objectives in NPDES permitting for CSOs:

- To ensure that no CSOs occur during dry-weather flow conditions.
- To bring all wet-weather CSOs into compliance with the technology-based requirements of the CWA and applicable state water quality standards.
- To minimize impacts on water quality, aquatic biota, and human health from wet-weather generated overflows.

To achieve these objectives, recommended strategies include the application of the best conventional pollutant control technology (BCT), or best available technology economically achievable (BAT), based on best professional judgment (BPJ).

The technology-based effluent limitation for CSOs were mandated to include six minimum technologies:

- Proper operation and maintenance

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- Maximization of collection system storage
- Pretreatment
- Maximization of flow to treatment plant
- Elimination of dry-weather overflows
- Control of solids and floatables

Following the development of a guidance document for implementing the National CSO Strategy, three more minimum technologies were added to the list:

- CSO inspection, monitoring, and reporting
- Pollution prevention
- Public notification of CSO impacts

EPA, with input from numerous state, municipal, and environmental organizations, released a new Draft CSO Control Policy on January 19, 1993. The final policy will provide guidance to permittees on developing consistent CSO control strategies, and to NPDES permitting authorities on developing permit language and enforcement strategies that will ensure consistent implementation of control strategies.

Pollution Prevention Act

With the passage of the Pollution Prevention Act of 1990, Congress established a national policy that emphasizes pollution prevention over control or treatment. With this policy, Congress defined a pollution prevention hierarchy for all pollution reduction programs:

- Pollution should be prevented or reduced at the source whenever feasible.
- Pollution that cannot be prevented should be recycled in an environmentally safe manner.
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner.
- Disposal or other release to the environment should be a last resort and should be conducted in an environmentally safe manner.

As stated in Chapter 1, one goal of this handbook is to integrate pollution prevention into urban runoff pollution control planning. Summarizing the goals of EPA's pollution prevention program, the National Pollution Prevention Strategy serves two basic purposes:

- To provide guidance and direction for incorporating pollution prevention in EPA regulatory and nonregulatory programs.
- To set forth a program that will achieve specific pollution prevention objectives in a reasonable time period.

To address the first objective, EPA is investigating changes to the institutional barriers to pollution prevention within the Agency by:

- Designating special assistants for pollution prevention in each assistant administrator's office.
- Developing incentives and awards for Agency staff who engage in pollution prevention efforts.
- Incorporating prevention into each program office's comprehensive 4-year strategic plans.
- Providing pollution prevention training to Agency staff.
- Supporting technology innovation.
- Including prevention-related activities in the Agency's operating guidance, accountability measures, and regulatory review and development process.

To address the second objective, EPA is targeting high-risk chemicals and seeking to reduce releases of these chemicals through a voluntary program.

This pollution prevention policy was originally developed to address industrial waste issues. Since it also applies to storm water and diffuse source pollution, EPA is now emphasizing pollution prevention at the municipal level in dealing with urban runoff pollution. Municipalities are encouraged to employ techniques and policies that reduce the amount of pollutants available for transport in urban runoff. Municipalities can implement activities and use management practices that are consistent with EPA's pollution prevention policies. Such activities include public education; household hazardous waste collection; location and elimination of illicit connections to separate storm systems; reduction of roadway sanding and salting; and reduction of pesticide, herbicide, and fertilizer use. Such programs, which are discussed in later chapters, can reduce the availability of pollutants for washoff.

Safe Drinking Water Act

The Surface Water Treatment Rule (SWTR) of the SDWA outlines requirements for watershed protection. Municipalities that use surface water for drinking-water supplies are required by EPA or the approved state agency to develop a watershed protection plan for such surface waters (AWWA, 1990). Municipalities are required to:

- Develop a watershed description, including:
  - the watershed's geographic location and physical features;
  - the location of major components of the water system in the watershed;
  - annual precipitation patterns, streamflow characteristics, and other hydrology information;

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- agreements and delineation of land use and ownership.

- Identify the watershed characteristics and activities detrimental to water quality, such as:
  - the effects of precipitation, terrain, soil types, and land cover;
  - the effects of animal population;
  - point sources of contamination;
  - nonpoint sources of contamination, such as road construction, pesticides, logging, grazing animals, and recreational activities.
- Control detrimental activities by implementing appropriate control practices.
- Conduct ongoing routine and specific monitoring.

Under the SDWA, watershed control programs also must:

- Minimize potential contamination by *Giardia* cysts and viruses in the water source.
- Characterize the watershed hydrology and land ownership.
- Identify watershed characteristics and activities that threaten or harm source water quality.
- Monitor activities that threaten or harm source water quality.

These watershed control programs are designed to protect surface drinking water supplies from urban runoff and NPS pollutants, and to reduce the need for subsequent water treatment.

Nonpoint Source Management Program

A 1975 federal program designed to address NPS pollution, called the 208 program, did not lead to significant implementation. A more recent program, initiated under the 1987 CWA amendments, is one of the few federal programs that specifically addresses and provides funding for NPS control. Through this program under CWA Section 319, states must submit a Nonpoint Source Assessment Report which:

- Identifies navigable waters that do not meet applicable water quality standards.
- Identifies categories of nonpoint sources that add significant pollution to the waters not meeting water quality standards.
- Describes the process for identifying BMPs to address the identified nonpoint sources.
- Identifies and describes state programs for controlling pollution from identified nonpoint sources.

To be eligible for funding under CWA Section 319, states can use the information in Nonpoint Source Assessment Reports to develop and gain EPA approval for Nonpoint Source Management Plans. These management plans provide a framework to address the state's NPS control issues and to develop priorities for implementation. At a minimum, management plans must include:

- An identification of the BMPs selected to address the nonpoint sources identified in the Assessment Report.
- An identification of the programs to implement these BMPs.
- A schedule with annual milestones for program implementation.
- A certification of existing adequate legal authority to implement the program.
- A description of available federal and state funding sources to be used.

Through CWA Section 319, EPA has the authority to base annual NPS funding on its review and approval of these management plans. EPA usually grants funds to the state authority overseeing NPS control and allows the state authority to earmark the funds for specific programs, which are to be implemented on a watershed basis to the maximum extent possible. The priorities set in a state's management plan influence how the funds will be spent each year. Depending on the state, funding through this program could be available for a municipality, or a group of municipalities, to implement aspects of an NPS management program in a high-priority watershed. Funds from this program, however, are limited and are available mainly for demonstration projects to educate or establish the effectiveness of particular controls.

Coastal Zone Nonpoint Source Pollution Control

Under Section 6217(g) of the 1990 Coastal Zone Act Reauthorization, states with existing coastal zone management programs are required to establish coastal NPS programs approved by EPA and the National Oceanic and Atmospheric Administration (NOAA). These programs will be incorporated into the existing state NPS management plans (CWA Section 319) and state Coastal Zone Management Programs (CZMA Section 306). The purpose of Section 6217(g) is to encourage states to work with local authorities and other states to develop and implement a program of NPS pollution management to restore and protect coastal waters (U.S. EPA, 1991). This program is limited to NPS pollution control in coastal areas and the contribution of inland sources of pollution to degraded coastal water quality. In order to maintain a federally

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approved coastal zone program, states must act to reduce NPS pollution through:

- Implementing EPA-specified management measures and additional state-developed measures to control NPS pollution in impaired or threatened coastal waters.
- Modifying the state coastal zone boundary, if necessary.
- Developing enforceable policies and mechanisms to implement the Coastal Zone Act Reauthorization management measures.
- Coordinating activities with existing CWA programs, such as basin planning (Section 303), NPS planning (Section 319), and the National Estuary Program (Section 320).
- Developing a technical assistance program for local governments and the public to implement the management measures.
- Developing a public participation program.

The coastal NPS program can directly affect municipalities in coastal areas with impaired or threatened waters if they are not covered by the NPDES municipal permit program (CWA Section 402). They will likely be required by the state coastal NPS control agency to implement management practices to address NPS pollution. In addition, since this program includes a requirement for states to reassess their coastal zone boundaries, municipalities that formerly were not within coastal areas might now be included.

EPA and NOAA, along with other federal and state agencies, are developing guidance materials: a document to assist states in developing their coastal NPS pollution control program (U.S. EPA, 1991) and a document specifying management measures for controlling NPS pollution in coastal areas (U.S. EPA, 1993). This management measures guidance document includes the following information for each management measure discussed:

- A description of activity categories and applicable locations.
- A listing of the pollutants addressed.
- A description of the water quality effects of implementation.
- An outline of the expected pollutant reductions achievable.
- A cost description.
- An outline of specific factors to be considered in adapting management measures to specific sites.

The major management measure categories are agriculture, forestry, urban, marinas and recreational boating, hydromodification, shoreline erosion, and wetlands. Where the proposed management measures do not address pollution problems adequately, states must develop additional management measures to prevent and reduce nonpoint sources of pollution. States with existing coastal zone management programs will be required to implement management measures in conformity with the approved NPS measures. This requirement could result in additional urban runoff pollution prevention and control requirements on affected coastal municipalities.

Clean Lakes Program

The Clean Lakes Program, initiated in 1972 under CWA Section 314, sets goals for defining the cause and extent of pollution problems in each state's lakes and for developing effective techniques to restore these lakes. Lake protection or restoration projects should include the development of watershed assessments that consider all point and nonpoint sources affecting lake quality. Each state is encouraged to organize and administer its own lakes program and to apply for EPA grants for lakes projects that meet state and EPA criteria.

A review of statewide lake quality, to be part of the biennial state Section 305(b) report, must include:

- Identification and classification of all publicly owned lakes.
- Description of the procedures, processes, and methods to control sources of pollution.
- Description of the methods and procedures to restore lake quality.
- Description of methods and procedures to control high acidity.
- List of the lakes for which uses are known to be impaired.
- Assessment of the water quality status and trends.

Clean Lakes projects are conducted in several phases: a diagnostic/feasibility study, implementation of recommendations, and long-term monitoring. The diagnostic section of the study must consist of the following information:

- Name, location, and hydrologic characteristics of the lake to be studied.
- Geologic description of the drainage basin.
- Public access to the lake.
- Size and economic structure of the watershed's population.

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- Summary of historical lake uses.
- Adverse impacts caused by lake degradation.
- Water uses of the lake.
- Point sources of pollution to the lake and abatement actions to reduce this pollution.
- Land uses in the lake watershed.
- Discussion and analysis of historical baseline limnological data and 1 year of current limnological data as described in 40 CFR Part 35.
- Identification and discussion of biological resources in the lake.

The feasibility section should include:

- Identification and discussion of pollution control alternatives.
- Benefits expected from implementing the project.
- Long-term monitoring schedule.
- Proposed milestone implementation schedule.
- Description of how nonfederal funds will be obtained for the project.
- Relationship between the proposed lake project and other water pollution control initiatives in the area.
- Summary of public participation in developing and assessing the project.
- Operation and maintenance plan.
- Copies of all permits and impending permits applicable to the project.

Once a diagnostic/feasibility report has been submitted and approved, federal grants may be available to implement project recommendations.

National Estuary Program

With the 1987 passage of CWA amendments (Section 320), Congress created the National Estuary Program (NEP) to identify nationally significant estuaries, protect and improve their water quality, and enhance their living resources (U.S. EPA, 1990b). NEP estuary selection is based on the estuaries' potential to include environments of significant national concern and the demonstrated commitment by involved local parties to protect these valuable resources. Currently, 21 estuaries are part of the NEP (see Table 2-1). Common problems found in these estuaries include pollution from agricultural and urban runoff and waste disposal activities, as well as high levels of toxins and pathogens, excess nutrient loading, habitat loss, and declining abundance of living marine resources.

Table 2-1. Estuaries in the National Estuary Program as of 1993

Albemarle-Pamlico Sounds, NC	Narragansett Bay, RI
Buzzards Bay, MA	New York/New Jersey Harbor, NY/NJ
Casco Bay, ME	Peconic Bay, NY
Chesapeake Bay, MD/PA/VA	Puget Sound, WA
Corpus Christi, TX	San Francisco Bay, CA
Delaware Bay, DE	San Juan Bay, PR
Delaware Inland Bays, DE	Santa Monica Bay, CA
Galveston Bay, TX	Sarasota Bay, FL
Indian River Lagoon, FL	Tampa Bay, FL
Long Island Sound, CT/NY	Tillamook Bay, OR
Massachusetts Bay, MA	

Once an estuary is accepted into the NEP, EPA formally convenes a Management Conference of Agency and local representatives to develop a Comprehensive Conservation and Management Plan (CCMP) to protect the estuary. The Management Conference must also build support to carry out the CCMP recommended actions, conduct extensive research, and implement projects to improve the water quality of the estuary. These projects are usually demonstration activities implemented on a small scale, but can be applicable to larger areas of an estuary.

The NEP is not specifically designed to address the issue of NPS pollution. All 21 estuaries currently in the program have identified storm water runoff and diffuse source pollution as problems. Municipalities located within an NEP estuary's watershed might be encouraged as part of the CCMP, therefore, to address diffuse source pollution issues. In addition, the NEP is a potential funding source for urban runoff control projects. Municipalities in the watersheds of major coastal embayments should be aware of this program and understand the management structure and program objectives of local NEPs.

Agricultural Nonpoint Source Programs

While this handbook focuses primarily on storm water and NPS pollution issues in urban watersheds, many municipalities have outlying agricultural and other areas that contribute solids, nutrients, pesticides, herbicides, and pathogenic organisms to urban receiving waters. In many areas of the country, a basinwide approach must be taken to correct receiving-water impacts, and the basin is likely to contain agricultural activities. The U.S. Department of Agriculture (USDA) administers programs that address agricultural NPS problems. These programs are managed by the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS), which conduct

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research; undertake demonstration projects; develop technologies; and provide education, technical assistance, and funding (Margheim, 1990).

USDA programs do not set specific regulatory controls on agricultural practices to prevent or reduce diffuse source pollution. Rather, they provide technical assistance and cost-sharing-based funding to farmers for implementing agricultural BMPs, such as animal waste control systems, conservation tillage, vegetative buffer strips, and filter strips. Also, informational and educational services are provided through these programs by the Cooperative Extension Service.

Examples of USDA pollution control activities include:

- *Conservation operations:* Provides basic funding for technical assistance to farmers, other landowners, and units of government.
- *Small watershed projects:* Provides planning, technical, and financial assistance for implementation of BMPs in small watersheds.
- *Resource conservation and development projects:* Provides funding for personnel to coordinate interorganizational cooperation and coordination on certain environmental activities in designated multicounty areas.
- *Hydrologic unit areas:* Provides technical assistance to targeted agricultural watersheds to improve and protect water quality.
- *Demonstration projects:* Provides funding for planning, educational, technical, and financial assistance in agricultural watersheds for demonstrating and accelerating the adoption and implementation of new and innovative technologies that emphasize protecting ground water from agrichemicals.
- *Agricultural conservation program:* Shares cost of implementing agricultural conservation practices (BMPs) on farmland
- *Special projects:* Shares cost of implementing water quality BMPs in identified watersheds.
- *Other:* Accelerate technical assistance to regional projects such as National Estuary Programs; develop and transfer water quality technology, training, and public involvement; promote many locally oriented and organized water quality projects (e.g., Lakes Lay Monitoring Program, educational programs for schools, conferences on wetlands and sludge, and certification programs for pesticide use).

Summary

As demonstrated in this chapter, numerous regulations address urban runoff pollution prevention and control at the federal, state, and local levels. In planning a program, all applicable regulations should be considered and integrated. For example, the planning process outlined in this handbook can be used to develop plans to address pollution from separated or combined systems, or where both systems exist. The process applies to BMP programs both for CSO problems and for separate storm water; in many instances, both sources exist within the same watershed. It can also be used in multijurisdictional planning efforts where storm water, CSO, drinking-water protection, or other elements are controlled by different levels of state, regional, or local government.

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When an NTIS number is cited in a reference, that document is available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

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Chapter 3
The Planning Process

This chapter outlines the process for developing and initiating urban runoff pollution prevention and control plans. It also discusses the establishment and refinement of program goals. Each step in the planning process is discussed separately and in detail in subsequent chapters.

Description of the Planning Process

The planning process for urban runoff pollution prevention and control programs presented in this handbook is based on regulations that require such programs and on technical literature about planning approaches. Table 3-1 compares planning approaches required by various regulations. Despite the increasing complexities and uncertainties as one proceeds from left to right in the matrix (as was demonstrated in Table 1-1), the required planning approaches are similar. The process generally consists of the following major components:

- *Determining existing conditions:* Analyzing existing watershed and water resource data and collecting additional data to fill gaps in existing knowledge.
- *Quantifying pollution sources and effects:* Utilizing assessment tools and models to determine source flows and contaminant loads, extent of impacts, and level of control needed.
- *Assessing alternatives:* Determining the optimum mix of prevention and treatment practices to address the problems of concern.
- *Developing and implementing the recommended plan:* Defining the selected system of prevention and treatment practices for addressing the pollution problems of concern and developing a plan for implementing those practices.

Table 3-1. Planning Approaches Defined in Regulatory Programs

Project Type	Engineering Facilities	CSO Facilities	Storm Water Management	Nonpoint Source Control	Lake Restoration	Watershed Management
Regulatory basis	National Environmental Policy Act	National CSO Strategy (8/89)	Storm Water Permit Rule, 40 CFR 122	CWA, Section 319	CWA, Section 314	SDWA
Determining existing conditions	Describe existing system	Describe existing conditions	Describe existing conditions	Analyze existing conditions	Describe environmental conditions	Develop watershed description
	Develop planning criteria					
Quantifying pollution sources and water resource impacts	Collect and analyze data	Collect and analyze data	Collect and analyze data	Collect and analyze data	Conduct diagnostic survey	Identify detrimental characteristics
				Identify and rank problems		
Assessing alternatives	Develop alternatives	Develop alternatives	Developing alternatives	Screen BMPs	Conduct feasibility study	Conduct risk assessment
	Assess alternatives	Assess alternatives	Assess alternatives	Select BMPs		
Developing and implementing the recommended plan	Develop recommended plan	Develop recommended plan	Develop management plan	Develop recommended plan	Develop recommended plan	Develop detrimental activities control plan
	Develop implementation plan	Develop implementation plan	Develop implementation plan	Develop implementation plan	Develop implementation plan	

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Each regulatory program outlined in Table 3-1 addresses the same components of water quality planning but uses different language to describe the process of each component.

For example, as a result of the differing regulatory approaches, municipalities might independently conduct CSO and storm water planning. Yet since these sources of pollution often exist in the same watersheds and affect the same water resources, this fractured approach is not desirable. To address urban runoff pollution control effectively, communities must consider multiple pollution sources in planning using a watershed approach. Table 3-2 lists selected planning processes outlined in the literature, which tend to resemble those required by the regulations cited in Table 3-1. The planning process described in this handbook has been developed to be consistent with regulatory requirements as well as technical literature.

The planning approach used in this handbook (see Figure 3-1) is intended to offer municipal officials a systematic approach to developing an urban runoff pollution prevention and control plan. In general, the planning process proceeds as follows:

1. Initiate program (Chapter 3)
2. Determine existing conditions (Chapter 4)
3. Set site-specific goals

Table 3-2. Planning Approaches Defined in the Literature

Literature Reference	Urban Surface Water Management (Walesh, 1989)	Developing the Watershed Plan (U.S. EPA, 1991a)	Developing Goals for Nonpoint Source Water Quality Projects (U.S. EPA, 1991b)	Santa Clara Valley Nonpoint Source Study—Volume II: NPS Control Program. (SCVWD, 1990)	State of California Storm Water Best Management Practice Handbooks (CDM, 1993)	Urban Stormwater Management and Technology: Update and Users' Guide (U.S. EPA, 1977)
Determining existing conditions	Establish objectives and standards Conduct inventory	Identify problems and opportunities and determine objectives Develop resource data	Inventory resources and forecast conditions	Initiate public participation Define existing conditions Review regulatory problems Define goals and objectives	Define goals Assess existing conditions	Assess existing data Compare conditions vs. objectives Determine extent of runoff problem
Quantifying pollution sources and effects	Analyze data and prepare forecasts	Interpret, analyze, and evaluate data and forecasts	Identify problems Develop goals or objectives	Define and describe problems	Set priorities	Conduct selective field monitoring Refine problem estimates
Assessing alternatives	Formulate alternatives Compare alternatives and select recommended plan	Formulate and evaluate alternatives Evaluate and compare alternatives	Formulate alternatives Evaluate alternatives	Identify NPS control measures Evaluate control measures Develop evaluation criteria Examine and screen measures Select measures Reassessment of measures	Select near-term BMPs	Assess alternatives
Developing and implementing the recommended plan	Prepare plan implementation program Implement plan	Select alternative and record decision	Select best alternative and record decision	Recommend control measures and implementation program	Implement near-term program Assess program effectiveness	Determine attainable improvements

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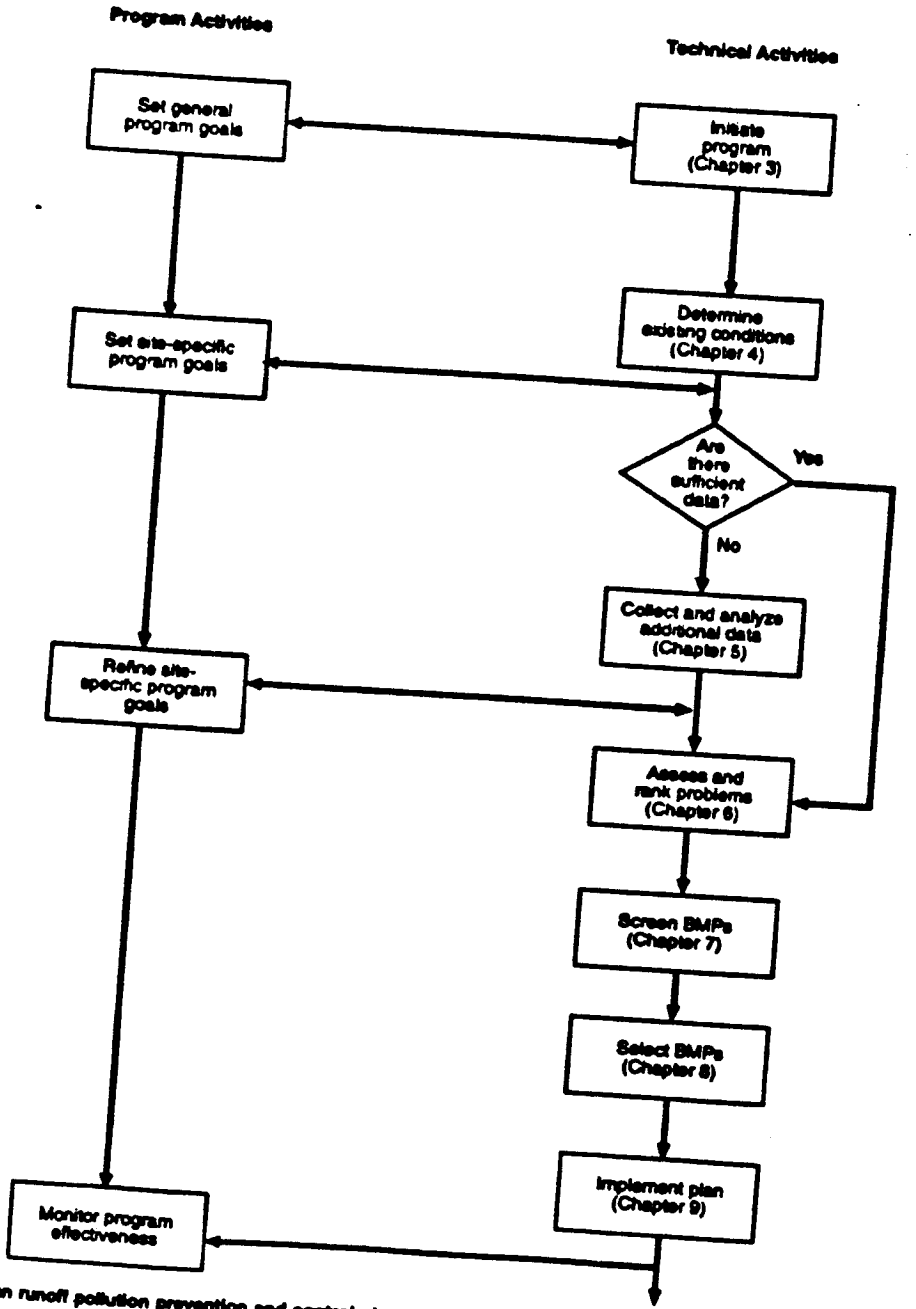

Figure 3-1. Urban runoff pollution prevention and control planning process.

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4. Collect and analyze additional data (Chapter 5)
5. Refine site-specific goals
6. Assess and rank problems (Chapter 6)
7. Screen BMPs (Chapter 7)
8. Select BMPs (Chapter 8)
9. Implement plan (Chapter 9)

While the planning process generally is intended to be followed in sequence, the process can always be altered depending on the specific situation. For example, a municipality might already have begun planning to address certain sources (e.g., storm water or CSOs). In such cases, starting later in this planning process or integrating other sources into the ongoing planning might be more efficient.

Goal setting and refinement is more appropriately shown as a parallel process rather than a specific step. Only very general goals should be considered at the outset of a program. Existing data should be assessed before setting any site-specific goals. As new data are analyzed, new findings and issues are likely to emerge. Program goals therefore must be reevaluated as the planning process progresses. Monitoring the effectiveness of what has been implemented is very important. Since further planning typically will be required, the point of reentry in the planning process needs to be flexible.

The remainder of this chapter describes each step of the planning process in greater detail. The chapter ends with a case study showing the process of setting and refining program goals for Lewiston, Maine.

Initiate Program

As a first step in the planning process, municipal officials undertaking urban runoff pollution prevention and control planning should develop an overall program structure. Early considerations include organizing a program team; establishing communication, coordination, and control procedures for members of the planning team and other participants; identifying tasks and estimating the number and types of personnel and other resources for each task; and scheduling tasks (Walesh, 1989).

For local urban runoff pollution prevention and control programs, the program team should be made up of municipal personnel: public works personnel; conservation officials; engineering personnel; parks personnel; and planning and other officials who regularly deal with or control issues such as utilities, land use and zoning, development review, and environmental issues. The team should be multidisciplinary and able to address the engineering, land use, and environmental issues that will need to be resolved. It is important to involve all entities, including political officials and the public, who have a stake in the program outcome. To win support for the end result, a shared ownership of the process is necessary. Given that municipal boundaries typically do not coincide with watershed boundaries, individuals from all affected communities should be involved in the program. Depending on the size and complexity of the program, private consulting resources might also be necessary. In addition, involving officials of other agencies at the county, state, and federal levels is prudent, especially if one of these agencies is directly responsible for controlling sources within the watershed. Also, such agencies might have regulatory oversight and might be able to contribute funding or provide technical assistance. Based on their potential contribution to the program, their role could consist of participation on a technical or management advisory group. Further discussion on program team composition is provided in Chapter 9.

Initiating the program also includes establishing the program management tasks necessary for successful program execution. Methods of project management and control might already be in effect in the municipality or may be developed specifically for the program, particularly in the case of multiagency involvement. These tasks include estimating, forecasting, budgeting, and controlling costs; planning, estimating, and scheduling the program activities; developing and evaluating quality control practices; and developing and controlling the program scope. The program team also will have to develop a funding plan, as well as a public information, education, and outreach program.

Once the program team is assembled and the program is structured, the remaining portions of the planning process can be undertaken.

Goal Setting

Setting goals is a key aspect of the planning process, and refining goals is an ongoing consideration. Projects such as those discussed in this handbook, some of which deal with multiple point and nonpoint sources, require an integrated urban runoff management program, including flood, drainage, and pollution prevention and control. Successful implementation of these programs depends on establishing clear goals and objectives that are quantitative, measurable, and flexible (U.S. EPA, 1991c). Setting goals is a process that moves from less to more specificity as additional information on the watershed and water resources is obtained. Figure 3-1 shows the iterative nature of setting program goals as the planning process proceeds. As noted earlier, site-specific goals should not be set at least until existing conditions are assessed.

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Types of Goals

The two main types of urban runoff goals are water resource- and technology-based goals. Water resource-based goals are based on receiving-water standards which consist of designated uses and criteria to protect these uses. For example, water resource-based goals may relate to uses, such as "opening half of the currently closed shellfish beds." They also may consist of more specific pollution reduction goals, such as lowering the Trophic State Index or reducing the number of oxygen-demanding substances in a lake. In addition, water resource-based goals can place numerical limits on the concentrations of specific pollutants. Further, examples of water resource-based goals include no degradation, no significant degradation, and meeting water quality standards. As a defining characteristic of water resource-based goals, the success in meeting such a goal is determined by the condition of the water resource. Applying water resource goals to urban runoff problems, however, might be difficult since water quality standards would need to be assigned to intermittent and variable events.

In contrast, technology-based goals require specific pollution prevention or control measures to address water resource problems. They can be very general, such as "implement the nine minimum technologies for CSO control," or very specific, such as "implementing runoff detention at 50 percent of the industrial sites in a watershed." A municipality might be able to determine the effectiveness of implementing these goals without conducting future water quality monitoring. With most technology-based goals, implementing the control measures is presumed to be adequate to protect water resources. Monitoring, however, is still essential after implementation to gauge the program's effectiveness and to see if the desired environmental results are being achieved.

The types of goals set by a municipality usually depend on the natural or political forces driving urban runoff control and the public's level of knowledge about the affected water body. If a community undertakes an urban runoff pollution prevention and control program because it has lost a resource (e.g., closed shellfish beds or loss of fishing or swimming areas), the community usually will set a water quality-based goal linked directly to recovering the resource. If a community expects to lose a resource from a known source (e.g., a farm located directly on a stream or frequent oil spills from an industrial plant), its goal can be specific and technology-based. On the other hand, communities that are not currently suffering from obvious problems with a water resource might launch urban runoff pollution prevention and control programs only to comply with regulations (see Chapter 2). These communities might not know or be aware of existing or potential water quality problems. Even under these conditions, however, setting general goals, such as "to meet the requirements of the regulations," is not only possible, but important. Even this general goal directs the program's focus, which then can be made more specific as more information is obtained. In these cases, the municipality typically has to rely on state-mandated goals for the specific water body of concern or general state mandates for the condition of all water bodies.

Although the water resource- and technology-based goals discussed above differ in specificity and complexity, they are all valid for an urban runoff pollution prevention and control plan. Goal-setting will focus the scope of work throughout a program.

Reassessing Goals

Far from static statements, water resource- or technology-based goals should be reassessed as appropriate in the planning process. Once early goals have been stated for a watershed or receiving water, all future actions affecting these resources can be considered against this backdrop and the goals can be reassessed. As more information is gathered, the goals can be maintained, made more specific, or changed completely. By the time the program is defined and ready to be implemented, however, fairly specific goals should exist so that program evaluators can determine whether or not goals have been met.

Determine Existing Conditions

After initiating the program, the planning team must develop a greater understanding of existing watershed characteristics and water resource conditions in order to:

- Define existing conditions pertinent to the urban runoff pollution prevention and control program.
- Identify data gaps.
- Maximize use of existing available information and data.
- Organize a diverse set of information in a useable way.

The required research is typically done by gathering existing available watershed information (e.g., environmental, infrastructure, municipal, and pollution source information), as well as receiving-water data (e.g., hydrologic, chemical, and biological data, and water quality standards and criteria). This information can be obtained from various data bases, mapping resources, and federal, state, and local agencies. The information can then be used to develop watershed maps; to determine water, sediment, and biological quality; and to establish the current status of streams,

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rivers, and other natural resources. Once these data are gathered, the program team can organize the information into a coherent description of existing conditions and determine gaps in knowledge. In this way, the existing conditions of the watershed and receiving waters can be defined. This step in the planning process is discussed in Chapter 4.

Collect and Analyze Additional Data

Even under the best circumstances, municipalities usually will not have all the required information to describe adequately a program area's existing conditions. The program team, therefore, might have to gather additional information through field investigation and data collection. With this additional information and existing data, the program team can evaluate more fully the existing conditions of the watersheds and water resources of concern. Given the cost and time involved in data gathering, the program team will have to weigh the benefits of additional data collection against using limited funds for plan development and implementation. If the additional data are required, a plan to gather these data must be developed. The plan should include an assessment of available staffing and analytical resources; identification of sampling stations, frequencies, and parameters for sampling and analysis; development of a plan to manage, analyze, and interpret the collected data; and analysis of available or needed financial resources. This step in the planning process is presented in Chapter 5.

Assess and Rank Problems

Once sufficient data have been collected and analyzed, the data can then be used to assess and rank the pollution problems. Based on data gathered in earlier steps, the team will need to develop a list of criteria to assess problems. These criteria are used in conjunction with water quality assessment methods and models to determine current impacts and future desired conditions.

Having determined the problems of concern, the project team can rank these problems to set priorities for the selection and implementation of pollution prevention and control measures. The emphasis on ranking of resources and problems is central to EPA's NPS strategy. This concept assumes that focusing resources on targeted areas or sources enhances water resource improvement. Further, it assumes that demonstrating water resource benefits increases public support of urban runoff pollution prevention and control programs as citizens become more closely attuned to overall water quality goals (U.S. EPA, 1987). The municipality, therefore, should investigate the sources of pollution affecting the high-priority water bodies to determine the order in which to address these problem sources. In many cases, an analysis at the sub-basin level is needed to determine which areas of a watershed contribute the greatest loadings. The data gathered in the previous step will be particularly useful in this assessment. Also, municipalities should investigate water resources within their region to develop priorities so that limited resources can be targeted to areas with greatest potential for improvement. Various levels of detail can be used in this assessment, ranging from simple unit load methods to complex computer models. This ranking procedure, one of the more subjective and difficult steps in the urban runoff planning process, is described in Chapter 6, along with problem assessment.

As additional data are collected and evaluated, the program team should refine the goals of the program and make them more specific. For example, at the beginning of the program, the municipality might have been aware of excessive algal blooms in a lake but might not know the cause. An initial goal of the pollution prevention and control program might have been simply to eliminate these algal blooms. After further investigation and water quality sampling, the municipality might discover that continuous high phosphorus loadings are directly contributing to the algal blooms. The goal could then be made more specific by focusing on reducing or eliminating phosphorus sources. The initial goal, rather than being abandoned in favor of another goal, is refined to focus future actions on the specific causes of the water resource impairment.

Screen Best Management Practices

Once the water resource problems have been prioritized, specific water resource problems and their sources can be addressed. The program team should compile a list of various pollution prevention and treatment practices and review them for their effectiveness in solving the prioritized problems. To assist the municipality in gathering information on various practices, Chapter 7 includes brief descriptions of various nonstructural and structural practices, and includes references for additional information. Also described is the initial BMP screening step, when potential practices are reviewed for their applicability to the watershed and water resource problems of concern. While the team initially faces a large number of potential practices, obviously inappropriate practices are eliminated in this step based on criteria such as the primary pollutants removed, drainage area served, soil conditions, land requirements, and institutional structure. Following this initial screening, the program team will have a list of potential practices to be evaluated further.

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Select Best Management Practices

During this step, the program team investigates the list of potential pollution prevention and treatment practices developed from the previous step to determine which to include in the plan. More specific criteria should be used for analyzing these potential practices than during the initial screening. To make the final selection, the program team must use the analytical tools developed during the ranking and assessment of problems, as well as decision factors such as cost, program goals, environmental effects, and public acceptance. As with the initial screening step, these evaluation criteria depend on established priorities. Generally, the selection process yields a recommended system of various pollution prevention and treatment practices which together address the pollution sources of concern. Availability of required resources to implement the practices is a major consideration. If needs and resources don't match, the municipality might have to adjust its expectations to what realistically can be accomplished. Both structural and nonstructural practices might be required. This step in the planning process is discussed in Chapter 8.

Implement Plan

After choosing pollution prevention and treatment practices, the program team moves from planning to implementation, which often occurs through a phased approach. Inexpensive and well-developed practices can be implemented early in the program as pilot or demonstration studies; and these results might influence further implementation. Given the added requirements of implementation, operation, and maintenance, the original program team might expand to include members with more construction experience. Also, funding sources are needed for initial capital expenses and continuing operation and maintenance costs. Nonstructural practices must be implemented, and the team must arrange for the detailed design and construction of structural practices.

During this step, program responsibilities must be clearly delineated. All involved entities must be familiar with and accept their role in implementing and enforcing the plan. Continuing activities also should be clearly defined and monitoring schedules should be set to determine the program's effectiveness in meeting its goals. Maintenance programs should be developed so that structural practices continue to operate as intended. Finally, the municipality should be aware of available federal and state technical assistance that could help throughout implementation of the plan. This step in the planning process is discussed in Chapter 9.

Summary

This handbook is based on the process outlined in this chapter. The process includes setting goals, analyzing existing data, collecting and analyzing additional data, assessing and ranking problems, screening BMPs, selecting BMPs, and defining and implementing the plan. The process is founded on approaches described both in technical literature and in regulatory requirements. Each step should be followed to develop an effective and realistic urban runoff pollution prevention and control program.

Developing and implementing an urban runoff pollution prevention and control program at the municipal level is a multidisciplinary effort that requires a program team that has varied experience and is familiar with program requirements. The process presented in this handbook is designed to provide program teams with a step-by-step approach to conducting these types of planning programs.

Planning, however, is only the first phase in the protection of water resources. The program team should keep in mind the ultimate goals of the program. Since implementation and program assessment are important, the setting and refinement of program goals is key. By reaching an early consensus on program goals and reassessing goals during the process, the program team can increase the possibility of successful implementation. During the planning process, increasing knowledge about the area's water resources and characteristics of the watersheds should be emphasized. All these steps are important to the program's ultimate success.

The following case study outlines some of the initial steps in program development and initial goal setting for Lewiston, Maine.

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Case Study:
City of Lewiston, Maine,
CSO, Storm Water, and Nonpoint Source Planning Program

Background

The city of Lewiston, situated on the Androscoggin River, is Maine's second largest city. Lewiston and its sister city, Auburn, serve as the industrial, commercial, and service center for Maine's southern, central, and western regions. With a population of about 40,000, Lewiston has a combination of residential, commercial, industrial, and parkland use with limited agricultural land. It has seven watersheds that will be described later.

In 1991, Lewiston launched a planning program to address issues such as CSO impacts, storm water management, and nonpoint source control. Known as the city's Clean Water Act master planning program, the effort was undertaken for a number of reasons: Maine required the city to develop a facilities plan for CSO abatement, and there was potential for development of new storm water and NPS requirements at the state and federal levels. Incorporating these considerations into an overall planning effort—a proactive approach—would meet requirements of existing regulations and prepare the city for future requirements. By undertaking a program consistent with watershed needs, Lewiston chose a comprehensive rather than fragmented approach based on different, and possibly conflicting and overlapping, regulatory requirements. The city also decided to set water resource-based goals that would be as consistent as possible despite the changing regulatory environment.

Program Initiation

The city's public works department assumed responsibility for the program and formed a team that would meet regularly and guide the planning process. The team included individuals from:

- Department of Public Works
- Planning Department
- Lewiston-Auburn Water Pollution Control Authority
- Highway Department
- General public

The public works department assigned a staff person who expended a significant amount of his time to support the effort. The department also secured funding (100% from city funds), developed a scope of services, and hired an engineering consultant to perform technical tasks and provide services which were beyond Lewiston's capability or available resources.

Regulatory Setting

One of the program team's first tasks was to compile information on current federal and state regulations that potentially pertained to the planning effort. A series of contacts were made, especially with state regulatory personnel, to determine the status of regulatory activities. Information on current regulatory setting was reviewed (as summarized in Table 3-3) and appropriate state regulatory personnel were identified. Changes were occurring in several areas, especially CSO and storm water, that needed to be monitored and incorporated into the program.

Set Initial Program Goals

Using available data, initial goals were developed along with assessment of existing conditions. This assessment is described in a companion case study at the end of Chapter 4. A basic goal was that the program should result in an understanding of and compliance with current and upcoming regulations related to CSO, storm water, and NPS control. Initial goals were also established for each major watershed. The watersheds are shown in Figure 3-2, and their characteristics are listed in Table 3-4.

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Table 3-3. Federal and State Regulation of Urban Runoff

Regulation	Federal	State
Combined Sewer Overflows	National policy (currently under review)	State CSO policy (approved by EPA)
Storm Water NPDES Permits	CWA, Section 402 NPDES regulations	General permit (does not currently affect Lewiston) Future impacts Municipal permits Municipally owned industrial facilities
Pollution Prevention Act	National Pollution Prevention Strategy	Not applicable
Safe Drinking Water Act	Surface Water Treatment Rule	State allows variance; however, not applicable to Lewiston
Nonpoint Source Pollution Regulations	CWA, Section 319	General guidance from state NPS office
Coastal Zone Nonpoint Source Pollution Control	Coastal Zone Management Act, Section 6217(g)	Probably not applicable (coastal boundaries not yet determined)
Clean Lakes Program	CWA, Section 314	Limited funding for state program
National Estuary Program	CWA, Section 320	Lewiston and Auburn in upper reaches of Casco Bay watershed; CCMP being developed
Agricultural Nonpoint Source Programs	Funding and guidance provided at the state level through SCS	SCS assistance to farms; no significant farms in city
Comprehensive Planning/Growth Management	Not applicable	Growth management plans required; Lewiston obtained approval
Shoreland Zoning	Not applicable	Requires special zoning practices within 75 ft of streams and 250 ft of other water bodies; Lewiston obtained approval

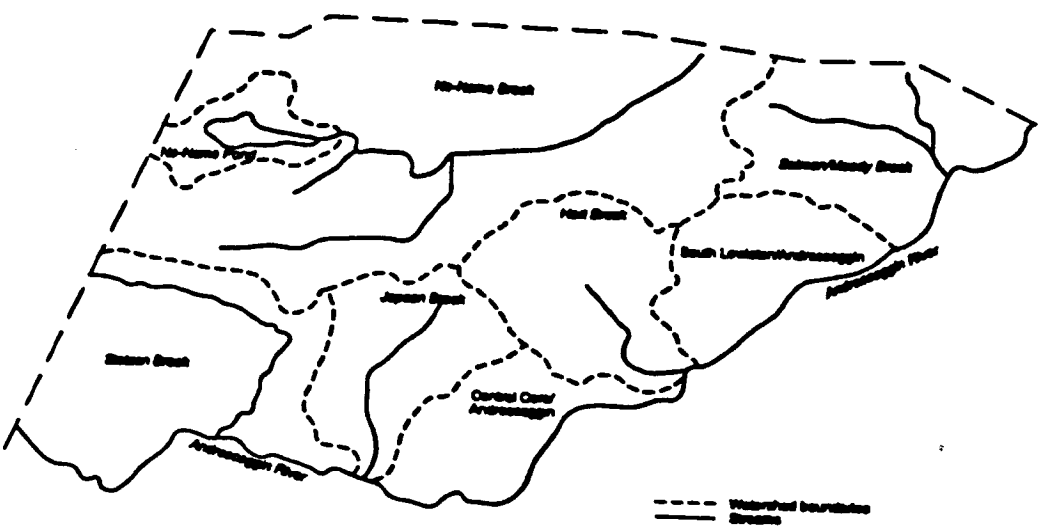

Figure 3-2. Watersheds in Lewiston, Maine.

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Table 3-4. Land Use Near Major Watersheds in Lewiston, Maine

Watershed Name	Size, ac	Land Use Description
No-Name Pond	750	Rural/residential, shore line cottages
No-Name Brook	10,000	Mainly undeveloped, some residential
Stetson Brook	3,000	Rural, residential, and commercial/industrial
Hart/Goff Brooks	1,600	Residential, commercial, and industrial
Salmon/Moody Brooks	1,900	Primarily undeveloped, minor agriculture
Jepson Brook	1,500	Residential and institutional
Androscoggin River	2,300	Urban in central core, undeveloped or industrial in outlying area

The program team held a workshop to facilitate discussion and obtain input on the city's water resources and appropriate initial program goals. A form similar to that shown in Table 3-5 was used to compile the information. Each watershed was discussed, including its water quality classifications, current uses, known problems, desired uses, and goals. A qualitative assessment or ranking of the individual watersheds was included to indicate the relative importance of the water resources to the city. This procedure was done to assist later decision-making which could involve setting priorities for funding or phasing of activities.

Table 3-5. City of Lewiston Initial Water Resources Goals

Watershed Name	Water Quality Classification	Current Uses	Known Problems	Qualitative Assessment of Importance	Desired Uses	Goals
No-Name Pond	A	Aesthetics Recreation-fishing, boating	Algal blooms Septic tank discharges	Most important town water resource	Same	Maintain and protect existing uses
No-Name Brook	C	Aesthetics	Erosion (use of ATVs) Debris	Second most important town water resource	Same	Maintain and protect existing uses Upgrade to Class B
Stetson Brook	B	Aesthetics	Erosion CSOs (one)	Third most important town water resource	Same, plus fishing	Meet Class B standards
Hart and Goff Brooks	B	Aesthetics	Erosion Industrial areas Interceptor sewer surcharging	Fourth most important town water resource	Same	Meet Class B standards
Salmon/Moody Brook	B	Aesthetics	Agriculture	Small watercourses of minor importance	Same	Meet Class B standards
Jepson Brook	B	Drainage	CSOs (no visual/odor) Debris	Channelized drainage ditch	Same	Maintain current use
Androscoggin River	C	Aesthetics Recreation-fishing, boating	Point sources (paper mills) Erosion (gravel pits) CSOs	Large regional water resource	Same	Meet Class C standards
Ground water	GWA*	Drinking water supply (for town of Lisbon)	None known	Currently of limited importance to town	Same	Maintain and protect existing uses

* Ground-water classification A.

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While the initial goals were recognized as expensive and potentially not attainable in the near future, the interactive process was desirable when feasible in terms of cost and effort. Moreover, the goals could be revised if unrealistic. Consideration was given to the existing regulatory requirements in the water quality standards (see Table 3-6). The main differences in water quality criteria for each classification are for dissolved oxygen and *E. coli* bacteria.

Table 3-6. Comparison of Maine Water Quality Standards

Classification	Designated Uses	Minimum Dissolved Oxygen		*E. coli* Bacteria	
		mg/L	% Saturation	Geometric Mean No./100 mL	Single Sample No./100 mL
AA	Drinking water (with disinfection); fishing; primary and secondary contact recreation; free flowing and natural habitat for fish and other aquatic life	As naturally occurs	As naturally occurs	As naturally occurs	As naturally occurs
A	Drinking water (with disinfection); fishing; primary and secondary contact recreation; industrial process and cooling water; hydroelectric power generation; navigation; natural habitat for fish and other aquatic life	7.0	75	As naturally occurs	As naturally occurs
B	Drinking water (with treatment); fishing; primary and secondary contact recreation; industrial process and cooling water; hydroelectric power generation; navigation; unimpaired habitat for fish and other aquatic life	7.0[a]	75[a]	64[b]	427[b]
C	Drinking water (with treatment); fishing; primary and secondary contact recreation; industrial process and cooling water; hydroelectric power generation; navigation; habitat for fish and other aquatic life	5.0	60	142[b]	949[b]

[a] From October 1 to May 14, the 7-day mean dissolved oxygen is not less than 9.5 mg/L, the 1-day minimum is 8.0 mg/L.
[b] May 15 to September 30.

In some cases, where desired uses of the water resource were being met, maintaining and protecting these uses was set as an initial goal. For some brooks, aesthetics was the only use of concern; the initial goal of meeting Class B standards was set even though the Class B standard also allows fishing and swimming. For Jepson Brook, which is a channelized drainage ditch, meeting Class B standards was not a priority. For No-Name Brook, there was a desire to upgrade the standard to Class B from Class C. Thus, the variety of watersheds and water resources was reflected in the range of initial goals.

Assessment of Existing Data

An extensive effort was made to assess existing information and data, as described in a separate case study at the end of Chapter 4. The following conclusions pertaining to the program's initial goals were based on already available data:

- The city has an aggressive and extensive regulatory control system which addresses many NPS and storm water control issues; with minor improvements, this system could fulfill the goals of maintaining and protecting existing uses.
- Virtually no water quality data or information on any of the brooks in the city are available; more information is needed to assess the existing conditions and establish goals for these systems.
- Extensive data exist on the Androscoggin River, which does not meet Class C standards; much of the pollution appears to stem from upstream sources, but the contribution of CSOs needs to be defined better.

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Future Activities

Several activities are planned for implementation. The data collection program (described in the separate case study at the end of Chapter 4) will be CSO-related and implemented in 1993. Additional data collection is being considered beyond that effort. After the initial planned data collection activities, the initial program goals are to be reviewed and refined as needed. The city is also considering changes in their current regulations to control urban runoff pollution better. Lewiston also plans to implement a cross-connection removal program. In the long term, Lewiston's Clean Water Act master planning effort plans to follow the overall planning approach outlined in this document, including data collection, refinement of program goals, data assessment and modeling, ranking of problems, and BMP screening and selection.

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Chapter 4
Determine Existing Conditions

Existing conditions must be investigated and described prior to data collection, problem assessment, and BMP evaluation. An investigation includes gathering, reviewing, analyzing, and summarizing mapping resources, hydrology, water quality and other environmental data, as well as municipal planning information for the subject region, county, municipality, or watershed. A description of existing conditions has two major components:

- Watershed description, which characterizes the sources of runoff and the "causes" of water resource problems.
- Receiving-water description, which characterizes the receptors of the watershed sources and their effects.

The watershed description defines the watershed area and its subwatersheds and further identifies pertinent geographic and environmental features (e.g., land use, geology, topography, and wetlands), infrastructure features (e.g., sewerage and drainage systems), municipal data (e.g., population, zoning, regulations, and ordinances), and potential pollution source data (e.g., in-stream sediments, landfills, underground tanks, and point source discharges). The receiving-water description provides water resource information for water bodies affected by the watershed, which can include any type of receiving water (e.g., rivers, streams, lakes, and estuaries) and its sediment and biota as well as ground water.

This chapter describes an approach and rationale for defining and assessing existing conditions. The objectives are to develop a convenient way to organize information, to develop a definition of existing conditions pertinent to urban runoff pollution prevention and control, to identify data gaps to be addressed under a field sampling program, and to maximize use of existing available information. Extensive applicable information usually is available from municipal government departments, state and federal agencies, and private vendors, as well as from files and data bases of maps and environmental data. The more persistent and thorough the investigator, the more information is obtained. These early efforts support future phases of planning by:

- Providing a basis for establishing and reassessing water resource protection and improvement objectives.
- Identifying pollutants of concern and related effects on water resources.
- Providing a base map for locating pollution sources and controls.
- Defining areas of concern where pollutant loadings pose a high environmental or public health risk and where source control efforts should be focused.
- Providing information for development of water quality models, if needed.
- Planning, designing, and implementing BMPs.
- Evaluating post-implementation improvements and beneficial use attainment.
- Identifying areas of good water quality and high value to focus protection efforts.

This chapter first discusses how to prepare a watershed description, including the types of information needed, sources of watershed mapping and data, and methods for organizing and presenting the information. For areas where watershed mapping does not exist or needs to be verified, techniques to develop mapping are discussed. Next, the chapter describes developing a receiving-water description including the types of water resource data useful in investigating pollution sources and assessing receiving water conditions, sources of data, and methods for organizing and evaluating the information.

Preparing a Watershed Description

The watershed is the entire surface area that drains into a particular water body. Runoff from precipitation falling on the watershed flows through systems of storm sewers, channels, gullies, and streams to the lowest elevation, usually to a river, lake, or estuary. Multiple watersheds often exist in a study area because many urban runoff pollution prevention and control programs are based upon political boundary areas, such as the limits of a municipality.

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The first step in describing each watershed is to delineate the watershed and smaller watersheds or subwatersheds within it, some of which might be identified later in the planning process as significant contributors to water resource impacts. Once the areas are delineated, the municipalities and other entities with jurisdiction for actions within them should be identified.

In many states, watershed delineation mapping is available either on large base maps or through a digital mapping resource. If mapping is not readily available, however, watershed delineation can be done using topographical maps; watersheds can be delineated by connecting the points of highest elevation on land surrounding the subject water body. Watershed maps can be prepared using town or county topographic maps, which are typically available at scales suitable for use as a base map. These scales range from 1 in=200 ft for small watersheds, to 1 in=2,000 ft or higher for large watersheds. The watershed map will serve as the base map for additional data.

Types of Watershed Data

Table 4-1 outlines the types of mapping available for preparing a watershed description and the pertinent information in these sources. Land use data are especially important to obtain given the relationship between land use and urban runoff pollution (see Chapter 1). Land use information can be separated into either a few general categories or many specific categories; an appropriate level of detail should be selected before undertaking a mapping effort. Table 4-2 presents two options: 9 general categories of land use and 37 specific categories. In addition to these options, combinations of the two may also be considered. Classifications should be selected based on the diversity of land use types in the watershed and the level of detail of existing information. They can also be selected so that they are consistent with local zoning. At a minimum, however, classification should include major categories of land use, such as residential areas, commercial and industrial developments, agricultural operations, forested areas, open space and park land, and other significant land uses that could affect water resources.

Once the watersheds are delineated on a base map and land use categories have been selected, additional features and data for each watershed are compiled. Pertinent information includes:

- Environment
  - topography,
  - land use,
  - recreational areas (e.g., beaches, boating areas),
  - soil and surface/bedrock geology,
  - vegetation,
  - natural resources (i.e., wetlands, wildlife resources, and shellfish beds),
  - temperature,
  - precipitation, and
  - hydrology.
- Infrastructure
  - roads and highways,
  - storm drainage systems,
  - sanitary sewer systems,
  - treatment facilities, and
  - other utilities (i.e., water, electric, gas).

Table 4-1. Use of Mapping Resources for Urban Runoff Planning

Types of Mapping	Use in Urban Runoff Planning
Drainage basins	Identify and delineate subwatersheds Identify and delineate pollution sources
Topographical	Delineate drainage areas, slopes, and patterns Calculate hydrologic model variables Identify areas prone to erosion
Land use	Qualitatively analyze runoff quantity and quality Identify land use trends Assess effects of land use on water quality Locate potential sites for installation of control structures
Soil/geology	Evaluate erosion potential Determine infiltration capacity for BMP design Determine depth to bedrock Identify depth to water table Determine treatability of soil column
Vegetation	Identify areas protected by wetland regulations Identify vegetative buffers Identify undeveloped areas (e.g., forested areas)
Zoning	Identify priority areas based on type of development Identify potential areas of future development Evaluate zoning changes and other regulatory controls
Infrastructure	Locate drainage system discharges Design drainage system modifications Identify opportunities for retrofit Design storm water sampling program Locate existing control practices Locate utilities for placement of controls
Assessor maps	Determine land ownership
Aerial photographs	Determine land use Identify resource areas Identify areas of erosion
Water bodies	Delineate potential problem areas Identify pollutant transport considerations

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Table 4-2. Land Use and Land Cover Classification System (Anderson, 1976)

Level I	Level II
1. Urban or developed land	11. Residential 12. Commercial and services 13. Industrial 14. Transportation, communications, and utilities 15. Industrial and commercial complexes 16. Mixed urban or developed land 17. Other urban or developed land
2. Agricultural land	21. Cropland and pasture 22. Orchards, groves, vineyards, nurseries, etc. 23. Confined feeding operations 24. Other agricultural land
3. Rangeland	31. Herbaceous rangeland 32. Shrub and brush rangeland 33. Mixed rangeland
4. Forest land	41. Deciduous forest land 42. Evergreen forest land 43. Mixed forest land
5. Water	51. Streams and canals 52. Lakes 53. Reservoirs 54. Bays and estuaries
6. Wetland	61. Forested wetlands 62. Nonforested wetlands
7. Barren land	71. Dry salt flats 72. Beaches 73. Sandy areas other than beaches 74. Bare exposed rock 75. Strip mines, quarries, and gravel pits 76. Transitional areas 77. Mixed barren land
8. Tundra	81. Shrub and brush tundra 82. Herbaceous tundra 83. Bare-ground tundra 84. Wet tundra 85. Mixed tundra
9. Perennial snow or ice	91. Perennial snowfields 92. Glaciers

- Municipality
  - population,
  - zoning,
  - land ownership,
  - regulations,
  - ordinances, and
  - municipal source control BMPs (e.g., street sweeping and catch basin cleaning).
- Potential pollution sources/existing structural BMPs
  - landfills,
  - waste handling areas,
  - salt storage facilities,
  - vehicle maintenance areas,
  - underground tanks,
  - NPDES discharges,
  - pollution control facilities,
  - retention/detention ponds, and
  - flood control structures.

Once these data are collected, some can be plotted on the watershed base map if useful.

Sources of Watershed Mapping and Data

Watershed data are site specific and can be obtained from municipal government departments, state and federal agencies, and private vendors, and by searching files and data bases of maps and environmental data. Much of this information is contained in reports and maps dealing with the watershed. At the federal and state levels, mapping is increasingly available in digital form that can be downloaded to a geographic information system (GIS)—a flexible and powerful computer-based tool that can store, display, and analyze geographical information. Digital data for use with a GIS are available from data bases maintained by many state and federal agencies, and the private sector. Two major sources of watershed data are U.S. Geological Survey (USGS) maps and aerial photographs. USGS maps depict many of the land attributes shown in Table 4-2, including urban, residential, forested, and wetland areas, as well as roads, buildings, and water bodies. Aerial photographs can provide a high level of detail on land use and also can be used later in the assessment and ranking of pollution sources. Aerial photographs are generally sold as 9 in by 9 in prints that cover about half a square mile; thus it may be necessary to overlap a number of photographs to map an entire study area. Satellite imagery is also available from several sources, but this tool is more useful for a regionwide analysis and might not provide the resolution required for analysis of smaller watersheds. The following paragraphs summarize sources of available watershed mapping and GIS data.

Local

Existing watershed mapping is most readily available from local municipal government departments that use mapping to track property ownership, plan for future development, maintain public utilities, and enforce environmental regulations. Potential local sources of mapping include the following municipal offices:

- *Assessor:* Maps of individual parcels, data on parcel size and property ownership.
- *Planner:* Land use maps, aerial photographs, zoning maps.
- *Engineer:* Storm sewer and other utility plans and structural information.
- *Public Works:* Utilities and maintenance activities.

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- *Conservation:* Mapping of wetlands, soils, and other vegetation and natural resources.
- *Water:* Supply and distribution system utilities and ownership of protected areas.
- *Health:* Septic system locations and maintenance records, status of water resources with respect to public use and consumption.
- *Other:* Watersheds and other information also might be delineated on maps prepared for special drinking water districts and flood control districts.

State

Watershed mapping might also be available from state agencies responsible for conservation, water quality, and oversight of state programs implemented at the local level, such as wetland protection and health codes. These maps, however, might not be as site specific or as current as those available from local sources and might be less accessible because of the location or the structure of state government. One method of locating mapping at the state level is to obtain a directory of state departments and services and contact those departments that would likely maintain mapping. Generally the following types of information are available:

- *State environmental agency:* Water quality data, previous studies, existing controls, NPDES permits, and compliance data.
- *Conservation districts:* Farm locations and inventories, locations of existing agricultural BMPs, soil descriptions.
- *Water resources:* Watershed delineations, locations of potential pollution sources, status of water courses, locations of public drinking water supplies.
- *Wetlands and wildlife:* Locations of protected wetlands and other habitat areas.
- *State colleges and universities:* Mapping as part of research, government contracts, or graduate program studies at institutions with programs in environmental engineering or science, civil or agricultural engineering, or biology.

In addition, some states offer an extensive list of GIS data. Data typically available from state GIS agencies include: topography, state plane coordinates, community boundaries, hydrography, major roads, land use, major drainage basins and sub-basins, aquifers, public water supplies, EPA-designated sole source aquifers, surficial geology, census data, hypsography, and protected open space. Each data type exists as a separate "layer" of digital information. Many states publish descriptions of available data layers and user services.

Federal

The federal government collects and maintains environmental mapping and data through a number of programs and agencies. Readily available sources include USGS Earth Science Information Centers, EPA regions, and other agencies. Several federal sources of mapping are listed in Table 4-3; some are national offices of federal agencies that may direct inquiries to satellite offices with data for specific regions. The federal government also has an extensive amount of GIS data available for use. Some of the more important sources of these data are shown in Table 4-4. Additional sources are available from EPA.

Table 4-3. Federal Sources of Watershed-Related Data

Source	Type of Information
U.S. Geological Survey National Cartographic Information Center 507 National Center Reston, VA 22092	Mapping of topographic features, land use, land cover, and slopes; aerial photographs; and satellite imagery
U.S. Geological Survey EROS Data Center 507 National Center Reston, VA 22092	High altitude aerial photography
U.S. Department of Agriculture Soil Conservation Service (Contact the office of SCS State Conservationist or the State Agricultural Experiment Station)	Soil survey reports that include soil maps, soil descriptions, aerial photographs, and soil management information including erosion potential, suitability for septic tank adsorption fields, and flooding frequency
Hazardous Substance Sites National Technical Information Service Computer Product Support Group 5285 Port Royal Road Springfield, VA 22161	Topography, soil types, soil conditions, and substance storage data for specific studied sites
U.S. Fish and Wildlife Service (Contact: National Cartographic Information Center P.O. Box 6567 Fort Worth, TX 76115)	Wetland mapping on USGS topographical quadrangles

Private

Numerous private firms produce mapping, GIS data, aerial photographs, and land surveys, frequently for municipal clients. Local firms involved in mapping and GIS data are listed in the yellow pages or local business directory. An extensive list of private GIS data sources and services can be obtained from private sources, such as trade journals. In addition, private colleges and universities with programs in geology, engineering, or environmental protection can be valuable sources.

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Table 4-4. Federal Sources of Geographic Information System Mapping Data

Source	Type of Information
U.S. Geological Survey Room 1C402 507 National Center Reston, VA 22092	Digital elevation models (DEMs)—digital terrain elevations at regularly spaced horizontal intervals
	Geographic names information system (GNIS)—proper names of places, features, and areas
	Planimetric data in digital line graph (DLG) form including boundaries of states, counties, and cities; transportation facilities including roads, trails; pipelines and transmission lines; hydrography including streams and water bodies; and topographical contours
	Land use and land cover (LULC) data on urban or developed land, agricultural land, rangeland, forested land, water, wetlands, barren land, tundra, and perennial snow and ice
U.S. Bureau of Census Data User Services Division Room 407 Washington Plaza Washington, DC 20233	Digital political and census data such as roads, rivers, political boundaries, address ranges, and zip codes
U.S. Fish & Wildlife Service National Wetlands Inventory 9720 Executive Center Drive St. Petersburg, FL 33702	Vegetated wetland and deep-water habitat mapping
U.S. Soil Conservation Service National Cartographic Center P.O. Box 6567 Fort Worth, TX 76115	Soils information (address shown is for the federal SCS office; soils information can also be obtained from individual state offices)

Analysis of Watershed Data

This section discusses several methods of analyzing watershed data to define existing conditions. These methods include development and use of watershed maps and analysis of existing regulatory and municipal practices and other existing BMPs.

Development of Watershed Maps

Maps are created to show watershed-related data, such as topography, land use, watersheds and subdrainage areas, soils, infrastructure, natural resources, recreational areas, special fish and wildlife habitat areas, and existing pollution control structures. All this information is important in urban runoff pollution prevention and control planning. If maps are generated from information that is several years old, field investigations might need to be conducted to verify and update the information. The most efficient way to verify this information is through a "windshield survey." In urban and suburban areas, most watershed areas are accessible by car. Field observations are compared with existing maps, and changes or additions are traced onto the base map.

When required information is not available from the sources discussed in the previous section, a more complete survey of the watershed will be required. In small watersheds of a few acres, these surveys are typically conducted by car and on foot. To conduct a survey of a large watershed, however, aerial photographs can supplement the site investigations and provide a more complete picture.

Another method of generating watershed maps is by computer. The data in a GIS are organized into thematic layers (such as land use, water bodies, watersheds, topography, or transportation) which can be overlaid and plotted in any combination. In addition, GIS systems are equipped with a data management system that can organize and store text and numerical descriptive information. This information can be very basic, such as whether a land use in a particular area is residential or industrial, or it can be very sophisticated, consisting of multiple tables of data, including land ownership information, discharge monitoring report information, soils information, or water quality information. Given the technical expertise required and the capital expenditures for computer hardware and software, the use of a GIS might not be feasible for some urban runoff pollution prevention and control program teams. A GIS requires an appropriate personal or mainframe computer and a graphics plotter.

Developing new mapping for an area, whether using GIS, aerial survey, or other means, can be expensive and time consuming. The urban runoff planning effort should not turn into a mapping and GIS effort. Since base mapping and GIS tools have numerous uses within a community, development of such a system should be considered as a separate program.

Use of Watershed Maps

Once watershed maps have been developed, additional data can be obtained by measuring the area of the watershed and its subwatersheds—useful information for calculating runoff flows and pollutant loads from the watershed. Available methods for measuring area range from manually measuring to using an electronic digitizer to using GIS software. In one method, a grid overlay is created on the watershed base map of known dimensions and the area is approximated by counting the grid squares in the watershed. Another similar method is to use a planimeter, a device designed to trace the watershed boundary. To use a digitizer, which functions as a computerized planimeter, the map is placed on a surface underlaid by an electronic grid system. The boundary of the watershed is traced with an electronic pointer which digitally records the coordinates, and the area is then calculated by

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computer. In addition, GIS software has algorithms that can be used to measure area.

Once the watersheds and subwatersheds are delineated and the existing conditions are indicated, the total area of each land use category for the entire watershed and each subwatershed can be calculated. This calculation is important because each type of land use tends to have its own pollutant loads and urban runoff pollution prevention and control issues. After the runoff from each type of land use is characterized, future changes in pollutant loading due to planned changes in land use can be estimated and used to assess potential future impacts and control scenarios. These data will be important to the problem assessment and ranking process described in Chapter 6.

Other land use analyses can be conducted by mapping and reviewing different watershed attributes. These analyses can be facilitated by creating overlays depicting individual watershed attributes or by displaying selected thematic layers on a GIS. For example, historical land use changes can be assessed by comparing historical mapping from USGS topographical maps, which are based on aerial photography and periodically updated, thus documenting land use changes over time. In many urban areas, the USGS maps exist from as early as the 1880s. Recent changes in land use can be used to focus source control efforts, to locate new sampling stations, or to modify land use regulations.

Analysis of Regulatory and Municipal Practices

Analyses of other types of watershed data generally consist of creating tabular summaries, plots and figures, or maps designed to describe the major characteristics of each data type and subtype. Public works, engineering, planning, and health department personnel can assist in developing a profile of existing regulations and practices. Table 4-5 is a simple format for presenting existing municipal practices; the information in this table is very general, indicating only whether or not certain practices are used. The comparison also can be more detailed as shown in Table 4-6, which describes the actual characteristics of each practice, such as the equipment used and frequency of actions.

In addition to these municipal practices, regulatory control practices affecting urban runoff pollution should be investigated and summarized. Table 4-7 outlines an example review of local subdivision regulations that could be used to prevent and reduce urban runoff pollution in four communities. The table analyzes the regulations' ability to provide runoff quantity control, solids control, and other pollution control. Such a review can be developed for all regulations (e.g., zoning, wetlands, earth removal, and special protection districts)

Table 4-5. Use of Nonstructural Practices in Study Area Watersheds (Adapted from Woodward-Clyde Consultants, 1989)

Control Practices	Watershed 1	Watershed 2	Watershed 3	Watershed 4
Street sweeping	Yes	Yes	No	Yes
Litter control	Yes	Yes	Yes	Yes
Public education	Yes	No	No	No
Pet waste removal	No	No	Yes	Yes
Local ordinances	Yes	No	Yes	Yes
Fertilizer control	No	Yes	Yes	Yes
Reduced sanding and salting	Yes	Yes	No	Yes
Catch basin cleaning	Yes	No	Yes	Yes
Hazardous waste collection days	Yes	Yes	No	No

Yes = Control measure exists
No = Control measure does not exist

that could affect urban runoff pollution. Generally, the municipality should investigate all aspects of current practices that could affect storm water runoff quality, including the practices and regulations shown in Tables 4-5, 4-6, and 4-7, as well as others: special requirements for stream corridor preservation, buffer zones, and open space preservation; septic system planning and testing requirements; and regulations pertaining to nontidal wetlands. These issues are discussed further in the regulatory control section of Chapter 7. An example analysis of both regulatory and municipal urban runoff practices is provided in two case studies at the end of this chapter.

Contents of a Watershed Description

Once the information on existing conditions has been gathered and the watershed maps have been developed, the watershed can be described. The watershed description is organized by data type (i.e., environmental, infrastructure, municipal, and potential sources/existing BMPs). Each data type has its own section with a narrative description of each data subtype supported by appropriate tables and/or maps. The maps and data developed in the previous steps provide the primary information in the description. While not all this information will be of immediate use to the program team at this stage, it could be important as planning continues.

Information gaps should be outlined and presented in the watershed description as a first step in developing a plan to gather additional information (see Chapter 5). A summary listing of information recommended for the

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Table 4-6. Frequency and Types of Nonstructural Practices Used in Study Area Watersheds (U.S. EPA, 1992)

	Community 1	Community 2	Community 3	Community 4
Street Sweeping				
Frequency	Every other day on 30 major streets and once a week on others	Once a week downtown and once a year in other areas	Twice a year	Once a year, except Lake Cochichewick (three times a year) and downtown (twice a year)
Equipment (number)	Mechanical (3)	Mechanical (1) Vacuum (3)	Mechanical (1)	Mechanical (2)
Catch Basin Cleaning				
Frequency	Once a year	Once a year	Twice a year	Once a year
Equipment (number)	Mechanical (1): Clamp	Mechanical (1): Orange Peel	Mechanical (1)	Mechanical (1): Orange Peel
Solid Waste Management				
Residential	Once a week	Once a week	Once a week	Once a week
Commercial	Twice a week	Private collection	Twice a week	Once a week
Recycling program	Paper Fall leaves	Paper	None	Paper Leaves/grass
Roadway Sanding and Salting				
Sand:salt ratio	4:3	1:1	4:1	7:1
Salt used (tons/road mile)	11	12	3.5	6
Special reduced-use zones	None	None	None	None
Other Nonstructural Practices				
Fertilizer and pesticide usage	None used	Fertilizer used on town ball fields	None used	Granular fertilizer used for sodding
Animal waste removal	No program	No program	No program	No program
Illicit connection identification and removal	No program	No program	No program	No program

watershed description is provided later in this chapter, and two examples are given in the case studies at the end of the chapter.

Preparing a Receiving-Water Description

In addition to a watershed description, a receiving-water description should be prepared, which includes the types of water resource data that should be sought, sources of data, and methods to summarize and analyze existing receiving-water conditions. Many program areas have multiple receiving waters, such as tributaries, larger rivers or estuaries, or lakes; in many cases, adding ground water to this list could be useful. Effective identification and use of existing water resources data could reduce the program schedule and cost, most significantly by reducing additional sampling and analysis. In addition, review of historical water quality data provides a basis for:

- Establishing and reassessing goals.
- Documenting the type and extent of urban runoff-related water resource impacts.
- Identifying data gaps that should be addressed with a sampling program.
- Identifying priority areas and major nonpoint pollution sources.
- Quantifying pollutant loads.
- Documenting impairment or loss of beneficial uses and water quality standard violations.
- Documenting areas with good water quality that could be threatened or that should be protected.

Types of Receiving-Water Data

The types of water resources data that should be sought include:

- Source input data (flow and quality)
  - CSO data,
  - storm water data, and
  - other NPS data.
- Physical/hydrologic
  - physiographic and bathymetric data,

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Table 4-7. Existing Regulatory Control Summary—Subdivision Control (U.S. EPA, 1992)

Subdivision Control	Community 1	Community 2	Community 3	Community 4
Scope of regulations	*All lots being subdivided come under Subdivision Regulations, lots on an accepted public way and with sufficient frontage are classified as "Approval Not Required"*	*All lots being subdivided come under Subdivision Regulations; lots on an accepted public way and with sufficient frontage are classified as "Approval Not Required"*	*All lots being subdivided come under Subdivision Regulations; lots on an accepted public way and with sufficient frontage are classified as "Approval Not Required"*	*All lots being subdivided come under Subdivision Regulations; lots on an accepted public way and with sufficient frontage are classified as "Approval Not Required"*
Runoff Quantity Control				
Open space	Requires due regard for maintaining natural features and open space	Requires that efforts be made to maintain natural features and open space	Requires that efforts be made to maintain natural features and open space	Requires that efforts be made to maintain natural features and open space
Postdevelopment flow control	None specified	Requires calculations showing no increase in peak flow during 100-year storm	None specified	Requires calculations showing pre- and postconstruction peak flows and total volumes for 2-, 10-, and 100-year storms
Runoff recharge	None specified	None specified	None specified	Requires that storm water be recharged rather than piped to surface waters to the maximum extent feasible
Additional Controls				
Solids control	None specified	Requires the development of a runoff control plan that minimizes erosion	None specified	Requires that an erosion control plan be developed for during and after construction
Other pollution control	None specified	None specified	None specified	None specified

- flow characteristics,
- tidal elevation in coastal areas, and
- sediment data.

- Chemical
  - water quality data and
  - sediment data.
- Biological
  - fisheries data,
  - benthos data,
  - plankton data, and
  - biomonitoring data.
- Water quality standards and criteria
  - federal criteria and
  - state standards.

These data should be gathered to help the program team develop a profile of the conditions in the water body of concern. Source discharge, water, sediment, and biological data typically will exist from past studies of the watershed. By gathering this information, a picture can be developed of existing conditions and data gaps can be identified.

Sources of Water Resources Data

A wide range of sources of existing water resources data can be found at the local, state, and federal levels. Each agency that has conducted water resource assessments in the study area should be contacted for its available data and asked about other potential sources. As this chain continues, fewer new sources are identified; diminishing returns indicate when most, if not all, available data have been obtained. The following paragraphs summarize potential, as well as established, sources of water resources data.

Local

Many municipal departments listed earlier as potential sources of mapping can also provide water resources data from previous studies, wetland or other permit applications, or routine water resources monitoring. For example, health departments typically conduct routine monitoring of water resources to protect the environment, to ensure the safety of recreational swimming areas, and to manage onsite sewage disposal systems or septic tanks. Municipal departments responsible for reviewing construction and wetlands permit applications can track local water quality conditions as part of local

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water resource regulations designed to prevent cumulative degradation of sensitive resources. Local permit applications can contain recent and historical water quality, source discharge, and hydrologic data to demonstrate compliance with local or state wetlands and water quality regulations. Receiving-water data also might be available from NPDES monitoring records, which often represent valuable information about the effects of a specific pollution source. Also data might be available for water bodies in special drinking-water or flood-control districts.

State

In most states, several agencies deal directly or indirectly with water quality issues, such as water resources, pollution control, clean lakes, transportation, fisheries, environmental review, wetlands, and coastal zone management. The agencies might also deal with water quality in terms of discharge permit applications, fisheries status reports, development review, wetlands impacts, and effects on coastal resources. Every 2 years, states prepare two reports—a Section 305(b) Water Quality Assessment Report, summarizing the status of the states' waterways, and a Section 319 Nonpoint Source Assessment Report, listing water bodies affected by nonpoint sources—that indicate sources of existing water data, programs that address NPS pollution, and sources of agency assistance. These reports are available from the state water pollution control agency or the EPA regional office. Information concerning water bodies in the Clean Lakes Program (CWA Section 314) also might be available from the state.

Federal

The federal government is an excellent source of hydrology and water resources data through agencies such as EPA, SCS, and the USGS. Table 4-8 outlines a number of major federal government sources of water resource data including water quality, hydrology, meteorology, biomonitoring, and sediment quality data. In some cases, information can be supplied through the mail; in other cases, such as the USGS National Water Data Exchange, the information can be accessed only by using a computer modem.

Analyzing Water Resources Data

Existing data collected by different local, state, and federal organizations likely were collected using different methods, at different times, and with different objectives. Each data set should, therefore, be reviewed to assess its quality and applicability to urban runoff pollution prevention and control program efforts. Although the criteria for this assessment should be site specific, basic considerations include sampling program design and quality assurance/quality control (QA/QC). Data that would be useful in the planning process can be entered into a data base to facilitate data organization, management, and analysis. One method is to enter the information into a personal computer-

Table 4-8. Federal Sources of Water Resource and Hydrology Data

Source	Type of Information
U.S. Environmental Protection Agency	
Clean Lakes Program	Water quality and other diagnostic information for lakes monitored under the Clean Lakes Program
National Estuaries Program	Water quality and other diagnostic and research data for 21 coastal embayments
Mussel Watch Program	Monitoring of mussel tissue for heavy metals and other toxic and xenobiotic compounds in areas of wastewater discharges
Ocean Data Evaluation System	Pollution sources, effluent, water quality, biological and sediment pollution data
Permit Compliance System (PCS)	Point source discharge data from NPDES monitoring programs
STORET Data	Flow and water quality data in receiving waters
U.S. Geological Survey	
Water Resources Division	Flow and water quality data collected at USGS streamflow gaging stations for rivers and streams
Water Quality Branch	Receiving waterflow and water quality data, point source data from NPDES monitoring programs
U.S. Department of Commerce	
National Climatic Center	Precipitation data and statistics from weather-monitoring stations nationwide
U.S. Food and Drug Administration	
Shellfish Sanitation Branch	Sanitary survey reports for coastal areas with shellfish habitat. Reports include shoreline surveys for actual potential pollution sources and water sampling data for total and fecal coliform
U.S. Army Corps of Engineers	
Reservoir water	Quantity and quality data
Dredging Permit Application Program	Water and sediment quality data collected in support of Clean Water Act Section 404 dredge and fill permit applications
Other	
U.S. Department of Agriculture, Soil Conservation Service	Sediment data for specific structural controls
National Oceanic and Atmospheric Administration	Marine charts for coastal areas, tide tables, and tidal current tables
Federal Emergency Management Agency	100-year flood plain elevations

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based standardized spreadsheet format that allows sorting and plotting of the data. Spreadsheets are extremely versatile and allow the user to:

- Organize data from multiple sources.
- Analyze data from individual sampling programs or of aggregate data.
- Sort data, such as by sampling station location, analytical parameter, or date of collection.
- Statistically analyze data.
- Create x-y plots of parameter concentration versus time or distance.
- Continuously update the data base.

Table 4-9 presents an example spreadsheet format with the results of example statistical calculations. Figure 4-1 illustrates an x-y plot of total suspended solids (TSS) concentrations over time at the monitoring station used in Table 4-9. More advanced applications of spreadsheets can be used for hydrologic calculations and for calculating pollutant loading based on runoff volumes and pollutant concentrations. Spreadsheets can also be used to create data input files for computer models that help evaluate pollutant concentrations in receiving waters and effects on water resources and beneficial uses.

In addition to simple spreadsheet programs for storing and organizing data, specialized database management programs can be utilized. These programs are designed specifically for organizing large amounts of data and manipulating the data to produce customized reports. These programs can often produce output for direct use in analysis programs, such as those discussed in Chapter 6. Also, since GIS applications generally use data bases to store and retrieve data for generating data layers, a GIS system could be used for analyzing the existing water resources data. In this way, the water resources information can be directly plotted on the base maps generated during the watershed description

Table 4-9. Example Water Resource Data Spreadsheet

Station[a]	Date[b]	Day[c]	Time[d]	Parameter[e]	Concentration,[f] mg/L	Flow,[g] ft³/s	Agency[h]	Method[i]
46	031985	108	0800	TSS	50	2.1	USGS	1
46	032085	110	1310	TSS	30	2	EPA	1
46	040185	122	1010	TSS	800	10.5	EPA	1
46	042985	150	1300	TSS	330	4.1	USGS	1
46	050385	154	1230	TSS	200	2.6	EPA	1
46	051385	164	1410	TSS	20	2.3	EPA	1
46	051585	166	2010	TSS	80	1.9	EPA	1
46	052085	171	1800	TSS	100	3	USGS	1
46	052985	180	1330	TSS	40	2.7	EPA	1
46	062585	207	0810	TSS	400	2.9	USGS	1
46	071785	229	2040	TSS	324	4.3	EPA	1
46	072385	235	0850	TSS	830	6.1	EPA	1
46	072685	238	1330	TSS	160	2.5	USGS	1
46	072785	239	1620	TSS	120	2.9	EPA	1
46	073185	243	1150	TSS	450	3.7	USGS	1
				Avg	286.93			
				Dev	272.08			
				Max	830			
				Min	20			

[a] The station number assigned to the collection location during the study; the same physical location may have more than one station number for surveys conducted by different agencies.
[b] Date of the sample collection.
[c] Sequential numbering of days starting with the earliest date of data collection.
[d] Time of the sample collection (HHMM).
[e] Water quality parameter (TSS = total suspended solids).
[f] Mass of constituent per unit volume.
[g] Volume per unit time during sampling.
[h] Agency conducting the survey.
[i] Analytical method (1 = Standard Method 2540 D).

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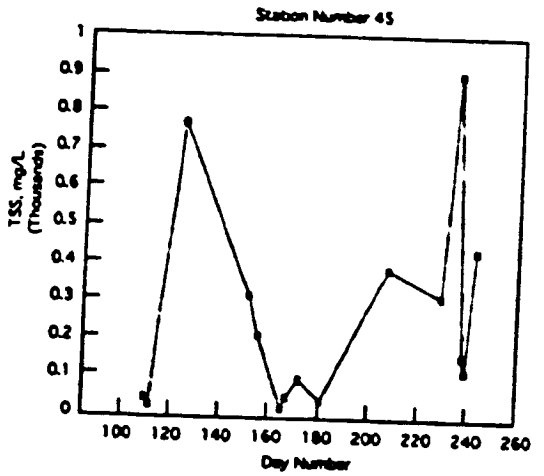

Figure 4-1. Total suspended solids (TSS) concentrations.

process, which allows the user to link watershed information, such as land use or soil conditions, directly with water resource data.

The Data Management and Analysis section of Chapter 5 discusses in more detail presenting and analyzing water resource data.

Contents of a Receiving-Water Description

After the water resource data have been gathered, a receiving-water description must be developed to describe the existing conditions of the water body being investigated. This description should include summaries of the data collected, organized by data type (i.e., physical/hydrologic, chemical, biological, and water quality standards and criteria). Each summary includes a narrative description outlining the information gathered for each data type. This information should be presented in a way that indicates existing data gaps and a priority for addressing those gaps.

Summary

This chapter discusses the collection of existing information to describe the planning area's watersheds and water resources. The information collected should concentrate on the delineation of watersheds; the description of land uses in the watersheds; and the identification of related environmental, infrastructure, municipal, and pollution source data. The water resource description should present data on physical, chemical, and biological conditions of the water body along with applicable standards and criteria. Based on the material presented in this chapter, a suggested outline for the existing conditions description is as follows:

- Project area
- Watershed data description
  - environmental data,
  - infrastructure data,
  - municipal data,
  - potential sources/existing BMP data,
  - miscellaneous data, and
  - data gaps.
- Receiving water data description
  - source input data,
  - physical/hydrologic data,
  - chemical data,
  - biological data,
  - water quality standards and criteria,
  - miscellaneous data, and
  - data gaps.
- Summary of data needs
- Refinement of goals

Expending resources at the beginning of the planning process to locate as much existing information as possible is cost effective in the long term, because it helps maximize use of existing information, minimize data collection costs, and avoid overlooking important data resources.

The information, having been gathered and analyzed, has to be examined to determine existing knowledge gaps. If necessary information is unavailable, the program team must collect additional data. The next chapter discusses obtaining and analyzing the water resource data required to describe existing conditions fully.

The program team can base site-specific program goals on the existing conditions information by examining the general initial goals and refining them. As discussed in Chapter 3, a knowledge of existing conditions is important to have before site-specific goals can be established.

The following case studies provide examples of existing conditions assessment for water bodies in Lewiston, Maine, and Pipers Creek in Seattle, Washington.

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Case Study:
City of Lewiston, Maine,
CSO, Storm Water, and NPS Planning Program
Existing Conditions Assessment

Background

Lewiston, Maine, embarked on a planning program in 1991 to address CSO, storm water, and NPS pollution issues. Overall aspects of this planning program are described in a companion case study at the end of Chapter 3. This presentation focuses on the city's efforts to evaluate existing conditions.

The city invested significant time and energy in assembling and analyzing existing information in an effort to maximize the use of existing data and minimize the need for new data (and the potentially high cost of collecting it). The city also wanted a systematic way to sort and analyze information with respect to the critical pollution control issues. A set of "baseline information" was also desired from which to compare and assess future program needs and activities.

Existing conditions were assessed using a methodology similar to that described in Chapter 4. A watershed description, a receiving-water description, and a summary of data needs were prepared. Each of these components, including the approach and results, is described below.

Watershed Data

The program team, using the list of watershed data in Chapter 4, contacted and held meetings with individuals who might have pertinent data. The list of data compiled is shown in Table 4-10. Environmental data on the watersheds were generally available from a combination of local, state, and federal sources, as shown. Infrastructure data were available from the city, who already had accurate mapping of the major roadways, drainage system, and sewerage system. Municipal data, as well as data on potential pollution sources and BMPs, were available but required significant effort to compile.

Areas requiring a lot of work—potential pollution sources, nonstructural controls, municipal source controls, and existing structural controls—are described in the following paragraphs.

Potential Pollution Sources

While a number of possible pollution sources existed within the city's watersheds, they had never been mapped. The city compiled extensive information on underground and aboveground storage tanks, landfills, vehicle maintenance areas, salt storage and snow dumping areas, CSOs, and storm drain cross-connections. These were plotted on a base map, along with watershed boundaries, receiving waters, and other important features such as gaging stations, recreational areas, and flood control structures. The map contains information similar to that required in the NPDES storm water permit regulations. It provided a convenient way of reviewing watersheds and potential pollution sources within them, possible threats to receiving waters, and the underlying zoning districts.

Most of the potential pollution sources exist within the watershed areas of Jepson Brook, Hart Brook, and Androscoggin River—the most developed watersheds. Stetson Brook watershed has several potential sources, and Salmon/Moody Brook has almost none. No-Name Brook and Pond watersheds did not have many source areas. One area of medium-density residential development on Sabattus Street with a concentration of underground tanks was noted. Located at the brook's downstream portion near the pond, this area is of concern.

Nonstructural Controls

The city's land use and zoning code and other development guides were reviewed to determine the status of nonstructural controls. The city was determined to have a comprehensive set of nonstructural

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Table 4-10. Lewiston Watershed Data

Description	Source
Environmental	
Topography	USGS topographical maps; city's 100- and 200-scale maps
Land use	Zoning Map Lewiston, Maine, revised 11/7/91; Comprehensive Land Use Plan (1987)
Recreational areas	Parks Department Inventory
Soil and surface/bedrock geology	USDA Soil Conservation Service Soil Survey
Vegetation	USGS quadrangle sheets and Maine DOT aerial photos
Natural resources	Comprehensive Land Use Plan (1987)
Temperature	NOAA
Precipitation	National Climatic Data Center; four rainfall gauges owned and operated by Lewiston
Hydrology	FEMA flood mapping
Infrastructure	
Roads and highways	Various city maps exist
Storm drainage system	Record drawings provided by the city
Sanitary sewer (and combined sewer) system	Record drawings provided by the city
Treatment facilities	Record drawings provided by the city
Other utilities	Gas, New England Telephone maps
Municipal	
Population	U.S. Census data; Maine Dept. of Data Research and Vital Statistics; Comprehensive Land Use Plan (1987)
Zoning	Zoning regulations; city zoning map; Comprehensive Land Use Plan (1987)
Land ownership	City Assessor's maps
Regulations and ordinances	Draft development permit provided by the city; Comprehensive Land Use Plan (1987)
Municipal source control BMPs	Interviews with various city departments and staff
Potential Sources/BMPs	
Landfills	Locations developed by city
Waste handling areas	Locations developed by city
Salt storage facilities	Locations developed by city
Vehicle maintenance facilities	Locations developed by city
Underground tanks	ME DEP list supplemented by the city
NPDES discharges	Locations developed by city
Pollution control facilities	Lewiston Area Water Pollution Control Authority
Retention/detention ponds	Public Works Department Inventory
Flood control structures	Public Works Department Inventory

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controls, which were analyzed and presented in a series of matrices—a convenient tool to assess the strengths and weaknesses of the regulations.

The major areas of existing regulatory authority include conservation districts, performance standards, and development review standards. Conservation districts (Table 4-11) are areas in the city that require special protection. Each district has requirements on the amount of open space or impervious surface area, on the size of buffer zones where applicable, and for solids control and pollution control.

Performance standards (Table 4-12) are designed to control impacts of certain activities (e.g., earth removal or timber harvesting) in specific areas (e.g., shoreline or flood plains). In each case, buffer or filter strips are required as appropriate. Controls also are specified in most cases for solids or other potential pollutants.

Development review standards (Table 4-13) apply to all new developments above certain specified sizes. The sizes are relatively small so that most new developments or redevelopments are covered. These standards contain a number of general review criteria for storm water management, erosion control, and other miscellaneous items.

Overall, the controls provide a more thorough and aggressive program than many communities of similar size have. The major area needing strengthening was the control of postdevelopment flows. Most requirements involved control of a 25-year storm which is oriented toward flood control. Because smaller storm events (i.e., 1-year return period or less) typically contribute most of the urban runoff pollutant

Table 4-11. Summary of Lewiston Nonstructural Controls—Conservation Districts

	Resource Conservation (RC)	Ground-Water Conservation (GC)	Lake Conservation (LC)
Scope of regulations	*Protects fragile ecosystems and areas of unique value as shown on city zoning map*	*Protects existing and potential ground-water supply areas*	*Protects water quality of No-Name Lake*
Runoff Quantity Control			
Open space	At least 90% open space Minimum 25-ft stream buffer Minimum 50-ft shoreline buffer	Maximum impervious surface ratio of 0.25	Maximum impervious surface ratio of 0.1 Minimum 50-ft shoreline buffer
Postdevelopment flow control	None specified	None specified	Increase of <20% for 25-yr/24-h storm
Runoff recharge	None specified	Specify measures to protect from loss of recharge	None specified
Additional Controls			
Solids control	Earth removal performance standards apply (see Table 4-12)	No earth removal below seasonal high ground-water table	Submit erosion and sediment control plan to minimize sediment discharge to pond
Other pollution control	Performance standards apply (see Table 4-12)	Prohibits solid waste disposal, petroleum storage, deicing chemical storage, snow dumping, hazardous waste storage, automotive repair shops, junkyards, cemeteries, and land application of sewage Ground-water protection plan required	Prohibits use of fertilizers within buffers, onsite sewage disposal within 250 ft Total lawn and garden area <30% of lot area No increase of phosphorus in pond >one part per billion for a development

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Scope of regulations	*Protects fragile ecosystems and areas of unique value as shown on city zoning map*	*Protects existing and potential ground-water supply areas*	*Protects water quality of No-Name Lake*
Runoff Quantity Control			
Open space	At least 80% open space Minimum 25-ft stream buffer Minimum 50-ft shoreline buffer	Maximum impervious surface ratio of 0.25	Maximum impervious surface ratio of 0.1 Minimum 50-ft shoreline buffer
Postdevelopment flow control	None specified	None specified	Increase of <20% for 25-yr/24-h storm
Runoff recharge	None specified	Specify measures to protect from loss of recharge	None specified
Additional Controls			
Solids control	Earth removal performance standards apply (see Table 4-12)	No earth removal below seasonal high ground-water table	Submit erosion and sediment control plan to minimize sediment discharge to pond
Other pollution control	Performance standards apply (see Table 4-12)	Prohibits solid waste disposal, petroleum storage, deicing chemical storage, snow dumping, hazardous waste storage, automotive repair shops, junkyards, cemeteries, and land application of sewage Ground-water protection plan required	Prohibits use of fertilizers within buffers, onsite sewage disposal within 250 ft Total lawn and garden area <30% of lot area No increase of phosphorus in pond >one part per billion for a development

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Table 4-12. Summary of Lewiston Nonstructural Controls—Performance Standards

	Shoreline Area	Earth Removal	Timber Harvesting	Floodplain Management
Scope of regulations	*All areas within 250 ft of Androscoggin River and tributaries and all areas in Resource Conservation District (see Table 4-11)*	*New earth removal or expansion of existing activities*	*Limits activities depending on zoning district*	*Controls development within floodplains*
Runoff Quantity Control				
Open space	75-ft buffer around high-value wetlands Filter strip of varying width required between road and water body	Natural vegetative strip at least 50 ft wide must be maintained around activity (can be as high as 100 ft)	Minimum 50-ft stream buffer Buffer strip required depending on slope Limits on amount of vegetation removed depending on area	None specified
Postdevelopment flow control	Road culverts and bridges shall pass 25-yr storm	No net increase in runoff discharge	None specified	None specified
Runoff recharge	None specified	None specified	None specified	None specified
Additional Controls				
Solids control	No grading or filling on slopes >25% All listed activities must prevent erosion and sedimentation Filter strip required near tilled land	No slopes greater than 2:1 Erosion prevention plans including the use of ditches, sedimentation basins, or dikes must be used if the activities are within 250 ft of a water body	None specified	Structures must be protected from floodwaters (limits erosion)
Other pollution control	Subsurface disposal not allowed within 100 ft of water body Agriculture shall minimize bacteria and nutrient contamination	Operation may not cause harmful leachate Petroleum or hazardous waste storage prohibited	Prohibited in resource conservation district Limited in shoreline areas and lake conservation district	Locate sewerage system to minimize contamination of waters

loading on a long-term basis, control of such smaller storm events was recommended. Another area that could be strengthened is the onsite disposal of storm water. While noted in the development review standards, this plan could be made more specific. Finally, other parts of the development review standards could be made more specific with respect to runoff pollution control.

Municipal Source Controls

Interviews were conducted to summarize the current city "source control" activities (summarized in Table 4-14). Most activities conducted by the city appeared reasonable with respect to standard practices of similar sized municipalities. Areas that appear to need further consideration include cross-connection removal, road salting, and household hazardous waste pickup. The city has identified some cross-connections and plans to implement a removal program. Road-salting policy does not vary in sensitive areas such as No-Name Pond; such a policy could be beneficial in the sensitive receiving waters. Many communities are involved in household hazardous waste pickup programs. Such a program could prove beneficial and would be consistent with the city's other aggressive solid waste programs. Such programs, however, also can be expensive. Further evaluation of municipal BMP/source control activities is planned after collection of data and evaluation of various possible BMP programs.

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Table 4-13. Summary of Lewiston Nonstructural Controls—Development Review Standards

	Storm Water Management	Erosion Control	Other
Scope of regulations	*Standards apply to all new subdivisions, residential developments with more than five units, nonresidential developments, and numerous other development categories.*		
Runoff Quantity Control			
Open space	Preserve natural drainage ways	Preserve natural vegetation	Landscaping plan required
		No fill storage within 50 ft of water body	Open space set-asides for larger developments
Postdevelopment flow control	Must handle 25-yr storm without surcharge	None specified	Storm water drainage plan required (25-yr/24-h storm)
Runoff recharge	Dispose of storm water on the property to the extent possible	None specified	None specified
Additional Controls			
Solids control	None specified	Earth material removal standards apply (see Table 4-12)	Erosion control plan required
		Permanent erosion control measures within 15 days after final grading, or use temporary measures	
		Use debris basins, silt traps, or other measures during construction	
Other pollution control	Cannot degrade biological and chemical properties of receiving waters; such controls as oil and grease traps, onsite vegetated waterways, and reductions of deicing and fertilizers may be required	None specified	Avoid extensive grading and filling
			No adverse impact on ground-water quantity or quality
			No undue water pollution
			No adverse impact on shoreland

Existing Structural Controls

The structural controls installed in the city within the last few years were inventoried. The information compiled is summarized in Table 4-15. Few structural controls exist largely because of the limited new development or redevelopment in recent years. Most of the projects used the 25-year storm required in current city regulations as the design criteria. As noted in the nonstructural control discussion, inclusion of smaller events is being considered as an additional requirement.

Most structural controls listed are detention ponds. In one case, subsurface infiltration is used. In another case, an inlet structure controls flow from the Garcelon bog wetland into Jepson Brook, and thus is not a development-related project. The summary indicates that there is currently no inspection or maintenance schedule for most of the facilities—a shortcoming for the flood-control use of the facilities as well as if the facilities were to be used to assist in urban runoff pollution control.

Receiving-Water Data

As shown in Table 4-16, data on receiving waters or on the major pollution sources to the receiving waters were limited. Data were available only for the Androscoggin and Little Androscoggin (which feeds into the Androscoggin River in Lewiston) rivers. The USGS maintains monitoring stations on both rivers, and published data are available on dissolved oxygen, temperature, pH, and conductivity. Maine Department of Environmental Protection (ME DEP) has collected grab samples on a weekly basis during summer, and data on dissolved oxygen, *E. coli* or fecal coliform bacteria, phosphorus, total Kjeldahl nitrogen (TKN), nitrate (NO_3), ammonia (NH_3), and conductivity are available for several years. The most

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Table 4-14. Existing Source Controls/Municipal BMPs

Source Control/BMP	Description
Street Sweeping	
Frequency	All roads once a year; downtown, greater frequency
Equipment	City owns two mechanical and one vacuum sweeper, and leases one mechanical sweeper
Catch Basin Cleaning	
Frequency	2,750 catch basins exist; about 1,500 are cleaned each year, April through November
Equipment	City owns a Vac-All catch basin cleaner
Roadway Sanding and Salting	
Sand:Salt Ratio	6:1
Salt used (tons/road mile)	15,000 yd^3/yr sand; 3,000 tons/yr salt
Special reduced-use zones	None
Solid Waste Management	
Residential	By city; once a week; downtown areas twice a week; three fall leaf pickups
Commercial	By commercial haulers
Recycling program	Curbside once a week, newspapers/cans/clear glass; dropoff for all residential as well as commercial, scrap metals/office paper/magazines and other materials
Composting program	None; home composting is encouraged by the city
Other Existing Controls/BMPs	
Household hazardous waste	Waste oil dropoff for residents; no other program
Fertilizer and pesticide usage	None
Animal waste removal	Dead-animal pickup on roads only; no program to remove animal wastes
Illicit connection identification and removal	No removal program currently in place; some cross-connections have been identified
Storm drainage system maintenance	General maintenance activities use 25% of annual Highway Department staff labor hours

comprehensive set of data available was collected by International Paper Company relative to its wastewater discharge upstream of Lewiston. Although the available data do not cover the entire reach of the Androscoggin River in Lewiston, significant data on fisheries and sediment exist. None of the existing data were oriented towards definition of wet-weather impacts in the receiving water. Some of the ME DEP grab samples were taken during or after storm events, and the bacteria data indicate elevated bacteria levels during these periods.

Because of the limitations in available data, two major areas of data collection were decided upon. The first is data on CSO flows, loads, and impacts, required as part of CSO planning efforts by the state. The second is information on selected city water resources where no data currently exist. These programs are described in the following sections.

CSO Data Collection

The CSO data collection program, being conducted in 1993, encompasses two major elements: CSO and storm water discharges, and receiving waters. Flow and water quality data are being collected for several storm events for several of Lewiston's CSO discharges. These data will be used to calibrate a computer model of the sewer system. Data are also being collected on several separate urban storm drain discharges to identify the quality of storm water discharge to the receiving waters.

Dry- and wet-weather sampling is being conducted at four locations on the Androscoggin River, and at two along Jepson Brook, where many of the CSOs discharge. Sampling is being conducted over a 2-day period during and after several storm events. Sampling is also being conducted during dry weather to

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Table 4-15. Lewiston Existing Structural Controls

	Kensington Terrace Phase II	Turnpike Industrial Park	Chalet Motel	Super Shop 'n Save	Sand Hill Estates	Andrews Pond	Jepson Brook Inlet Structure	Lewiston Recycling Facility
Structure type	Detention pond	Two detention ponds (P1 and P2)	Detention pond	Underground piping detention system	Detention pond	Small pond	Inlet control structure	Detention pond
Type of control	8-inch orifice 48-inch orifice stand pipe	P1: 12-inch orifice P2: 18-inch orifice	8-inch orifice	6-inch by 3-foot 4-inch orifice	10-inch orifice	48-inch orifice	Concrete weir	8-inch orifice 18-inch orifice
Location	Southerly side of Sherebrook Extension	P1: North of Cottage Road P2: South of Cottage Road	Southwest of Lisbon Street	Sabattus Street and Highland Spring Road	Southwest of Woodlee Road	Bates College, behind Olin Arts Center	East of Farwell Street	West of recycling center
Ownership	City of Lewiston	City of Lewiston	Chalet Motel	Super Shop 'n Save	City of Lewiston	Bates College	City of Lewiston	City of Lewiston
Receiving water	Tributary to No-Name Brook	Drainage ditch to Hart Brook	Hart Brook	Tributary to Garcelon Bog/Jepson Brook	Intermittent stream to Jepson Brook	Jepson Brook	Jepson Brook	Tributary to Androscoggin River
Year constructed	1990	1990	1992	1988	1989	Unknown	1986	Scheduled for spring 1993
Design criteria	2-yr and 25-yr storms	25-yr storm	25-yr storm	25-yr storm	Volume = 0.52 acre-feet	Not available	Not available	25-yr storm
Land use	Neighborhood Conservation "A" and Res	Industrial	Highway business	Highway business	Neighborhood Conservation "A"	Institutional Office District	Neighborhood Conservation "A"	Industrial
Inspection schedule	None	None	None	None	None	Unknown	2-3 times/yr	N/A
Maintenance schedule	None	None	None	None	None	Unknown	None	N/A

Table 4-16. Lewiston Source Input and Receiving-Water Data

Description	Source
Source Inputs (Flow and Quality)	
CSO	None
Storm water	None
Other NPS	None
Receiving Water	
Physiographic and bathymetric data	Some available; see water quality data below
Flow characteristics	USGS flow data
Sediment data	International Paper—Androscoggin River
Water quality data*	ME DEP; USGS; CMP; Union Water Power Co.
Sediment data	International Paper—Androscoggin River
Fisheries data	International Paper—Androscoggin River
Benthos data	International Paper—Androscoggin River
Biomonitoring results	None
Federal standards and criteria	EPA
State standards and criteria	ME DEP

* Note: All water quality data in Androscoggin River only.

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establish background conditions. Data are being analyzed for several parameters including *E. coli* bacteria, pH, dissolved oxygen, and temperature.

Water Resources Data Collection

Due to the absence of available data, collection of new data was recommended in the major watershed tributaries (except for Jepson Brook, which is being sampled as part of the CSO sampling effort) as well as in No-Name Pond. The details of the program will be developed after the CSO sampling effort is completed in 1993. In general, the program will consist of dry- and wet-weather data collection at various stations. Grab sampling is contemplated because the major purpose of this effort is to characterize the quality of each water resource.

Case Study: Pipers Creek Watershed Characterization and Water Quality Assessment

The Pipers Creek watershed borders Puget Sound in northern Seattle, Washington. Pipers Creek is an urban freshwater stream that drains a 3.5-square-mile watershed. Land use in the watershed is approximately 56 percent residential and 12 percent industrial and commercial, with the remaining 32 percent left as open space. Figure 4-2 shows the creek and its watershed.

As part of an overall effort to improve water quality in Puget Sound and its tributaries, an NPS pollution control plan was developed in 1989 and 1990 by the city of Seattle and the Washington Department of Ecology (WA DOE). The purpose of the plan was to develop a program of control measures to reduce or prevent NPS pollution to Pipers Creek. The plan was developed after Pipers Creek was selected by the WA DOE as one of the state's first early action watershed projects for NPS pollution control. The plan was funded by the WA DOE through a grant to Seattle.

An early step in action plan development was characterizing the natural and manmade environments in the Pipers Creek watershed to help determine the land use practices and physical conditions that contribute to NPS pollution in the watershed. Also, existing water resource conditions were determined by gathering and analyzing available water quality data for Pipers Creek. The results are summarized in the "Pipers Creek Watershed Action Plan for Nonpoint Source Pollution: Watershed Characterization and Water Quality Assessment" (WA DOE, 1990), which includes the data required to develop pollution prevention and control measures for the Pipers Creek watershed.

The types of watershed and water resources data collected and used in the Pipers Creek characterization, compared with the types of characterization data recommended for collection in this chapter, are shown in Tables 4-17 and 4-18. In general, the full range of relevant baseline information was gathered, except perhaps information that might have been available on certain potential pollution sources. While some existing watershed data were found to be available, existing water resource, sediment chemistry, and biological data were less complete. Water resource data came primarily from periodic sampling efforts carried out by the Seattle Engineering Department and the Metro Wastewater Treatment Plant. In general, samples were collected during dry weather and were collected for bacteria. Some wet-weather data were also available. The major sources of data were the monthly fecal coliform sampling conducted

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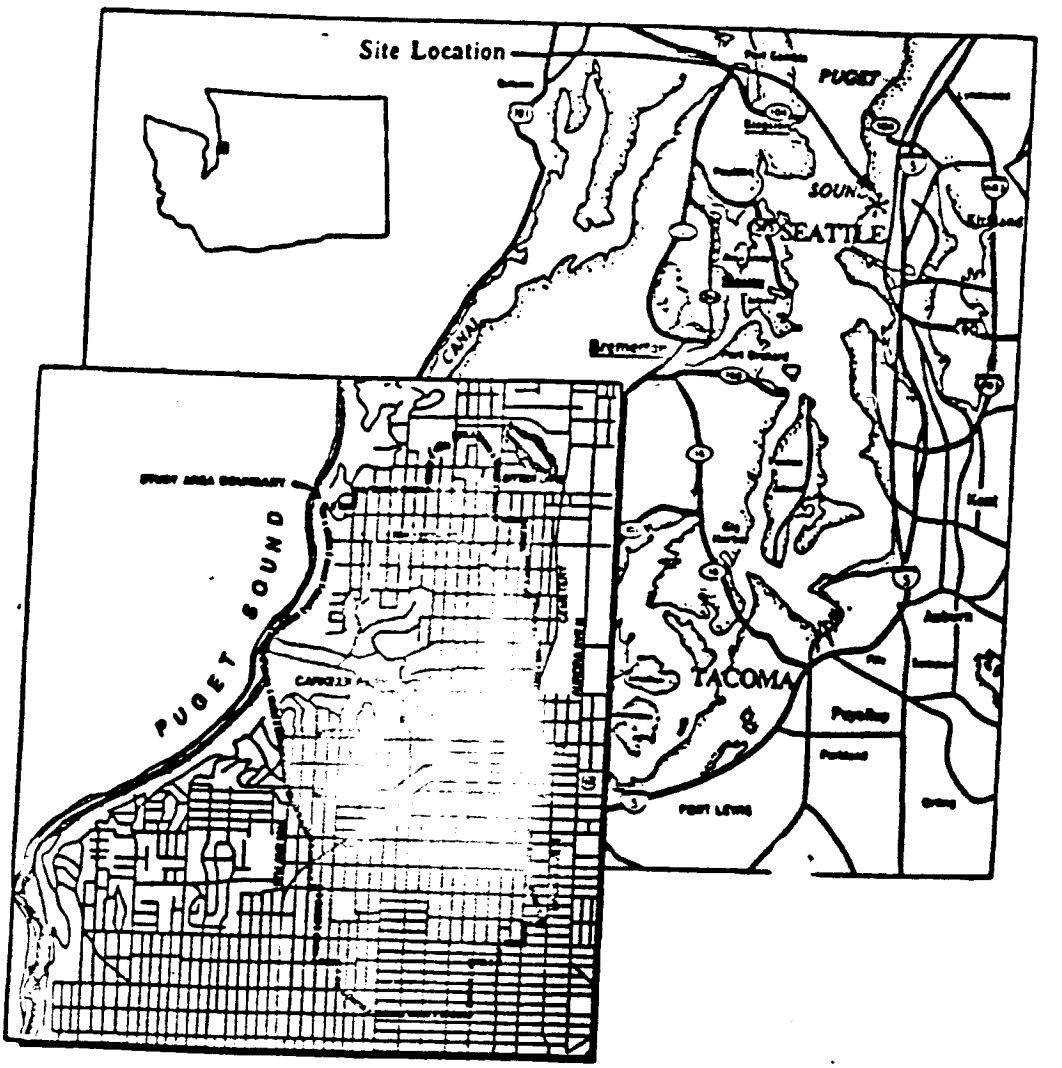

Figure 4-2. Pipers Creek watershed.

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Table 4-17. Pipers Creek Watershed Characterization Data

Watershed Characteristics	Type of Information Included
Environmental Data	
Topography	Description of topography focusing on steep areas subject to erosion
Land use	Detailed discussion of current and projected land use with map showing residential, commercial, and recreational uses
Recreational areas	General discussion of recreational lands
Soil and surface bedrock	Description of soils and geology with emphasis on erosion potential
Vegetation	Detailed discussion of vegetative habitat with maps of watershed
Natural resources	Discussion of natural resources with maps of watershed
Temperature	General discussion indicating average, high, and low temperatures
Precipitation	Fifteen years of data to calculate rain event durations and intensities
Infrastructure Data	
Roads	Description of roadways in watershed
Storm drainage systems	Detailed discussion including map of major trunk drains
Sanitary sewer systems	General description of sewerage system
Treatment facilities	Discussion of size and location of treatment plant and outfall
Other utilities	Not addressed
Municipal Data	
Population	Detailed discussion including current and projected population data
Zoning	Description including watershed zoning map
Land ownership	Description of the amount and location of land publicly owned
Regulations	Detailed description of existing regulations and programs addressing potential NPS pollution
Ordinances	Detailed description of ordinances addressing NPS pollution
Municipal BMPs	General description of garbage disposal practices in the watershed
Potential Sources/Existing BMPs	
Landfills	Not addressed*
Waste handling areas	Brief description of existing facilities in the watershed
Salt storage facilities	Not addressed*
Vehicle maintenance areas	Not addressed*
Underground tanks	Description of underground tank program and potential extent of problems
NPDES discharges and pollution control facilities	Treatment plant discussed but not flows and loads
Retention/detention ponds	Not addressed*
Flood control structures	Not addressed*

* These sources may or may not exist in the watershed.

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Table 4-18. Pipers Creek Water Quality Characterization Data

Receiving Water	Type of Information Included
Physical/Hydrologic Data	
Tidal elevation	No discussion of tidal influence on Pipers Creek
Flow characteristics	No available data on Pipers Creek flow characteristics
Physiographic/bathymetric	General discussion of physical characteristics
Sediment physical characteristics	No physical sediment data available
Chemical Data	
Water quality	Available water quality data from previous studies; data include sediments, metals, pathogens, nutrients, and organics
Sediment quality	Some available sediment heavy metal data from previous studies was discussed
Biological Data	
Fisheries	General description of fish populations in watershed
Benthos	No discussion of benthic data
General	Description of plant and animal life throughout the watershed
Other	
Quality standards and criteria	General description of federal and state water quality standards

by Metro at two stations in Pipers Creek since 1970 and a source tracing program conducted at 40 stations in Pipers Creek in 1987 and 1988. Some of these sites were sampled fewer than four times and others were sampled more than 25 times. Other parameters were analyzed only on a sporadic basis. Available data were summarized in text, tables, graphs, and maps to help develop a profile of existing watershed characteristics and water resources. Based on this information, the need for collecting additional water resource, sediment, and biological data was determined. The project team decided that no additional data collection was needed before developing the action plan (see Chapter 9 case study).

Once the existing conditions of the watershed were defined, the project team conducted an initial analysis of the NPS pollution problems using the available data. In this project, problems were defined as:

- Significant impairment of designated uses.
- Unfavorable conditions in comparison with similar watersheds.
- Relatively frequent exceedances of water resource standards.
- Lack of specific types of data that are necessary to quantify conclusions.
- Occurrences that contribute to NPS pollution.

Based on this qualitative assessment, the general problems identified included:

- Bacterial contamination
- Turbidity, sediments, and other solids caused by erosion
- Heavy metals
- Oxygen depletion

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- Organics from pesticides and petroleum products
- Nutrients (e.g., phosphorus)

According to available wet-weather data, these problems worsened during rainy weather. The assessment concluded that urban runoff is the primary cause of pollution problems in Pipers Creek. More specific evaluations of NPS pollution could not be accomplished with the available data, and the project team proposed collecting additional data in conjunction with the implementation of preliminary pollution prevention measures. The areas requiring additional data collection are:

- Storm-related receiving water and storm runoff quality data.
- Periodic dry-weather sampling throughout a larger area of Pipers Creek.
- Flow and tidal data to help isolate specific sources.
- General biological sampling to determine the water body's overall health.

While the lack of such data prevented the project team from recommending specific structural BMPs to address identified pollution sources, the team determined that a general pollution prevention program focusing on municipal, regulatory, and public education approaches should be implemented as a first step. In addition to these measures, the program team incorporated additional water quality monitoring and implementation of structural demonstration projects to collect more data.

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Springfield, VA 22161
703-487-4650

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Chapter 5
Collect and Analyze Additional Data

Urban runoff pollution problems are rarely clear cut. While information from existing studies might be sufficient to understand certain issues, new data often must be collected before the assessment and ranking of problems or the screening and selection of BMPs.

Because of the diffuse and intermittent nature of urban runoff pollution, its characteristics are difficult to quantify. Nonetheless, documentation and quantification of pollutant characteristics and effects are critical in developing an urban runoff pollution prevention and control plan. Data collection activities are often the most expensive aspect of the urban runoff planning process. A common pitfall in urban runoff programs is expending extensive resources on collecting data that turns out to be of limited value to the overall planning. Data collection efforts therefore should be carefully planned with very specific objectives given the difficulty in characterizing urban runoff problems. In this way, only data that is necessary and valuable to the program are collected, saving scarce program resources for implementation of controls.

This chapter describes how to develop a data collection program that supports the urban runoff pollution prevention and control planning process. The chapter first outlines possible goals and objectives of data collection and the general types of data required depending on the program. Important factors in developing a data collection program are highlighted, including selection of parameters, selection of sampling stations, and frequency of data collection. Planning the data collection work is then discussed, including work plan development, sample analysis, and quality assurance/quality control. Executing the program is then discussed, including sampling techniques for water resource, hydrologic, and rainfall data collection. The chapter ends with a discussion of management and analysis of the collected data, including various methods for analyzing and presenting the data.

Objectives of Data Collection

The scope of a data collection program for urban runoff pollution investigations must be site specific. It should reflect the data needs determined during analysis of existing conditions in conjunction with initial program goals identified in the planning process. Data needs may focus on potential pollution sources; water resource problems; compliance with local, state, and federal regulations; or other issues. A discussion of typical data collection objectives at this stage of the program follows.

Assess Existing Conditions

If existing data are not sufficient to establish current dry- or wet-weather conditions, additional data are needed. Dry-weather sampling of water resources could include areas affected by urban runoff loading and areas upstream of, and therefore not influenced by, the urban runoff discharges in the watershed. It might also include sampling of dry-weather base flows entering the water resource through creeks, pipes, or ditches which could contain illicit connections. In addition to water sampling, sediment and biological sampling are particularly useful for determining a water resource's relative health, as discussed in the Chapter 6 case study. Also, sampling of habitats, wildlife, soils, and other components of the watershed might be required to establish existing conditions.

Wet-weather sampling can be used to determine runoff pollutant concentrations and to observe their downstream effects. Wet-weather sampling is critical in urban runoff pollution prevention and control planning because most of the source loadings occur in wet weather. Sampling of runoff and measurement of flow in both sources and receiving waters during a storm can be used to determine the variability of runoff volumes and pollutant loads and to assess receiving-water impacts for a particular storm. Results from sampling of receiving waters during storms can be used to evaluate the effects of storm water runoff on ambient water quality, violations of water quality standards, and the effects of storm water on beneficial uses. Other types of wet-weather observations could be useful to assess flow paths, ponding, areas of erosion, and other wet-weather conditions in the watershed.

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Refine Problem Identification

Data collection programs might focus on collecting the additional information needed to identify problems clearly, such as pollutant sources and water resource impacts, that first were identified during the existing conditions assessment. These data can provide the basis for source identification, problem assessment, and BMP selection. Data collection for problem identification could again involve dry- or wet-weather sampling of sources, receiving waters, or watershed factors.

Calculate Pollutant Loads

Flow concentration data from sources of pollutants collected in dry or wet weather, as appropriate, can be used to estimate pollutant loadings and to identify priority pollution sources and watersheds. Pollutant loadings may be estimated using numerous methods ranging from simple to complex (see Chapter 6). These estimates can be used to evaluate event or annual pollutant loadings from the watershed, evaluate resource impacts, and select appropriate BMPs.

Provide Data for Computer Models

Computer models can be used as predictive tools to assess problems and the potential benefits of alternative pollution prevention and control strategies (see Chapter 6). Quantitative models that are calibrated and verified using data from site-specific sampling programs can be used to estimate impacts of future pollution loadings anticipated under potential control strategies. Models quantify pollutant loads as well as assess impacts on receiving waters or other ecosystem components. These models often require particular types of input data that might have to be collected. These typically involve dry- or wet-weather source flow and concentration data, but can also include other specialized parameters. For example, data on sediment oxygen demand in the receiving water might be needed if dissolved oxygen modeling is a primary concern, or physical and chemical characteristics of street surface solids might be tested if pollutant buildup and washoff is to be simulated.

Address Important Pollution Sources or Resource Areas

The monitoring program might need to focus on known or suspected major pollution sources, to supplement available data and confirm the existence of pollutant loading from a source. Pollution sources could be either point or nonpoint sources expected to be of particular importance to the program. The monitoring program also might need to focus on critical resource areas. Natural resources that could warrant special consideration for sampling include shellfish beds, wildlife sanctuaries and refuges, wetlands, coral reefs, spawning grounds, recreational fishing areas, bathing beaches, and drinking-water resources.

Fulfill Regulatory Requirements

Specific regulatory programs might require collection of certain data types. As discussed in Chapter 2, programs such as the NPDES storm water permit program have specific data collection requirements. As another example, flow and quality data at CSO outlets might have to be collected to satisfy state CSO planning requirements.

Each data collection program should be developed based on one or a combination of the above objectives, or other objectives as appropriate. Data should be collected only if a specific purpose relevant to the program is fulfilled.

Data Collection Programs

Developing a data collection program depends on numerous factors. The program should have clear objectives, as discussed in the previous section of this chapter. The program should also reflect the goal-setting process described in Chapter 3. Design of the data collection program also depends on factors such as the size and nature of the watersheds and receiving waters. The plan must take into account available funding, resources, and schedule constraints.

This section discusses how to implement urban runoff data collection programs. First, the major elements of designing a data collection program, including selection of parameters, sampling locations, and sampling frequency, are summarized. The selection of an analytical laboratory, laboratory methods and data quality assurance procedures are then discussed. Finally, the chapter discusses how to conduct the sampling program, including water sampling, sediment sampling, and hydrologic and rainfall monitoring. Some of the numerous, detailed technical references on monitoring that this handbook is not attempting to reproduce are included in Appendix A.

Designing the Data Collection Program

Since data collection programs are site specific and varied, providing detailed guidance on what should "typically" be done is not realistic. This chapter opens with an overview of the type of objectives often established. The major considerations in design of a data collection program—parameter selection, sampling station selection, and the frequency of data collection—are presented in this section.

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Selection of Parameters

Parameters to be measured during the sampling program should be selected based on the review of existing conditions; the program's overall goals; the specific objectives of the data collection program; and the requirements of local, state, and federal regulations. For example, most state water quality standards have numeric limits for indicator bacteria levels in waters intended for swimming and boating. If local beaches are threatened by bacterial contamination from storm water or CSOs, bacteria sampling needs to be included in the program.

Given the long list of potentially important parameters, site-specific considerations drive the selection of parameters to be tested. The most common pollutant categories associated with urban runoff are solids, oxygen-demanding matter, nutrients, pathogens, and toxic substances as discussed in Chapter 1. The sampling plan may include analysis of specific parameters included in these or other pollutant categories (see Table 1-3). Table 5-1 lists the most commonly identified priority pollutants in the Nationwide Urban Runoff Program (NURP). Specific pollutant parameters are required for characterizing storm water as part of an NPDES permit application for a municipal storm sewer system discharge (Table 5-2).

Table 5-1. Priority Pollutants in at Least 10 Percent of Nationwide Urban Runoff Program Samples (U.S. EPA, 1983a)*

Metals and Inorganics	**Halogenated Aliphatics**
Antimony	Methane, dichloro
Arsenic (50%)	**Phenols and Cresols**
Beryllium	Phenol
Cadmium	Phenol, pentachloro
Chromium (60%)	Phenol, 4-nitro
Copper (90%)	**Phthalates Esters**
Cyanide	Phthalate, bis(2-ethylhexyl)
Lead (95%)	**Polycyclic Aromatic Hydrocarbons**
Nickel	Chrysene
Selenium	Fluoranthene
Zinc (95%)	Phenanthrene
Pesticides	Pyrene
Alpha-hexachlorocyclohexane	
Alpha-endosulfane	
Chlordane	
Lindane	

* Frequency of detection in parentheses when 50% or greater.

Based on more recent data than NURP's, the most commonly detected organic compounds are shown in Table 5-3 (U.S. EPA, 1990a). In this same study, seven metals (aluminum, cadmium, chromium, copper, lead, nickel, and zinc) were tested for both filtered and unfiltered fractions from numerous source areas (i.e., roofs, parking areas, storage areas, streets, loading docks, vehicle service areas, landscaped areas, and urban creeks). Detection frequencies were very high for every metal tested in the unfiltered samples.

The information in Tables 5-1 through 5-3 can be used as a starting point and can be refined to reflect program-specific needs. Other conventional parameters

Table 5-2. Storm Water Sampling Parameters (U.S. EPA, 1991a)

Sediments/Solids	**Metals**
Total dissolved solids (TDS)	Antimony
Total suspended solids (TSS)	Arsenic
Bacteria	Beryllium
Total coliforms	Cadmium
Fecal coliforms	Chromium (total)
E. coli	Chromium (hexavalent)
Enterococci	Copper
Fecal streptococci	Lead
Nutrients	Mercury
Total phosphorus	Nickel
Dissolved phosphorus	Selenium
Total nitrogen	Silver
Total ammonia	Thallium
Organic nitrogen	Zinc
Other	**Organics**
pH	Volatile organic compounds (VOCs)
Cyanide	Base/neutral and acid extractable compounds (BNAs)
Biochemical oxygen demand (BOD)	Pesticides/PCBs
Chemical oxygen demand (COD)	Phenols
	Oil and grease

Table 5-3. Detection Frequencies of the Most Frequently Occurring Organic Compounds (U.S. EPA, 1990a)

Organic Compound	Frequency of Detection, %
1,3-Dichlorobenzene	23
Fluoranthene	23
Pyrene	19
Benzo(b)fluoranthene	17
Benzo(k)fluoranthene	17
Benzo(a)fluoranthene	17
Bis(2-chloroethyl)ether	14
Bis(chloroisopropyl)ether	14
Naphthalene	13
Chlordane	13
Benzo(a)anthracene	12
Benzyl butyl phthalate	12
Phenanthrene	10

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such as temperature, dissolved oxygen, turbidity, and specific conductivity can be included as indicator parameters to support specific assessments of urban runoff pollution sources and receiving waters. It is also important to characterize particle settling velocities, particle diameters, and dissolved and nondissolved chemical fractions for use in evaluating runoff treatability and pollutant routing in the watershed and receiving waters.

In addition to the source and receiving-water quality parameters outlined above, sediment samples may be analyzed for physical and chemical parameters, such as grain size distribution, organic content, total organic carbon (TOC), nutrients, metals, petroleum products, polychlorinated biphenyls (PCBs), or other parameters. As pollutants are partitioned between the dissolved and particulate phase, sediment chemistry reflects the portion of the particulate-bound pollutants that settle. These pollutants can, through other physical and chemical mechanisms, be introduced into the water column. Sediment chemistry can indicate potential pollution problems caused by the sediments, such as the release of metals and other pollutants into the water column and the depletion of overlying dissolved oxygen (DO) as organic matter is broken down by microorganisms.

The sediment characteristics reflect the long-term effects of intermittent and variable urban runoff discharges. These long-term effects could be more significant than short-term water quality variations that occur in response to individual runoff events. In fact, it is easier and more cost effective to test sediments and plant and animal populations in the affected areas than to conduct sampling of the intermittent pollution sources and receiving-water responses. The existing substrate and communities integrate the cumulative effects and can be characterized rapidly since they do not vary extensively. Numerous runoff event samples are necessary to obtain reliable statistics, however, and such data gathering is expensive and time consuming.

Sampling of aquatic biota involves collecting biological species from the water column and sediments to determine the species diversity, dominance, and evenness. This process can include sampling for plankton, periphyton, macrophyton, macroinvertebrates, and fish and determining the number and density of populations in the water resource. In addition, physical habitat indicators, such as substrate and plant types and conditions, are useful indicators of pollution impacts. As with sediment, these habitats reflect the long-term effects of the intermittent urban runoff impacts. These effects might be subtle and take a long time to occur, depending on the nature of the transport mechanisms and receiving-water body.

Toxicity test sampling can be used to determine the relative toxicity of storm water runoff from a conduit, creek, or other flow stream that might be receiving contaminants. Toxicity testing, an integral part of the NPDES point source monitoring program, has been included in several states' storm water permitting programs. Toxicity test results also provide information on the relative degree of chronic and acute toxicity, which again reflect the period of exposure of organisms to toxic effects. A thorough discussion of toxicity testing can be found in the *Technical Support Document for Water Quality-Based Toxics Control* (U.S. EPA, 1991b).

Selection of Sampling Stations

Sampling stations should be selected strategically so that data collected from a limited number of stations satisfy multiple sampling objectives. The major types of sampling are watershed-based (urban runoff sampling) and water resource-based (receiving-water and aquatic ecosystem sampling).

Urban Runoff Sampling. Wet-weather generated discharges (e.g., storm water, CSO, and NPS) can contribute large pulses of pollutant load and could constitute a significant percentage of long-term pollutant loads from urban and suburban areas. Wet-weather sampling can be used to characterize runoff from these discharges, determine individual pollutant source and total watershed loadings, and assess the impact on receiving waters. Pollution sources, tributaries, or entire watersheds can be ranked by total pollutant load and prioritized for implementation of pollution prevention and control measures (see Chapter 6).

In selecting a site for urban runoff sampling during wet weather, the following criteria should be considered:

- *Discharge volume:* Select sites that constitute a significant portion of the flow from a watershed.
- *Pollutant concentrations:* Based either on historical information or on land use or population density, select sampling sites to quantify representative or varying pollutant load sources.
- *Geographic location:* Select sites that permit sampling of flows from major subwatersheds or tributaries to permit isolation of pollutant sources.
- *Accessibility:* Select sites that allow safe access and sample collection.
- *Hydraulic conditions:* Utilize existing flow measurement devices, such as weirs or gaging locations, or sample where hydraulic conditions are conducive to manual or automated flow measurements.

Sampling should also include dry-weather flows from storm drains or other structures to determine if they

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result from illicit connections, or from ground-water infiltration. The magnitude of these dry-weather discharges determines the need to identify and remove these illicit connections. Detailed procedures for this have been developed (U.S. EPA, 1993).

Water Resource Sampling. For the impact of urban runoff to be assessed, the water quality of receiving waters during normal dry-weather periods should be known. Water quality data collected during dry-weather conditions provide a basis of comparison to data collected during wet-weather conditions. These data are also needed to quantify dry-weather pollutant transport from tributaries and ground-water flows. If existing data are not sufficient to characterize current conditions, stations should provide good spatial coverage within the receiving waters. Based on initial sampling results, the number of stations potentially could be reduced. For example, if initial sampling results show that a particular stream within a watershed is of high quality, sampling coverage of this stream could be reduced. Additional stations could be added in response to expected changes in land use (such as high-density development projects), which might affect water quality. Critical stations, however, such as those that previously indicated water quality violations, need to be maintained. Also, use of existing stations from other programs should be maximized.

Wet-weather sampling stations should be located to assess impacts of significant urban runoff pollutants and major storm drain systems and CSO outfalls. Receiving water stations should include the dry-weather monitoring stations for comparison. Additional stations may be sampled within tributaries affected by storm water, CSO, or other discharges and land use types of particular concern.

Other general site selection criteria for receiving waters include:

- History of available data
- Easy accessibility
- Safety of personnel and equipment
- Entry points of incoming sources or tributaries
- Adequate mixing of sources or tributaries
- Straight reaches, rather than bends

Sediment Sampling. Sediments in receiving waters affected by urban runoff integrate the long-term effects of dry- and wet-weather discharges because of their relative immobility. Grab samples can be taken to indicate historical accumulation patterns. Sampling sites could be distributed spatially at points of impact, upstream (or downstream) reference sites, areas of future expected changes, or other areas of particular interest. Selection of specific locations is subject to accessibility, hydraulic conditions, or other aforementioned criteria.

Biological Sampling. Benthic or bottom-dwelling organisms are affected both by contaminants in the water column and through contact or ingestion of contaminated sediments. The type, abundance, and diversity of these benthic organisms thus can be used to investigate the presence, nature, and extent of pollution problems. Comparisons of areas upstream and downstream of a suspected pollution source require that sampling locations have similar bottom types, because physical characteristics affect both the chemical composition as well as the habitat requirements of organisms.

Regional data or indices might be available for comparisons with local site conditions to determine whether an ecosystem is stressed. An example of the use of ecoregional data and biotic indices is presented at the end of Chapter 6. Such data provide a reference for comparison and might suggest appropriate habitat types or areas to sample in determining the level of pollution impact.

Frequency of Data Collection

The frequency of data collection significantly affects program cost and should be determined judiciously based on the need for sufficient data to develop statistically valid conclusions. Information on determining valid sampling frequencies is available (U.S. EPA, 1983b). Wet-weather runoff sampling is often limited to several events and selected representative subwatersheds because of the large resource requirements and high costs. Data must then be extrapolated to other similar subwatershed areas and used to calculate storm-related pollutant loading for an entire watershed. Depending on the area's size and number of watersheds, and on financial resources, adequate characterization of storm water runoff from different watersheds might require a phased approach. Areas of most concern are sampled first, with subsequent sampling to characterize other areas based on a watershed priority sequence. Given the cost of such sampling, collection of sediment and ecosystem data that integrate the long-term effects of urban runoff may be fruitful since they are relatively stable and do not need to be characterized as frequently.

For water resources monitoring, the sampling schedule should account for seasonal climatic changes as well as seasonal land use activities, such as fertilizer application in spring, or road deicing activities in winter, that might influence water quality. In temperate areas with pronounced seasonal changes, monitoring stations are usually sampled at least seasonally. This is especially important for sampling of aquatic biota. For characterization of urban runoff sources, several

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sampling events are ordinarily scheduled during worst-case conditions: in spring during snowmelt and heavy rains when runoff and contaminant transport is significant, or during summer conditions when streamflow is low, receiving-water dilution is minimal, and contaminant concentrations are potentially highest. In addition, the relatively high temperatures in summer can affect aquatic biota, as well as reduce the capacity of water to maintain high DO levels and stimulate bacterial metabolism, placing additional demand on oxygen supplies in the water column. This scenario represents worst-case conditions in areas that experience organic and nutrient enrichment. In areas with fairly constant climate, less emphasis is placed on seasonality, with perhaps more attention placed on land use activities.

After the implementation of BMPs, additional data might be collected to assess their effectiveness. Data collection after BMP implementation is discussed in Chapter 9.

Planning the Data Collection Program

After the data collection program is designed, more detailed planning and preparation is necessary. This planning includes development of a data collection work plan, selection of analytical laboratories and methods, and organization of the necessary staff and equipment resources.

Quality Assurance/Quality Control

The sampling program should include a Quality Assurance Project Plan (QAPP) to ensure the collection of meaningful and cost-effective data. An EPA guidance manual, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (U.S. EPA, 1983a) is designed to help EPA and its contractors prepare QAPPs. Another EPA document, entitled *Guidelines for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring* (U.S. EPA, 1984), combines a work plan with revisions to the QAPP format and includes a generic plan. The elements of this plan, listed in Table 5-4, are discussed below.

Title pages of QAPPs should include places for signatures of personnel with approval authority. Municipal programs may use this format for approval by the project manager or other responsible individuals. Additional information could include project name, requestor, date of request, and date of initiation (U.S. EPA, 1984).

The project description is intended to define the goals or objectives of the project and how the plan will satisfy those objectives. A subsection on data usage identifies the recipients of the data and establishes their requirements, thus ensuring that the plan will produce usable and effective data. A description of the monitoring network includes sampling site locations and the rationale for their selection. A subsection on monitoring parameters and frequency includes a list of the types of samples to be taken at each site and how they will be collected. These parameters are then listed in a table that includes the number of samples, sample matrix (e.g., water and sediment), analytical method to be used by the laboratory, sample preservation method, and sample holding time.

Table 5-4. Typical Combined Work/Quality Assurance Project Plan (Adapted from U.S. EPA, 1984)

1. Title page
2. Table of contents
3. Project description
   - A. Objective and scope statement
   - B. Data usage
   - C. Monitoring network design rationale
   - D. Monitoring parameters and frequency of collection
   - E. Parameter table
4. Project fiscal information (optional)
5. Schedule of tasks and products
6. Project organization and responsibilities
7. Data quality requirements and assessments
8. Sampling procedures
9. Sample custody procedure
10. Calibration procedures and preventive maintenance
11. Documentation, data reduction, and reporting
12. Data validation
13. Performance and system audits
14. Corrective action
15. Reports

Fiscal information as to projected costs for sampling labor, equipment and supplies, analyses, and requirements for outside support may be included to support a budgetary analysis of the project. This information will ensure that available resources are adequate and properly allocated to maximize the project's effectiveness.

One section details the schedule for the project from the conceptual stage through the completion of the final report. This schedule aids in assessing the availability of resources and arranging for outside support. A following section details the project organization and identifies individuals responsible for the various aspects of the project, as well as other outside support. An organizational chart is frequently included.

Data quality requirements (frequently subject to regulatory and budgetary constraints) are determined through input from data users, samplers, and analytical

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personnel and focus on the data needs of the program. Objectives should be established prior to development of a work plan. The objectives include the required level of detection, analytical precision (repeatability of a set of measurements), and accuracy (agreement of result with true value) obtained from analytical results. Accuracy and precision are identified through the use of performance standards, analytical spikes and surrogates, method blanks, and replicate samples. Many of these approaches are parameter-specific, as are the acceptance criteria. These considerations should be discussed with the analytical support personnel for the parameters to be sampled. Acceptable criteria for various analytical methods are listed in the federal regulations (40 CFR 136, Tables A and B).

Other quality assurance considerations include representativeness (whether the collection samples represent conditions and matrices that support the program's objectives), comparability (whether the analysis results can be compared with other data bases), and completeness (whether the valid data obtained satisfies the program's objectives). These considerations are basic to the development of the sampling plan, and are used to assess the success of sampling efforts.

Detailed sections follow in the combined Work Plan/QAPP that describe sampling procedures and documentation of sample custody, equipment calibration, and data handling. Sampling procedures can be generally described, citing method-specific references such as *Standard Methods* (APHA, 1992) for detailed sampling considerations. Sample documentation typically employs a chain-of-custody form that describes and follows the transfer of each sample bottle. Every time responsibility for the samples is transferred, signatures are used and copies retained to document the transaction. Equipment logbooks are maintained to document maintenance, calibration, and repairs. Data documentation includes provisions to meet the needs of legal or scientific challenges to the data, as well as quality control over data entry, transfers, and any calculations performed.

The remaining sections of the combined work/QAPP are used to document procedures to validate data, to record performance of laboratory personnel and equipment, to record steps for corrective action, and to note reporting requirements. Data validation consists of an objective review of the data base generated by the project against criteria established prior to sampling, including holding times, detection limits, and QA/QC results for accuracy and precision. Performance audits are done prior to making arrangements to ensure laboratory capabilities, as well as during the program to identify problems and institute corrective actions if required. Corrective action provisions define how to proceed in the event that QA/QC objectives are not met. Reporting requirements include interim progress reports to management personnel to document the status of the project, as well as a final report that presents the results and conclusions of the study, including a summary of QA/QC performance.

Analytical Laboratories

Before undertaking the data collection program, arrangements must be made to have the samples analyzed by a laboratory. If the laboratory analyses are not conducted inhouse, or if an appropriate laboratory is not already under contract to the municipality, a service contract can be developed with an outside laboratory that specifies the number of samples, the price per sample, the analytical methods to be used, and a QA/QC plan.

A laboratory should be selected based on a number of criteria, including price, analytical capability, past experience, reputation, and certification. In most instances, laboratories that are state certified for specific chemical analyses should be used. The laboratory should be familiar with the type of sampling program and the schedule. This familiarity facilitates development of a scope of services, which, in turn, helps ensure quality data and timely results. The laboratory should be asked to provide a list of past clients as references. The laboratory should have a strong QA/QC program and sufficient capacity to handle the volume and types of samples generated by a multifaceted sampling program. Because of the unpredictable nature of storms for wet-weather monitoring programs, the laboratory must be available to receive samples on short notice, including at night and on weekends, and to perform analyses within the required holding times.

Other important steps in selecting a laboratory include comparison of costs per analysis or per sample, and evaluation of savings through volume discounts for the large number of samples that might be generated, especially during wet-weather sampling. Turnaround time for data submittal and the form of deliverable offered are additional considerations. A turnaround time of 3 weeks is considered reasonable for typical analyses for nutrients, solids, and bacteria. Some laboratories can submit results in digital format so that it can be directly inputted to a database management system. Many laboratories can supply bottles and other equipment, such as coolers, for the preservation and transport of samples and courier service for sample pickup. Such details should be clearly communicated before finalizing the contract for analytical services.

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Analytical Methods

Of the many analytical methods to determine the pollutant concentration in water and sediments, standard methods for water and wastewater, as published in the *Federal Register* and *Standard Methods for the Analysis of Water and Wastewater* (APHA, 1992), usually achieve the desired objectives of the program. The laboratory can modify these methods based on the type of sample and the level of detection required. For example, storm water pollutant concentrations might be significantly greater than those diluted by receiving water; therefore, methods for analysis of pollutants in storm water might require less sensitivity than methods used to analyze drinking water. Other particulars of the type of sample (e.g., salt water or fresh water) might dictate the analytical method or sample preparation requirements for certain parameters, such as metals. The desired detection limit, or the lowest concentration that can be reliably detected in a sample, should be determined in advance. As mentioned, the *Standard Methods* text provides complete documentation of applicable methods for physical, chemical, and biological analysis. Specific guidance on the analysis of pollutants as required under the NPDES program is provided in the federal regulations (40 CFR 136.3, Tables IA through IE). These guidelines establish standard analytical methods, detection limits for all parameters, and the volume of sample required.

Organization of Resources

Resources required for the data collection include personnel and equipment. Personnel should be familiar with their roles and responsibilities as defined in the work plan and the team leader and each crew chief should visit the sites in advance. A health and safety plan should be prepared which identifies the necessary emergency procedures and safety equipment. Special training might be required, particularly if potentially hazardous chemicals are involved, or if confined space entry (into manholes, for example) is required. The Occupational Safety and Health Administration (OSHA) sets forth requirements for worker safety and protection while conducting such work.

Equipment also must be prepared in advance: An inventory of all the necessary equipment should be taken; all equipment to be used in the effort, such as boats, motors, automobiles, and batteries, should be checked; field monitoring equipment should be properly calibrated and tested.

Specific sampling logistics vary with the objectives of the program. For example, dry-weather sampling can often be conducted during daytime work hours in an unhurried manner, though sampling must be scheduled appropriately to coincide with diurnal, tidal, or other variations of importance to the program. By contrast, investigations of wet-weather impacts in a large sampling program could require several teams who can mobilize with only a few hours notice to conduct concurrent sampling at several locations. Receiving-water sampling could frequently include sampling for several days after the rainfall event to assess the residual effects of urban runoff pollutant loads.

Wet-weather sampling requires thorough planning and rapid mobilization to implement an effective sampling program. It also requires specific and accurate weather information. Local offices of the American Meteorological Society can provide a list of Certified Consulting Meteorologists who provide forecasting services specific to the needs of a sampling program. Radar contact can also be established for real-time observation of conditions. If a sampling criterion requires a minimum of 0.5 inches of rainfall because of resulting CSO discharges, additional insight into the timeframe of heaviest rainfall can be developed. While incurring an additional cost, these efforts could result in significant savings in costs associated with false starts and unnecessary laboratory charges.

The rainfall, darkness, and cold temperatures that often occur when conducting wet-weather field investigations render even small tasks difficult. Contingency planning and extensive preparation, however, minimizes mishaps and helps ensure safety. Prior to field sampling, all equipment should be organized, sample containers should be assembled, and the bottle labels filled out to the extent possible. Labeling is best done by writing directly onto the sample bottle with permanent markers. If stick-on labels are used, they should be waterproof and secured with clear tape. The label should indicate the sampling event (e.g., storm #1), station location or number, sample number, preservative used, and the parameters for which the sample is to be analyzed. The sample number is the most important identifier, and should be unique to each sample.

Conducting the Data Collection Program

A comprehensive data collection program with both source and receiving-water sampling can consist of dry- and wet-weather monitoring including water quality, sediment, and sampling of aquatic biota; flow monitoring; and rainfall monitoring. This section describes the common types of sampling used for urban runoff programs.

Water Sampling

Sampling as part of an urban runoff control program primarily involves collecting water samples, preserving them, and transporting them to a laboratory with as little change in character as possible. Certain parameters, including temperature, pH, and dissolved oxygen, are

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measured in the field (in situ) because values for these parameters can change substantially if measured from a sample of water that has been disturbed or held for a long time. These parameters are usually measured using battery-powered instruments with probes placed directly in the water; results are taken from a digital or analog readout and values are recorded in a field notebook.

For samples undergoing laboratory analysis, the volume of sample required by the laboratory should be considered. In addition, accurate measurement of many pollutants requires specific sample container types, container cleaning or other preparations, or specialized collection techniques. After collection, sample bottles should be placed in a cooler with bagged ice or reusable ice packs. Glass bottles should be separated by plastic bottles or packing material to prevent breakage during transport to the laboratory. Documentation of analytical methods, volume requirements, containers, preservatives, and maximum holding times is provided in the federal regulations (40 CFR 136.3, Table II), and detailed in such documents as *Standard Methods* (APHA, 1992).

Sampling for water chemistry can involve a number of approaches. The following terminology is referred to:

- *Grab sample*: Samples collected manually and analyzed individually.
- *Discrete sample*: Individual samples collected at specific times collected manually or automatically, often combined to create a composite sample.
- *Composite sample*: Samples combined based on a predetermined formula involving flow weighting, time interval, or other approach.
- *Automatic sample*: Samples collected using an automated sampling device.

Grab samples usually are analyzed individually to characterize conditions at the time of sampling. Many parameters, such as nutrients and metals, may be composited, but attention must be paid to preservative requirements. If sampling protocols permit and program objectives are satisfied, composites represent a cost-effective approach to quantifying pollutant loads by reducing the number of samples submitted for analysis. Other analyses, including bacteria, oil and grease, and volatile organic compounds (VOCs), cannot be composited and individual grab samples must be used.

Urban Runoff Sampling. During wet-weather sampling, water samples may be taken manually or by automatic samplers installed at the sampling site before the rainfall. Automatic samplers may be installed in manholes to sample storm water or combined sewer systems, or placed in enclosures next to creeks or culverts to sample runoff. They can be controlled by flow-measurement devices, by stage height monitors, or by timers, permitting comprehensive sampling of flow quality with minimal labor.

Automatic samplers may be used to collect discrete samples into individual bottles at predetermined intervals of time or flow rate, or to collect discrete samples and automatically composite them directly into one container using a pre-set formula. The option of using discrete or composite sampling is dictated by the objectives of the program and the parameters to be measured. Automatic sampler units can be either purchased, leased, or furnished as part of a contractor's service.

Wet-weather sampling must be performed by two-person teams to reduce the time required to sample each station and for safety reasons. Typically, one team can sample at least two stations if the stations are in close proximity. Because of the typical rapidity of rainfall-runoff responses, however, the area that can be covered is limited. One team member typically fills sample bottles while the other performs flow measurements and records relevant information in a field book, including station number, time, date, weather conditions (e.g., rain intensity, wind intensity and direction), and other observations, such as oil sheens, odors, or the presence of foam.

Proper characterization of urban runoff, either by manual or automated sampling, requires periodic sampling of the flow stream. This sampling should begin with the pre-storm condition, if possible, followed by the "first flush," when rainfall first washes accumulated contaminants from the surface of the watershed and pollutant concentrations are highest, and should continue through the duration of the rainfall event. Storm water pollutant loadings can then be characterized using discrete samples taken over the course of the storm, or by creating a flow-weighted composite based on the relative flow rate (or other appropriate parameter) associated with each sample taken. Flow measurement methods and an example of flow-weight composited data are discussed later in this chapter.

Receiving-Water Sampling. Sampling of receiving waters to provide background water quality data and to assess impacts from urban runoff pollutants could range from manual collection of bacterial samples from a stream to a full-scale oceanographic investigation of a harbor using a sizable vessel and considerable logistics. The important considerations are to sample the parameters of concern using proper sampling techniques (i.e., USDI, 1984; U.S. EPA, 1982; Plumb, 1981; APHA, 1992). Further references are cited in Appendix A.

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Other considerations for sampling are specific both to the program objectives as well as to the sampling station location characteristics. For example, while surface sampling of shallow, well-mixed systems, such as streams, is adequate to assess water quality, additional samples of a cross section of wider rivers might be necessary to meet study objectives. Deeper systems subject to stratification from salinity or thermal conditions should include some form of vertical sampling, which could entail samples taken separately from several depths analyzed individually or composited to yield one sample. Such a case requires the use of sampling devices such as Kemmerer or Nansen bottles which can be lowered to the desired depth and tripped by a weight dropped from the surface to produce a discrete sample. Instruments for in situ sampling of pH, temperature, dissolved oxygen, or salinity also can be lowered to specified depths, with measurements transmitted to the surface by cable and recorded.

Sediment Sampling

Analysis of sediment chemistry data can indicate the historic water quality. Water column contaminants are concentrated in the sediments through mechanisms such as sedimentation, adsorption, and organic complexation.

Chemical and physical sampling involve the collection of representative samples of sediments, with methodologies dictated by the physical character of the system (e.g., depth, substrate type) and the type of analysis being conducted. In most cases, shallow-water sediments can simply be collected by hand using a stainless steel spoon, spade, or push-corer. Deeper systems, such as lakes and estuaries, may require the use of vessel-deployed grab samplers or corers. These types of samplers are described in existing guidance (U.S. EPA, 1990b) and *Standard Methods* (APHA, 1992). The grab or core is then subsampled in a manner consistent with the requirements of individual analyses.

In most cases, the sample is placed in a plastic bag or other container and transported to the laboratory in iced coolers. While this approach is appropriate for physical analysis and certain chemical analyses (e.g., carbon and metals), some analyses require special containers or preservatives. Parameter-specific requirements, as well as the required volume of sample for various analyses, are listed in methodological references (Plumb, 1981).

Biological Sampling

Biological sampling of benthic organisms depends on the water body and the type of organism being sampled. Estuaries, lakes, and large rivers typically are sampled by a grab sampler of specified area and penetration depth. Samples then are screened through a sieve, and the organisms retained on the sieve are transferred to a sample bottle and preserved. Streams and small rivers can be sampled using a variety of samplers, again depending on depth, flow rate, substrate, and community type. In addition, artificial substrates can be employed which minimize the problem of locating similar substrates in all sampling areas. Comprehensive guidance exists for collecting biological samples using these devices (U.S. EPA, 1990b).

Flow Measurement

Flow measurement of streams, rivers, and runoff in and from drainage systems is needed to calculate pollutant loads and to design BMPs. Flow rate measurements can be made using a variety of methods: The velocity-area method (ISO, 1979; USGS, 1982; USDI, 1984) can be used to estimate flow rates in streams, rivers and other open channels. In this method, the channel's cross-sectional area, as computed from channel width and depth measurements, is multiplied by flow velocity readings. Flow measurements should be taken with a portable velocity meter at 20 and 80 percent of the depth, or at 60 percent of the depth at regular intervals across the channel (Chow, 1959).

Flow measurements can also be made by automatic devices installed in channels, storm drains, or CSO structures (U.S. EPA, 1975). These devices utilize a variety of sensor types, including pressure/depth sensors and acoustic measurements of stage height or Doppler effects from flow velocity. Data are stored in a computer chip that can be accessed and downloaded by portable computer. Data are processed based on the appropriate pipe, flume, or weir hydraulic equations. Field calibration of data using such equations is critical because these types of data might be influenced by surcharging, backwater, tidal flows, and other complex hydraulic conditions typical of urban runoff flows. Such devices can be purchased, leased, or furnished as a contract service.

Accurate flow measurements can also be made at hydraulic control structures, such as weirs or flumes, where the rate of flow is a function of the water elevation. If project finances allow, portable weirs or flumes can be purchased or leased and installed in storm drains, sewers, or channels for taking flow measurements during storms (USDI, 1984). Flow and elevation can also be taken at concrete weirs or staff gages owned by the U.S. Geological Survey. For weirs, flumes, and other standard structures, records of stage height taken at the time of flow measurements can be used to develop a stage discharge rating that can be used as a quick reference for future readings (USGS, 1982). Figure 5-1 provides an example of a stage discharge rating curve for a river. In general, flow measurement stations should have uniform channel

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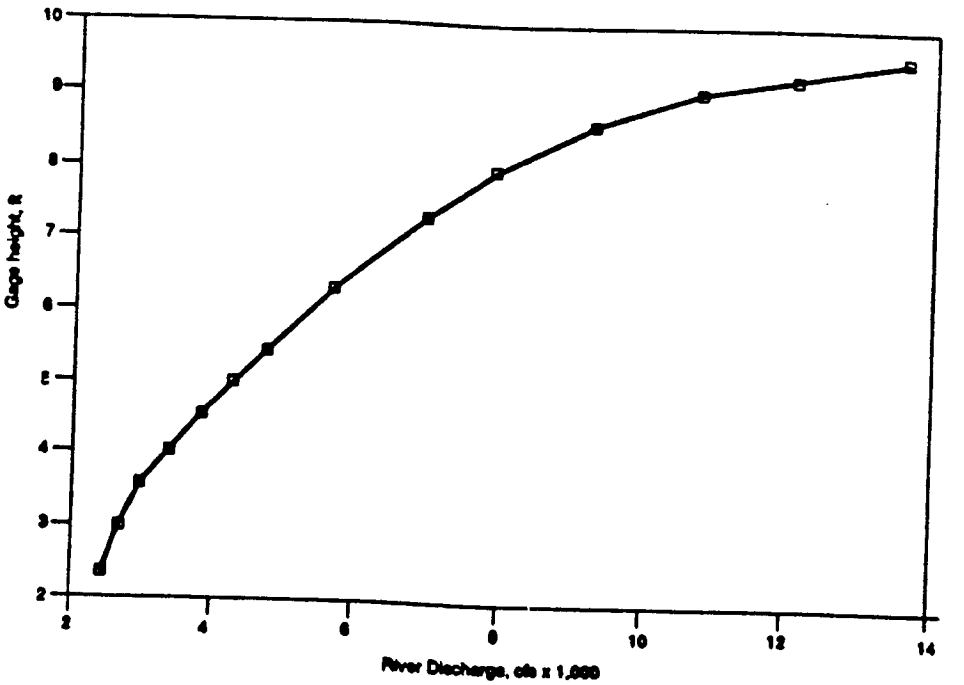

Figure 5-1. Example stage discharge rating curve.

conditions for six channel widths upstream to eliminate any turbulence, to avoid tidal or backwater effects that would interfere with flow patterns, and to allow adequate mixing of upstream flow from tributaries (U.S. EPA, 1991a).

Rainfall Monitoring

Rainfall data are necessary to estimate the amount of runoff generated during an event, which is then used to predict runoff volumes and predict responses to events of different magnitudes. Existing long-term rainfall data might be available near the area from the network of gages operated by the National Oceanic and Atmospheric Administration. Because of the variability in the possible distribution of rainfall over a relatively small area, a network of rain gages might be necessary to support these objectives. The number of gages required depends on the size of the program, the area, topography, season, and typical characteristics of local rainfall events. Available resources for rainfall monitoring should be concentrated in critical areas under investigation. Guidance in determining rain-gage network density is available (U.S. EPA, 1976).

Rainfall gages consist of two types: nonrecording gages, which measure total rainfall, and continuous-recording gages, which measure intensity over the duration of the event. The latter type is more desirable for most urban runoff programs because an understanding of the time-varying watershed hydrologic response to rainfall variations within a storm event can be gained from such data. One type of continuous-recording gage is the tipping-bucket gage, which records the number of times a calibrated bucket is filled and subsequently tipped and emptied into a larger reservoir. Other continuous gages utilize a weighing mechanism to record rainfall amounts.

Rainfall gages should be located in open spaces away from the immediate shielding effects of trees or buildings. Ground installations are preferable (if vandalism is not a significant problem). Roof installations are another option, and public buildings, such as police, fire, or public works buildings, are often used. The installation should be in an unobstructed area of the ground or roof.

Cost Estimating for Data Collection Programs

State and federal funding for urban runoff control programs typically is limited; the burden of financing these efforts therefore falls on a municipality. As the data collection program is being developed, the cost of the program should be considered. A cost estimate should be prepared for the entire program, including in-house and outside services from consultants and analytical laboratories. If funding levels are not adequate to complete the sampling program, the

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program should be redefined by scaling down the scope of sampling (i.e., number of sampling stations and/or sampling frequency) or by using a phased approach and completing critical components first and other components as funding becomes available.

Data collection for an entire municipal area with multiple watersheds can be very costly, and might use up limited resources that could be applied to actual implementation of controls. Sampling limited but representative areas and extrapolating this information to other unmonitored areas might be more cost effective. Although such extrapolation is risky and should be done with caution, it might be necessary given program budget constraints. As discussed earlier in this chapter, a focus on ecosystem components which integrate long-term effects (e.g., aquatic biota, habitats, sediments) could yield valuable data at a more reasonable cost.

Some large municipalities might have the in-house resources to undertake a comprehensive urban runoff sampling program, including staffing, equipment, analytical capabilities, and the technical expertise required for data interpretation. For smaller municipalities, or those without extensive technical resources, the sampling program should take full advantage of technical assistance offered by state and federal agencies; contracted laboratories can be used for necessary analytical services.

The major cost elements of the data collection program include the following:

- Personnel costs, in-house and/or contracted, for the field effort.
- Laboratory analysis costs.
- Monitoring equipment costs.
- Miscellaneous equipment costs.
- Data analysis and reporting costs.

Each item should be estimated in as much detail as possible. Labor costs should include direct salaries plus overhead and profit costs for contracted work. Laboratory analysis costs are often provided on a unit cost-per-sample basis. Other equipment costs are based on rental or purchase prices. Data analysis and reporting will include technical labor plus clerical time, and perhaps office supplies and computer costs.

Data collection cost estimates are highly site and circumstance specific and range from several thousand to millions of dollars. As stated earlier, it tends to be a major component, often the largest single element, of the planning program. Therefore, designing the program to respond to appropriate objectives requires the utmost care.

Data Management and Analysis

Since data collection programs generate large amounts of information, management and analysis of the data are critical to a successful program. Even small-scale programs, such as those involving only a few storm water and receiving-water monitoring stations, can generate hundreds of pages and thousands of data records. Monitoring these stations over time adds significantly to the amount of data. Thus, a key requirement is the ability to store large amounts of environmental data in an accessible format, allowing the data to be manipulated for a variety of analyses.

Methods to manage and analyze data are presented in this section: spreadsheets, graphical presentations, database management systems, and statistical analysis. Examples of how these methods can be used to assess a sample data set are given. These methods can also be used to analyze existing data (Chapter 4). More detailed methods of assessment, such as watershed and receiving water modeling, are presented in Chapter 6.

Spreadsheets

Selection of the most efficient method for data management depends on the scale of the program. For small-scale urban runoff programs, a computer spreadsheet program can be used. Entry of data into a computer format permits easy manipulations, such as calculations and graphics. Whether a computer is available or not, data records should be organized into tables by sampling station. An example of such a table is shown in Table 5-5. Parameters recorded during a survey can be entered into columns of data, with each row in the table representing a sampling event. For storm event monitoring, each row can consist of consecutive samples collected during the event. The sample ID number, which should be unique to every sample, can be used as the principal sample identifier should data be exported to a GIS or other computer applications.

Most spreadsheet programs can also be used to create graphs of the data and to perform calculations. Once a format has been developed for data entry, calculations such as contaminant load or percent oxygen saturation can be automatically performed as the data are entered. An example of a format used to calculate nitrogen loads (ammonia and total nitrogen) is presented in Table 5-6. Spreadsheet files can be combined as required to present selected information, perform investigations, or export data to other computer applications such as GIS (see Chapter 4) or urban runoff and receiving water models (see Chapter 6).

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Table 5-5. Example Spreadsheet Format for Water Resource Data

Sample	Date: Month	Date: Day	Date: Hour	River Stage, ft	Temp., °C	pH	DO, mg/L	Conductivity, mS/cm	Fecal Coliforms, MPN/100 mL	TSS, mg/L	BOD_5, mg/L	Total Nitrogen, mg/L	Total Phosphorus, mg/L
6	7	18	2030	2.31	24.8	7.7	7.65	0.23	<20	<1	5.6	0.899	0.061
10	7	19	0920	2.34	21.2	7.7	8.14	0.23	20	1.2	4.4	0.897	0.033
23	7	20	1020	2.15	22.5	7.8	8.35	0.22	<20	<1	<4	0.853	0.030
38	9	4	1710	2.61	23.0	8.3	8.80	0.20	<20	1.8	<2	1.081	0.142
42	9	5	0656	2.59	21.8	7.8	8.20	0.20	<20	2.9	<2	*	0.113
47	9	5	1750	2.55	23.0	8.3	8.78	0.20	20	2.8	<2	0.775	0.122
51	9	6	0003	2.63	22.7	7.6	7.75	0.19	80	3.1	<2	0.832	0.153
61	10	17	1730	2.48	18.5	7.8	8.90	0.19	560	4.5	<2	0.914	0.059
65	10	19	0525	2.72	18.5	7.6	8.50	0.19	300	6.8	<2	0.906	0.049
69	10	18	1117	2.75	18.7	7.1	6.90	0.19	140	5.9	3.2	0.903	0.065
75	10	18	1714	2.57	18.5	7.3	8.20	0.19	140	5.8	<2	*	0.048

* Sample not analyzed.

Table 5-6. Spreadsheet to Calculate Nitrogen Loads

Sample	Date: Month	Date: Day	Date: Hour	Freshwater flows, ft^3/s	Total Nitrogen, mg/L	TN Load, kg/d	Ammonium, mg/L	Ammonia (NH_4) Load, kg/d
6	7	18	2030	19.4	0.899	42.8	0.015	0.7
10	7	19	0920	20.5	0.897	44.9	0.013	0.7
23	7	20	1020	12.1	0.853	25.3	0.011	0.3
38	9	4	1710	35.9	1.081	94.9	0.017	1.5
42	9	5	0656	36.3	*	*	0.021	1.8
47	9	5	1750	33.1	0.775	62.7	0.004	0.3
51	9	6	0003	37.1	0.832	75.4	0.010	0.9
61	10	17	1730	28.0	0.914	62.5	0.093	6.4
65	10	19	0525	45.3	0.906	100.4	0.066	10.9
69	10	18	1117	49.2	0.903	108.6	0.204	24.6
75	10	19	1714	33.9	*	*	0.180	14.8

* Sample not analyzed.

Graphical Presentation

Graphic displays enhance data analysis and interpretation. Plots translate large sets of data into easy summaries. Another effective use of graphics is the spatial presentation of environmental data, such as on a hand-drawn or GIS-simulated map (see Chapter 4). Whether using the capabilities of spreadsheet programs or a GIS, or plotting data on graph paper by hand, a trend analysis for a particular parameter, location, or sampling program can be developed from a data set. Figure 5-2 illustrates a simple line plot of routine monitoring data for fecal coliform data taken monthly over a 1-year period. Figure 5-3 depicts fecal coliform data at a receiving water station influenced by a storm sewer during a 24-hour period after a rainfall event. In both figures, the state water quality criterion for fecal coliform bacteria is indicated and quick, visual comparisons of the collected data to the criterion can be made.

Database Management Systems

A computer-based database management system is used to store collected data and to permit easy retrieval for subsequent calculations and analyses. Database design involves a knowledge of the database management system being used and the requirements of database manipulation and interaction with other software. The data base can be coordinated with, or be part of, a GIS. In addition, the data base can be used

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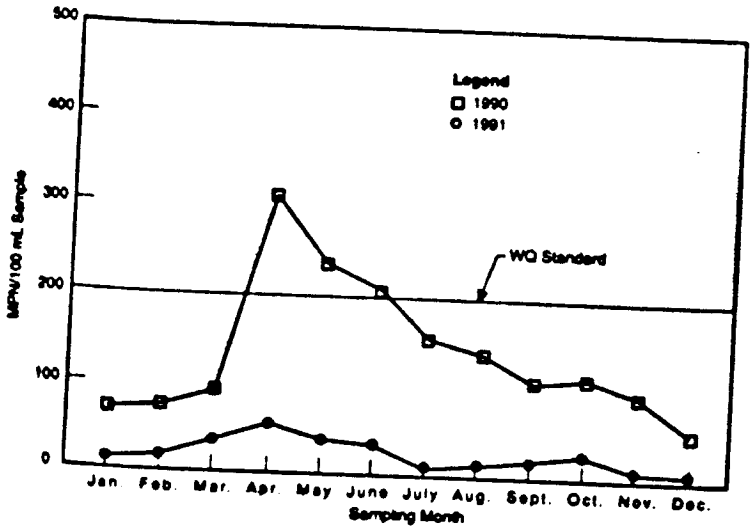

Figure 5-2. Fecal coliform densities at Station A.

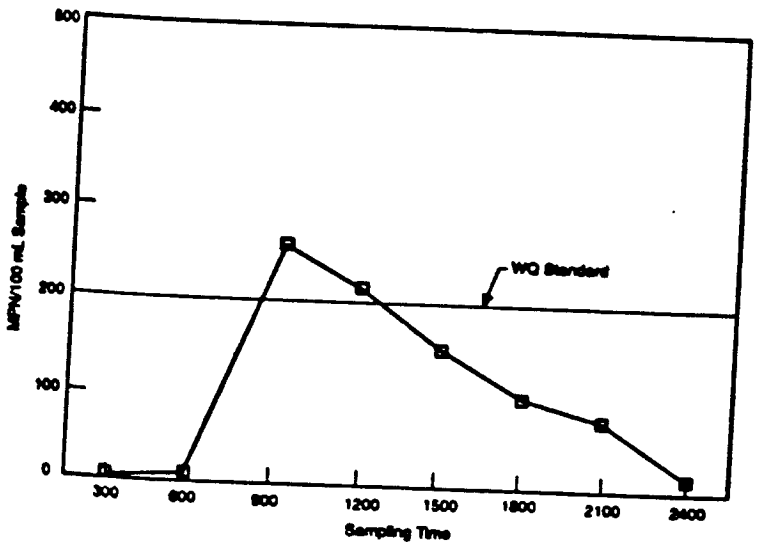

Figure 5-3. Fecal coliform densities at Station E.

as input to urban runoff and receiving water models (see Chapter 6).

Types of sampling information that could be included in the data base include: sample identification number, type of sample (e.g., rain water), sampling date and location, analyses performed, results of chemical analyses, detection limits, name of laboratory, name(s) of personnel collecting samples, climatic information, and comments regarding the sampling or analyses. Database queries can request information that focuses on specific attributes. For example, the user may select all dissolved oxygen concentration data for a specific sampling location, or the user may select all dissolved oxygen data below a certain concentration from all stations to determine compliance with water quality standards. More detailed information concerning data bases is available in the user manuals of database management software and in the literature (Date, 1985; Korth and Suberschatz, 1986; Maier, 1983; Hursch et al., 1988).

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Statistical Analysis

Statistical analyses can be conducted to establish trends and comparisons of the collected data such as pollutant concentrations and loadings associated with specific sampling locations or storm events. Statistical interpretation provides information that can be used to determine characteristics of the data set such as whether a concentration is high or low compared to the others, the amount of variation among the data, and the way in which the data are distributed. Statistical methods can also be applied to results of biological sampling of receiving waters and sediments. These methods can be used to identify shifts in species abundance and community structure which might result from exposure to pollutants.

Commonly used statistical calculations are shown in Table 5-7 and discussed in the following sections. Table 5-8 presents results for TSS samples from a CSO monitoring program to illustrate the use of these statistical calculations. This CSO monitoring program included 10 sampling sites at combined sewer overflow locations for two storm events (November 3 and 22). Table 5-8 also includes estimates for flow-weighted composites for comparison with the statistical values. Flow-weighted composite data are frequently generated when discrete sampling is performed within a storm event, as discussed earlier in this chapter. Figure 5-4 depicts the results from one sampling site plotted against the overflow discharge rate and rainfall hyetograph to illustrate the relationship between flow and discrete samples upon which the flow-weighted composite value is based.

Measures of Location

Statistical measures of location describe the relationship between various values in a data set, including the mean, median, and frequency distribution. These statistical values can be used to determine average values and the most likely value of future sampling results.

Mean. The arithmetic mean, or average, is calculated by summing the observations and then dividing the sum by the number of observations (see Table 5-7). A mean value can be used as a benchmark for comparison to individual data points or to regulatory standards. In some cases, state water quality standards employ the use of the geometric mean (e.g., bacterial standards). In this case, the individual observations are multiplied, and the *n*th root (n = number of observations) is calculated. Arithmetic means for each station and an overall mean for the entire storm are provided in Table 5-8.

Median. To obtain the median or central point value of a data set, the observations must first be put into numerical order and then divided into two equal parts. If the number of observations is odd, the median is the single middle value. If the number is even, the median is obtained by calculating the mean of the two middle values of the ordered list. Median values for each station and an overall median for the entire storm are provided in Table 5-8.

Frequency Distribution. Frequency distributions are developed by dividing the range of data points or observations into evenly spaced intervals and then counting the number of observations that fall within each interval. A relative frequency distribution is obtained by dividing each number in the frequency column by the number of observations in the data set (Devore, 1987). A graphical representation of a frequency distribution can be obtained by plotting a histogram, or bar chart, of the intervals along the x-axis and the number of observations along the y-axis.

Many types of environmental data are either normally or lognormally distributed. Normally distributed data are symmetric about the mean (which in the case of normal distribution is equivalent to the median), with a histogram that resembles the shape of a bell curve. Lognormally distributed data could exhibit a curve which is skewed to the right or left, or could be flatter or more peaked than a normal curve. Storm water and CSO data are often lognormally distributed.

Many statistical tests (parametric statistics) to determine if mean values from two sets of data are significantly different require that data be normally

Table 5-7. Commonly Used Statistical Calculations

Statistical Parameter	Formula	Variable Definitions
Arithmetic mean	$\bar{x} = (x_1 + x_2 + \ldots + x_n)/n$	x_n = value of the nth data point
Geometric mean	$\bar{x} = \sqrt[n]{(x_1 \times x_2 \times \ldots \times x_n)}$	n = number of observations in a data set
Variance	$s^2 = [\Sigma(x_i - \bar{x})^2]/(n-1)$	x_i, y_i = variables that are being correlated
	$s^2 = [\Sigma x_i^2 - (\Sigma x_i)^2/n]/(n-1)$	
Correlation coefficient	$r = [\Sigma(x_i - \bar{x})(y_i - \bar{y})]/[(\Sigma(x_i - \bar{x})^2)^{1/2}(\Sigma(y_i - \bar{y})^2)^{1/2}]$	
	$= [n\Sigma(x_i)(y_i) - (\Sigma x_i)(\Sigma y_i)]/[((n\Sigma x_i^2) - (\Sigma x_i)^2)^{1/2}((n\Sigma y_i^2) - (\Sigma y_i)^2)^{1/2}$	

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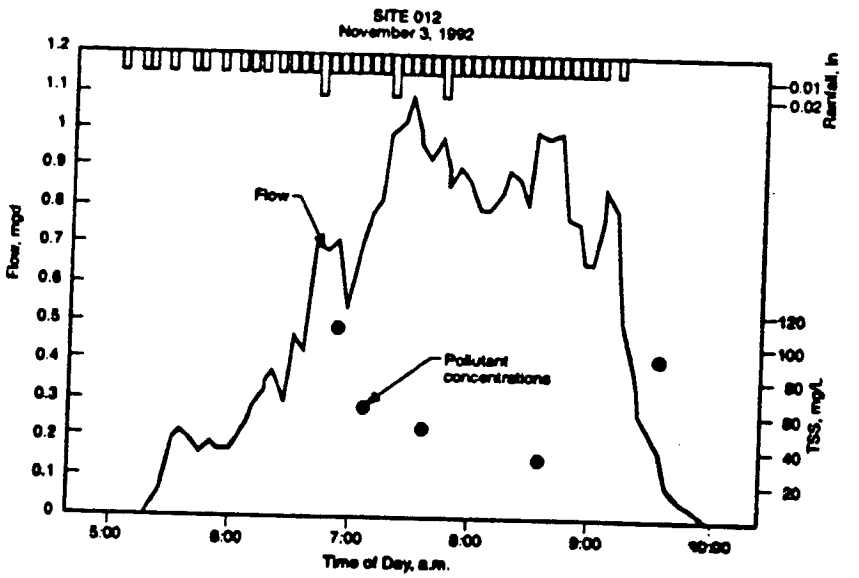

Figure 5-4. Relationship between flow and pollutant concentrations.

distributed. It is therefore necessary to determine whether a particular data set satisfies this assumption prior to employing parametric statistics. Tests for normality (e.g., Kolmogorov-Smirnov one-sample test, Sokal and Rohlf, 1969) are used to compare the data distribution with a normal one to determine if it is sufficiently similar.

Prior to comparisons with other data sets, such a test was performed on the pooled data for all measurements of TSS given in Table 5-8. A histogram of the pooled (untransformed) data was made first (Figure 5-5). A Kolmogorov-Smirnov one-sample test indicated the data were significantly different from a normal distribution (dotted line in histogram). A log transform was then applied (Figure 5-6), and the test for normality repeated. The transformed data were found to be normally distributed. The transformed data now met the assumptions for parametric statistical analysis. In the event that all attempts at data transformations prove to be ineffective, nonparametric statistics (e.g., Mann-Whitney U-test) can still be employed for comparison and assessment of data.

Many parametric and nonparametric tests can be found in statistical packages for personal computers. These statistical packages can easily access information from data bases, and greatly facilitate the evaluation of the data generated by a monitoring program.

Measures of Variability

Statistical measures of variability describe how closely the data set is grouped around the mean value. Statistical tests performed to determine significance between two means require as a basic assumption that the variance components of the two data sets are not significantly different. The two most frequently used measures of variability are variance and standard deviation.

Variance. Variance is a measurement of the dispersion of observations about the mean—the sum of the squares of the differences between each observation and the mean divided by the degrees of freedom in the data set (see Table 5-7). The term, degrees of freedom, equals the number of observations minus 1.

Standard Deviation. The standard deviation is the square root of the variance and is expressed in the same units as the mean. For a normal distribution, the data included in the range of 1 standard deviation from the mean represent 68.26 percent of the total data set. A range of 2 standard deviations from the mean represents 95.44 percent of the data set and a range of 3 standard deviations from the mean represents 99.74 percent of the data set. For example, the standard deviation in the pooled TSS data for all sites was 102 mg/L, indicating a high degree of variability when compared with an overall mean value of 91 mg/L.

Confidence Intervals

To determine whether an estimated parameter measurement such as a contaminant concentration measured in a laboratory or forecasted by a model represents the actual value of that parameter, the

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Table 5-8. CSO Sampling Results for Total Suspended Solids

Site	Date	Time	TSS, mg/L	Date	Time	TSS, mg/L
003	11/3	0525	35	11/22	1530	27
	11/3	0545	31	11/22	1545	33
	11/3	0615	38	11/22	2150	48
	11/3	0632	48	11/23	0215	16
	11/3	0632	46	11/23	0315	49
	11/3	0715	31	11/23	0535	22
	11/3	0815	42			
Mean value			37			32.5
Median value			38.5			30
Flow-weighted value			37			27
004	11/3	0705	160	11/23	0000	100
	11/3	0805	110	11/23	0015	110
	11/3	0905	63	11/23	0015	180
				11/23	0210	48
				11/23	0310	44
				11/23	0410	77
				11/23	0810	66
Mean value			111			78.5
Median value			110			71.5
Flow-weighted value			109			59
SMF	11/3	0745	400	11/23	0115	80
	11/3	0815	120	11/23	0130	140
	11/3	0845	73	11/23	0300	180
	11/3	0945	58	11/23	0300	190
	11/3	1045	29	11/23	0400	76
	11/3	1215	20	11/23	0510	30
	11/3	1215	18	11/23	0510	24
	11/3	1345	25	11/23	0800	31
Mean value			103			90
Median value			59			78
Flow-weighted value			105			45
023	11/3	1100	150	11/22	1820	38
	11/3	1115	91	11/22	1920	71
	11/3	1145	110	11/22	2020	33
	11/3	1215	55	11/22	2120	11
	11/3	1246	44	11/22	2120	12
	11/3	1315	46	11/22	2220	15
	11/3	1415	14	11/23	0020	13
	11/3	1515	26	11/23	0220	58
	11/3	1515	28	11/23	0520	160
Mean value			67			50
Median value			50.5			52
Flow-weighted value			58			53
090	11/3		No data	11/22	1605	110
				11/22	1620	140
				11/22	1650	49
				11/23	0105	45
				11/23	0205	74
				11/23	0405	21
				11/23	0605	30
				11/23	0905	33
Mean value						63
Median value						47
Flow-weighted value						42

Site	Date	Time	TSS, mg/L	Date	Time	TSS, mg/L
012	11/3	0650	110	11/23	0130	68
	11/3	0705	63	11/23	0145	200
	11/3	0735	51	11/23	0215	170
	11/3	0835	35	11/23	0315	170
	11/3	0935	95	11/23	0415	80
				11/23	0615	21
				11/23	0615	22
				11/23	0805	23
Mean value			71			102
Median value			63			68
Flow-weighted value			89			82
003	11/3	0725	180	11/23	0015	44
	11/3	0740	39	11/23	0030	32
	11/3	0810	17	11/23	0200	22
	11/3	0910	47	11/23	0300	190
	11/3	0910	130			
	11/3	1010	230			
	11/3	1210	160			
Mean value			116			
Median value			124.5			
Flow-weighted value			160			
070	11/3	1025	42	11/23	0300	380
	11/3	1255	13	11/23	0330	110
	11/3	1325	18	11/23	0430	120
				11/23	0530	73
				11/23	0720	40
				11/23	0920	31
Mean value			24			122
Median value			18			91.5
Flow-weighted value			27			58
086	11/3	0840	27	11/22	1605	180
	11/3	0855	21	11/23	0025	140
	11/3	0925	17	11/23	0225	340
				11/23	0335	230
				11/23	0540	170
				11/23		67
Mean value			22			183
Median value			21			180
Flow-weighted value			23			266
088	11/3	0840	160	11/23	0205	780
	11/3	0940	91	11/23	0220	240
	11/3	1040	42	11/23	0250	150
	11/3	1140	25	11/23	0350	310
	11/3	1240	28	11/23	0450	230
	11/3	1240	24	11/23	0550	51
				11/23	0550	47
				11/23	0750	41
Mean value						257
Median value						230
Flow-weighted value						161
All Sites Combined						
Mean value			73			104
Median value			45			66

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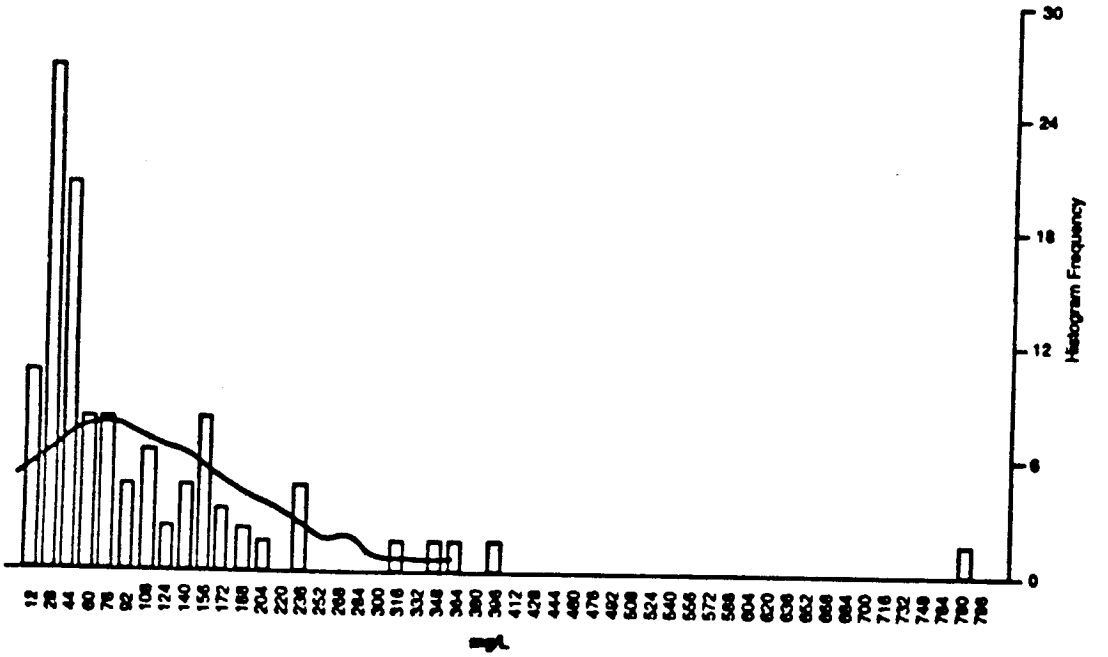

Figure 5-5. Untransformed total suspended solids (TSS) data.

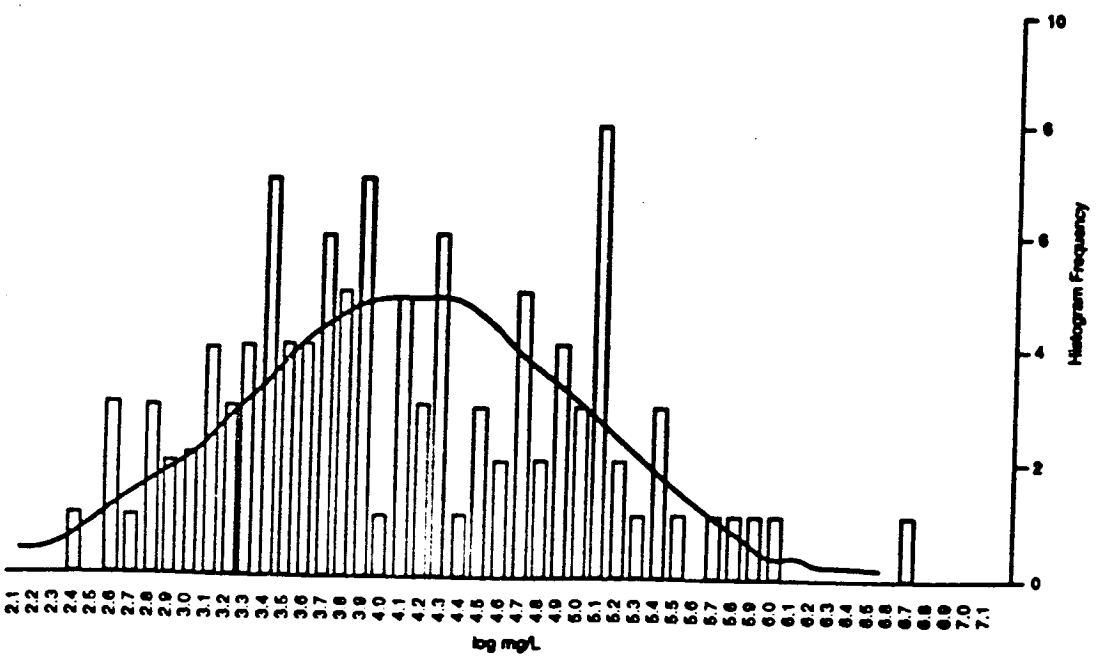

Figure 5-6. Log-transformed total suspended solids (TSS) data.

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estimated value can be compared to a confidence interval. A confidence interval can be interpreted as the probability that an estimated value falls within the calculated limits of the interval. For example, a 95-percent confidence interval indicates a 95-percent probability that the estimated value falls within the specified limits of that confidence interval. Thus, only 5 percent of the estimated values would fall outside of this range. The technical details of deriving confidence intervals are beyond the scope of this document; however, there are numerous references that could be useful, including Devore (1987) and other textbooks on probability and statistics.

Correlation Coefficient. The correlation coefficient (r) provides useful information concerning the relationship between pairs of data, denoted as x and y. An example would be the relationship between TSS concentrations from a site and the area that contributes runoff to the site. The value of r does not depend on which of the two variables is labeled "x" and which is labeled "y," nor does it depend on the units of x and y. Generally, a correlation coefficient is considered weak if $0 \leq |r| \leq 0.5$, strong if $0.8 \leq |r| \leq 1.0$, and moderate otherwise (Devore, 1987).

Analysis of Biological Data

The evaluation of biological data could involve a number of statistical approaches, which include both qualitative and quantitative methods. Qualitative methods frequently include the use of indicator organisms whose presence or absence indicates the level of water quality. Quantitative methods include comparisons of biomass, organism densities, and community indices.

Qualitative Methods. Indicator species have been used for several community levels, including plankton, fish, and benthic macroinvertebrates. For example, phytoplankton species have been categorized as indicative of clean and polluted water, and responsible for taste and odor problems in reservoirs (APHA, 1992). Indicator species of organic enrichment and other pollutants in marine systems have been described by Pearson and Rosenberg (1978). In the case of freshwater benthic macroinvertebrates and fish, pollution-tolerant or -intolerant organisms have been assigned index values corresponding to their pollution tolerance (Hilsenhoff, 1977, 1987; U.S. EPA, 1989; summarized in U.S. EPA, 1990b). These index values typically utilize scales of 0 to 5, or 0 to 10, to indicate the level of tolerance to pollutants.

The use of benthic macroinvertebrate indicator species is illustrated in results from a stream survey to assess the relative impact of nutrients and other contaminants from an area affected by sewage leachate (Figure 5-7). In the survey, EPT taxa (*Ephemeroptera, Plecoptera, Trichoptera* = mayflies, stoneflies, and caddisflies) were used to represent species sensitive to pollution, while chironomid dipterans (blackflies), nonchironomid flies, and oligochaete worms were used to represent pollution-tolerant organisms.

The results reflected a fairly even distribution of the four groups of organisms at the upstream control site (Site A). Pollution-tolerant species, particularly the oligochaete worms which are good indicators of organic enrichment, were found in elevated numbers downstream of the impact area (Site B). Further downstream (sites C through E), the relative abundance of the four groups of organisms came to reflect conditions found at the upstream control site. In many urban environments, it might be difficult to find an upstream control site. This is common for feeder streams and creeks which originate within the urban area such that the entire reach is impacted. In such cases, it is necessary to consider reference sites in other areas which are not affected.

Quantitative Methods. Quantitative methods to analyze biological data utilize results for biomass, number of organisms, and species composition. Statistical methods described in earlier sections are used to interpret numeric data on biomass and densities. Community composition is analyzed through the use of diversity and similarity indices, which examine the number of organisms and taxa to determine if communities are stressed by pollutants. A number of these indices exist, which are described in the literature (Washington, 1984).

The most frequently used diversity indices describe species diversity, dominance, and evenness (Table 5-9), which provide the basis for comparisons of results from different sampling stations and study areas. Because of the influence of natural variability on the distribution of species, such comparisons are restricted to similar habitats such as fast-moving sections of a shallow stream (riffles), or deeper pooled areas. These indices have been employed in ecological studies for a number of years, permitting comparisons with historical data bases.

Calculation of these indices using the data in the stream survey (Table 5-10) mirrored the results for the

Table 5-9. Commonly Used Ecological Diversity Indices

Shannon-Wiener Diversity Index	$H' = \Sigma_i n_i/n \, [\ln (n_i/n)]$
Simpson's Dominance	$D = [\Sigma n_i(n_i - 1)/[n(n - 1)]$ where $i = 1 \ldots s$
Evenness	$E = H'/\ln(s)$

where:

n_i = number of individuals in a species i of a sample from a population

n = number of individuals in a sample from a population

s = number of species in a sample or population (also called richness)

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Table 5-10. Diversity Indices for Sewage Leachate-Affected Stream Samples

Station	Total Taxa	Mean Number of Organisms per ft²	Diversity	Dominance	Evenness
A	44	372.2	2.932	0.077	0.77
B	33	1261.9	1.196	0.536	0.34
C	31	1193.1	1.864	0.263	0.54
D	39	796	1.541	0.442	0.42
E	15	60	2.273	0.138	0.84

distribution of indicator organisms illustrated in Figure 5-7. Diversity and evenness values were both highest at the control Site A, and lowest at Site B, indicating the shift toward opportunistic, pollution-tolerant species which had a competitive advantage over less tolerant species. These results can also be plotted in a manner similar to the indicator species results. Statistical tests to determine the significance of the observed differences can be easily performed following the methods of Solow (1993).

Similarity indices permit comparisons of results to a reference station by calculation of similarity coefficients. These similarity coefficients can be subjected to cluster analysis, with the results illustrated through the use of dendrograms which graphically group similar communities together. Guidance exists using examples of the most widely used indices (U.S. EPA, 1990b), including examples of applying statistical methods described earlier to determine the level of significance associated with comparisons using these quantitative approaches.

A dendrogram for the Bray-Curtis coefficient calculated from the stream survey example (Figure 5-8) illustrates the similarities between sites influenced by the sewage leachate (Sites B through D). The upstream control site, A, and the most downstream site, E, clustered together, indicating a high degree of dissimilarity with the sites most influenced by the sewage leachate. Again, tests of significance can be applied to the results, and are typically included in statistical packages which are available to run cluster analyses.

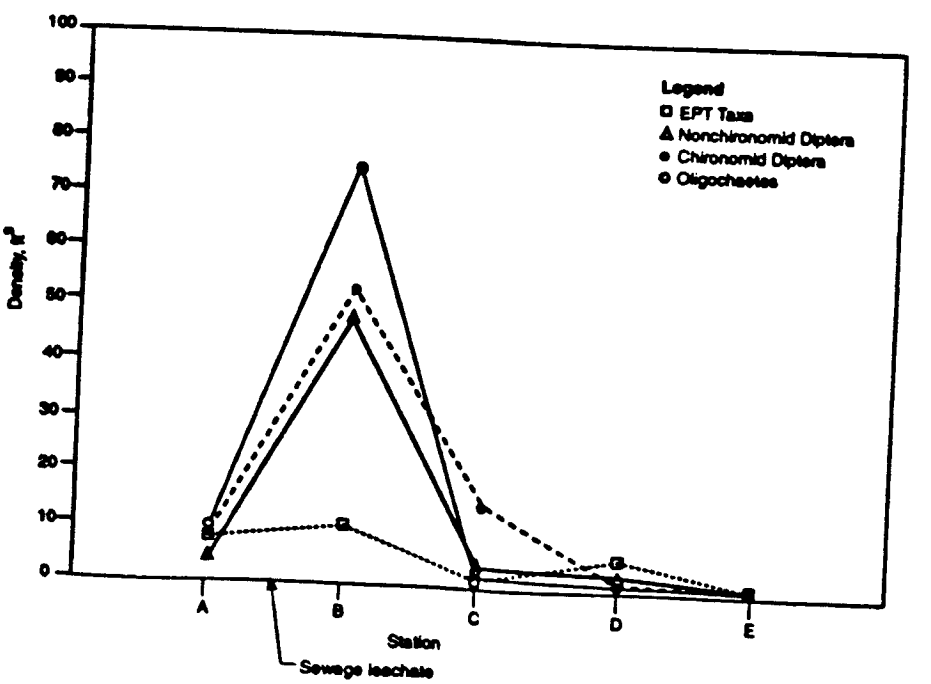

Figure 5-7. Distribution of macroinvertebrate indicator species along a sewage leachate-affected stream.

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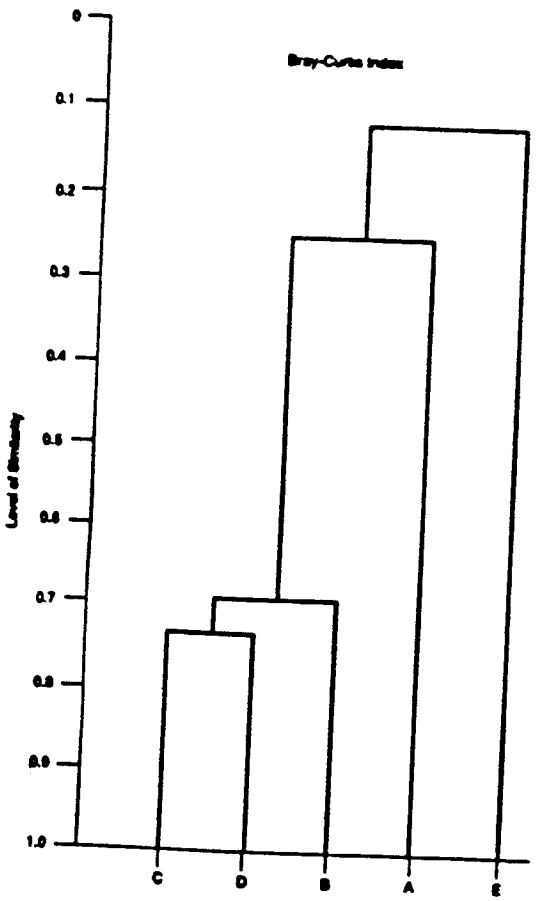

Figure 5-8. Cluster analysis dendrogram for sewage-affected stream survey results.

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When an NTIS number is cited in a reference, that document is available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

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Chapter 6
Assess and Rank Problems

This chapter presents methods for evaluating available or newly collected data in order to assess problems. Problem assessments, as defined in this chapter, are evaluations performed to determine the extent and severity of urban runoff-related problems. Problem assessments are used to determine the need for and appropriate level of pollution prevention and control measures for the program. It is important to consider both existing and potential problems, so that the program addresses resource protection, as well as problems that already exist.

The first step is defining problem assessment criteria, which are used to assess the extent or severity of an urban runoff-related problem. Following this definition, the most commonly used methods of problem assessment are presented, including pollutant source assessments, resource assessments, institutional assessments, and goals and objectives assessments. Finally, methods for ranking problems based on results of the assessments are included in this chapter because of the complexity of urban runoff problems and the frequent need to set priorities. Results of problem assessment and ranking presented in this chapter provide the basis for BMP screening and selection in subsequent steps of the planning process.

Problem Assessment Criteria

Problem assessments can address a wide range of issues, including:

- The types of urban runoff pollution in the watershed.
- The extent to which these pollution sources adversely affect resources.
- The institutional needs and constraints in addressing the problems.
- The goals established for the program area.

Criteria for the assessment can be developed to address these major issues, to determine the important issues, and to provide a basis for problem assessment. Only criteria considered most critical and helpful in distinguishing between problems should be selected. Assessment criteria, such as those listed in Table 6-1, can be evaluated qualitatively or quantitatively. These criteria are briefly described below and elaborated upon later in the chapter in the discussion of assessment methods.

Pollutant Source Criteria

Assessment criteria focusing on pollutant characteristics and the pollutant sources that affect a resource are among the most critical in determining which problems should be addressed. Pollutant source criteria, such as those listed in Table 6-1, describe the range of pollutant characteristics and sources and the size of each source. The distance between the source and the affected resource and the mode of pollutant transport are also useful assessment criteria. Pollutant loading during wet weather versus dry weather can also be considered. Tools useful in evaluating pollutant source criteria include GIS and urban runoff models (described later in this chapter).

Resource Criteria

Resource criteria assess effects on resources and aid in determining locations where preventive and corrective measures are needed. Water resources of various types (e.g., ground water, surface water, and drinking water) are often the driving force for such assessments, but many other types of resources, such as biological, wildlife, and infrastructure could be appropriate to consider. Examples of these assessment criteria, as listed in Table 6-1, describe the importance or value of a resource with respect to issues such as habitat, recreational use, and public water supplies. The current and desired uses of a resource may be included as resource criteria. The degree to which a resource is impaired and the type of impairment may also be considered. Tools such as receiving-water models and biotic indices (see the case study at the end of this chapter) and habitat evaluation procedures are used to assess the existing conditions and simulate responses of the resources to potential preventive and corrective measures. Information gathered during existing conditions assessment (Chapter 4) and data collection and analysis (Chapter 5) are useful in analyzing the resource criteria. The relative health of each resource

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Table 6-1. Criteria for the Assessment of Pollution Problems (Adapted from U.S. EPA, 1987a)

Pollutant Source
Type of pollutant
Pollutants typically associated with the source
Source magnitude/pollutant loading
Transport mechanisms to the resource (direct pipe, overland flow or ground water)
Wet-/dry-weather trends
Resource
Existing use of the affected resource (type, status, and level of use)
Designated or desired use of the affected resource
Type and severity of impairment
Relative value of resource affected
Institutional
Available resources and technologies
Understanding of problems and opportunities
Appraisal of potential for solving the identified problem
Implementability of controls
Applicable regulations
Multiagency responsibilities
Funding sources and limitations
Public perception
Goals and Objectives
Water resource goals (water use objectives)
Technology-based goals
Land use objectives
Objectives of planner and sponsor

in a community and the desire of the community to improve its quality helps determine the priorities for implementation.

Institutional Criteria

Urban runoff-related problems can also be assessed using criteria that focus on the institutional constraints on regulators, owners, and the public. Institutional criteria are based on applicable regulations, preferences of the local authorities and regulatory agencies, funding sources and limitations, multiagency responsibilities and overlaps, and public acceptance of the program. Interviews and meetings with interested parties, including agencies, environmental groups, advisory groups, and private citizens, can be conducted to help develop institutional criteria. Questionnaires can be prepared and distributed to help identify concerns. Complaints, either filed with local authorities or available through interviews with citizens, also provide useful input. Knowledge of problems gained through public interaction programs can help to ensure public support of urban runoff pollution prevention and control programs which are implemented later. Examples of institutional criteria are listed in Table 6-1.

Goals and Objectives Criteria

Urban runoff problems can be evaluated with respect to current and future goals. Using goals and objectives assessment criteria, presented in Table 6-1, allows the program team to focus on problems where preventive or corrective measures would provide the greatest benefit. One goal, for example, might be to increase the usage of public beaches by improving the conditions of degraded water bodies meant for swimming. Application of goals and objectives criteria could identify where corrective measures would provide the greatest benefit, perhaps at beaches only slightly degraded and needing only minimal cleanup before they are restored, or at beaches in heavily populated areas where many people could benefit from restoration of the water body. Goals and objectives can be set for restoration of affected resources, but protection of existing uses is as valid a goal as restoration.

Methods of problem assessment, presented in the following sections, use the criteria discussed in this section as a basis for comparison and evaluation.

Pollutant Source Assessments

Pollutant source assessments address the type, magnitude, and transport mode of pollution sources (existing or potential) in a watershed or program area. These assessments are frequently aimed at quantifying the source flows and pollutant loads under various conditions.

Source Determination and Data Evaluation

Urban runoff pollution sources can be defined using the watershed description (Chapter 4) and other information such as the type(s) of pollution affecting a water resource, the pollutant transport mechanisms, the characteristics of drainage patterns and drainage structures, and the land uses in the program area. Activities or land uses within a watershed that are, or potentially could be, causing pollution problems need to be identified. Pollutant types found in the watershed can provide clues regarding the source(s) of the problems. To isolate pollution sources, the watershed can be divided into smaller areas so that individual pollution sources can be tracked down. Depending on the size of the watershed, a drainage basin can first be divided into sub-basins, which can, if necessary, be divided into individual tributaries, pipe systems, or drainage channels. Pollutant types typically associated with certain activities or land uses are listed in Table 6-2.

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Table 6-2. Types of Activities and Associated Pollutants (U.S. EPA, 1990a)

Categories and Subcategories	Nutrients	pH	Sediment	Organic Enrichment	Pathogens/ Indicator Bacteria	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Agriculture												
Cropland	X		X									
Pastureland	X		X	X	X							X
Animal holding areas	X		X	X	X							
Animal waste storage	X		X	X	X							
Hayland	X			X	X							
Wash and processing water	X	X	X	X	X			X				
Waste application areas	X		X	X	X		X					X
Construction												
Highways, bridges, roads			X		X	X		X	X	X	X	
Land development			X		X			X		X	X	
Urban Land												
Storm water sewers, combined sewers, surface runoff—pavement	X		X	X	X	X	X	X	X	X	X	
Surface runoff—turf areas	X				X			X				
Infiltration wells and basins	X				X	X		X	X			
Land Disposal												
Wastes, sludge, septage	X	X	X	X	X	X	X	X	X			
Landfills	X	X	X	X	X	X	X	X	X	X	X	X
In situ wastewater system	X	X			X	X	X	X	X			
Hazardous waste areas	X				X	X	X	X	X			X
Hydrologic Modification												
Earth fills, channelization			X							X		
Dam construction/reconstruction	X	X	X	X						X		
Other Sources												
Atmospheric deposition	X	X				X	X					
Underground storage tank leaks						X	X	X				X
Illegal disposals/dumping, release of contaminants from in-place deposits	X	X	X	X	X	X	X	X	X			X

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Table 6-2. Types of Activities and Associated Pollutants (Continued)

Categories and Subcategories	Nutrients	pH	Sediment	Organic Enrichment	Pathogens/ Indicator Bacteria	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Highway/bridge maintenance			X			X	X	X	X			X
Auto salvage						X	X	X				
Washing and processing areas	X	X	X	X	X	X	X	X	X		X	X
Snow dumping areas	X		X	X	X	X	X	X	X			
Utility ROWs			X							X	X	X
Surface runoff from gasoline stations						X	X	X				
In-place sediments	X	X	X	X	X	X	X	X	X	X		
Sewer leaks, domestic/wild birds and mammals	X			X	X							
Natural vegetation (leaves, fallen trees)	X		X	X	X							
Marinas and boat moorings, boat maintenance and boat washing	X		X	X	X	X	X	X				

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This information can be used to identify potential sources. Problem sources can also be identified based on resource conditions, such as eutrophication of a water body resulting from excessive nutrients, or closures of shellfish beds because of high levels of bacteria. In addition, sediments from aquatic systems and storm sewers can provide useful information for identifying potential sources (U.S. EPA, 1991a).

Pollutant Source Flow and Load Estimation

Computer modeling is valuable in quantifying the flows and loads of pollution sources needed for pollution source assessments. Models can be used to estimate source strengths as well as to evaluate the effectiveness of proposed corrective measures or BMPs. Models available for urban runoff assessments vary widely in complexity, ranging from simple estimation techniques to sophisticated and expensive computer models. The following discussion highlights a number of commonly used methods, focusing on models used to predict pollution characteristics in an urban environment. Information on urban and non-urban models is available from literature (U.S. EPA, 1987b,1991b; Nix, 1991; Walesh, 1989) and from agencies that sponsor the models. Methods of urban runoff modeling discussed in this section include the constant concentration or unit load estimates, preliminary screening procedure, statistical method, universal soil loss equation, rating-curve or regression approaches, and hydrologic and pollutant buildup-washoff models.

Constant Concentration or Unit Load Estimates

Constant concentrations or unit pollutant loads, which can be used to estimate pollutant source loads, can be obtained from available data or estimated based on the types and sizes of land uses in the watershed. Constant concentrations can be coupled with runoff volume estimates to calculate runoff loads or can be used in hydrologic models to calculate time variable flows and loads. The constant concentration or unit load method is easy to use, and can be helpful as a first-cut estimate to identify which areas within a watershed contribute the largest pollutant loads. Wet-weather and dry-weather conditions can also be evaluated separately, to determine the relative contributions of pollutants during these weather periods. This method can be facilitated using a GIS with information such as wet- and dry-weather pollutant concentrations from different sources, land use or source boundaries, and quantities of flow produced in each area. Constant concentrations or unit loads can also be estimated using a spreadsheet.

EPA's Nationwide Urban Runoff Program (NURP), conducted from 1978 to 1983, is one example of a comprehensive study of storm water runoff from residential, commercial, and light industrial areas throughout the United States. It contains a large data base of pollutant concentrations and loads measured during various storm events (U.S. EPA, 1983a). Other data bases of storm water pollutant concentrations and loads include Driver and Tasker (1990); Tasker and Driver (1988); and U.S. EPA, 1974, 1977,1982a, 1990. Such data bases, however, must be used cautiously. For example, since the NURP data are based largely on areas without sanitary waste or industrial waste influences, they might not be representative of the location being studied.

These types of data can be applied to source load estimation techniques such as the constant concentration or unit load method. For example, Table 6-3 presents median and mean values of event mean concentrations (EMCs) derived from urban runoff from EPA's NURP study (U.S. EPA, 1983a). Typical ranges of concentrations of various pollutants found in rainfall, storm water, combined wastewater, and wastewater effluent are presented in Table 6-4. With the aforementioned cautions, such values can be used as first-cut estimates of pollutant loadings. Because of the high variability of urban runoff data, however, site-specific data are required to ensure the accuracy of this or other methods.

Table 6-3. Water Quality Characteristics of Urban Runoff for the NURP Site (U.S. EPA, 1983a; Adapted from Novotny, 1992)

Constituents	Site Median Event Mean Concentration	Site Mean Event Mean Concentration
Total suspended solids, mg/L	100	141 to 224
Biochemical oxygen demand (5-day), mg/L	9	10 to 13
Chemical oxygen demand, mg/L	65	73 to 92
Total phosphorus, mg/L	0.33	0.37 to 0.47
Soluble phosphorus, mg/L	0.12	0.13 to 0.17
Total Kjeldahl nitrogen, mg/L	1.50	1.68 to 2.12
Nitrate and nitrite nitrogen, mg/L	0.68	0.76 to 0.96
Total copper, µg/L	34	38 to 48
Total lead, µg/L	144	161 to 204
Total zinc, µg/L	160	179 to 226

Table 6-5 shows an example of the constant concentration method used to estimate loadings of fecal coliform bacteria and nitrate-nitrogen and to prioritize nonpoint sources in a watershed. To estimate the loadings, mean concentrations for different land uses were multiplied by the estimated annual runoff volume.

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Table 6-4. Characteristics of Rainfall, Storm Water, Combined Wastewater, and Treated Effluent (Adapted from various sources; see Metcalf & Eddy, Inc., 1991; Novotny, 1992)

Parameter	Rainfall	Storm Water	Combined Wastewater	Primary Effluent	Secondary Effluent
Suspended solids, mg/L	—	141 to 224	270 to 550	40 to 120	10 to 30
Biochemical oxygen demand (5-day), mg/L	1 to 13	10 to 13	60 to 220	70 to 200	15 to 45
Chemical oxygen demand, mg/L	9 to 16	73 to 92	260 to 480	165 to 600	25 to 80
Fecal coliform bacteria, MPN/100 mL	—	1,000 to 21,000	200,000 to 1,100,000	—	—
Total phosphorus, mg/L	0.02 to 0.15	0.37 to 0.47	1.2 to 2.8	7.5*	6*
Total nitrogen, mg/L	—	3 to 24	4 to 17	35*	30*
Total Kjeldahl nitrogen, mg/L	—	1.68 to 2.12	—	—	—
Nitrate nitrogen, mg/L	0.05 to 1.0	0 to 4.2	—	—	—
Total lead, µg/L	30 to 70	161 to 204	140 to 600	—	—

* Average value.

Table 6-5. Estimated Urban Runoff Loadings Using Constant Concentrations (U.S. EPA, 1992)

Source Area	Description and Location	Area, ac	% Impervious	Land Use	Runoff Coefficient	Annual Runoff Volume, Mgal	Annual Fecal Coliform Loading org x 10^{12} (rank)	Annual Nitrate Nitrogen Loading lb (rank)	Qualitative Ranking
A	Main St. and Freeport outlet stores	3.3	85	Commercial[a]	0.73	2.7	1.7 (12)	14 (11)	Low
B	Commercial development at I-95 interchange, Main and Pine streets	30.6	50	Commercial	0.46	15.7	9.8 (1)	82 (1)	High
C	A portion of Freeport Crossing outlets, Main St., Varney Rd., and Kar Klean	13.9	60	Commercial	0.61	9.7	6.0 (3)	51 (4)	High
D	Main St., Varney Rd., a portion of Linwood Rd., and adjacent residential development	21.0	10	Multifamily residential[b]	0.13	3.1	2.0 (10)	24 (8)	Low
E1	Southern L.L. Bean parking lot	6.5	85	Industrial[c]	0.73	5.4	2.8 (7)	28 (7)	Medium
E2	Northern L.L. Bean parking lot	5.5	80	Industrial	0.69	4.3	2.2 (8)	23 (9)	Medium
F	Independence Way, Eastland Shoe warehouse, Horseleathers Restaurant, and Main St.	14.1	20	Commercial	0.21	3.4	2.1 (9)	18 (10)	Low
G	Somerset Condominiums, Summer St., Upper West St., and Freeport Place Condominiums	38.0	20	Single-[d] and multifamily residential	0.21	9.1	5.9 (4)	73 (3)	High
H	Municipal garage, Main St., and town office parking lot	15.0	60	Industrial Commercial	0.53	9.1	4.7 (5)	48 (5)	High
I	Downtown Village area along Main St. between Morse and West streets including Oak	19.2	75	Commercial	0.65	14.2	8.8 (2)	75 (2)	High

[a] Fecal coliform concentration = 16,000 org/100 mL, NO_3-N concentration = 0.63 mg/L
[b] Fecal coliform concentration = 17,000 org/100 mL, NO_3-N concentration = 0.96 mg/L
[c] Fecal coliform concentration = 14,000 org/100 mL, NO_3-N concentration = 0.63 mg/L
[d] Fecal coliform concentration = 37,000 org/100 mL, NO_3-N concentration = 0.96 mg/L

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Runoff volumes were based on the size, imperviousness, and land use of each source area. Table 6-5 presents the estimated pollutant loadings for the watershed. Based on this analysis, 5 of the 10 areas (B, C, G, H, and I) of nonpoint source pollution were qualitatively assigned ratings of "high" based on their pollutant loadings. These areas contribute more than 75 percent of the total pollutant loading in the watershed.

Preliminary Screening Procedure

Simple equations can be used to estimate annual average loading contributions of urban runoff for 5-day biochemical oxygen demand (BOD_5), suspended solids, volatile solids, total phosphate phosphorus, and total nitrogen. The preliminary screening procedure is a sophisticated unit load method which can be used to calculate unit loads as a function of land use, population density, and frequency of street sweepings (U.S. EPA, 1982b). Pollutant loadings can be estimated based on the relative contribution of pollutants from each land use; however, the equations are not location specific and are useful only for screening purposes. Using the preliminary screening procedure, unit loads are calculated by the following equation developed by EPA (U.S. EPA, 1976a) as reported by Walesh (1989):

$$L = u(i,j) \times P \times PDF \times SWF$$

where:

- L = average annual amount of pollutant j generated per unit of land use i, lb/ac/yr
- u(i,j) = load of pollutant j generated per unit of runoff from land use i, in lb/acre-inch
- P = average annual precipitation, in
- PDF = population density factor, a dimensionless parameter with a value for residential areas of $0.142 + (0.218)(PD)^{0.54}$, where PD is a population density in persons per acre, equal to 1.0 for commercial and industrial areas, and 0.142 for institutional areas (e.g., parks, cemeteries, and schools)
- SWF = street-sweeping factor, a dimensionless parameter; SWF = 1.0 when streets are swept infrequently, with the average time between street sweepings being greater than 20 days; for more frequent street sweeping, SWF is less than 1.0 and could be estimated from site-specific data or literature values.

The unit pollutant loads (u) are obtained from measured or estimated concentrations or loadings from various land use or source areas.

Statistical Method

The statistical method of modeling urban runoff assumes that EMCs are distributed log-normally and characterizes EMCs by their median values and their coefficients of variation. EPA's statistical method (U.S. EPA, 1979) includes statistical properties of rainfall, area, runoff coefficients, median EMCs, and coefficients of variation of EMCs of various pollutants. The Federal Highway Administration (FHWA) has implemented EPA's statistical method for various locations in the United States (Driscoll et al., 1989; Woodward-Clyde Consultants, 1990a).

The runoff flow rate and volume from a mean event are computed by the FHWA model using the following equations:

$$MQR = Rv \times MIP \times ARW \times (3{,}630/3{,}600)$$

$$MVR = Rv \times MVP \times ARW \times 3{,}630$$

where:

- MQR = average runoff flow rate for mean storm events, ft^3/s
- Rv = runoff coefficient (ratio of runoff to rainfall), equal to $0.007 \times IMP + 0.10$, where IMP is equal to the impervious fraction of the drainage area, %
- MIP = rainfall intensity for mean storm event, in/hr
- ARW = drainage area of the highway segment, ac
- MVR = volume of runoff for mean storm event, ft^3
- MVP = rainfall volume for mean storm event, in

The numbers 3,630 and 3,600 are dimensional conversion factors.

The log-normally distributed EMCs are calculated by the equation:

$$MCR = TCR \sqrt{(1 + CVC^2)}$$

where:

- MCR = EMC for site, mg/L
- TCR = site median pollutant concentration, mg/L
- CVC = coefficient of variation of EMCs

and the mean event mass load is computed by:

$$M(MASS) = MCR \times MVR \times (62.45 \times 10^{-6})$$

where:

- M(MASS) = mean pollutant mass loading lb/event
- MCR = mean runoff concentration, mg/L
- MVR = mean storm event runoff volume, ft^3

Universal Soil Loss Equation

The Universal Soil Loss Equation is primarily applicable to agricultural areas and is used to estimate the soil loss

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and sediment yield from a homogeneous parcel of land (U.S. EPA, 1976b). The discussion in this handbook is general, and more detailed information can be obtained from referring to more specific sources (SCS, 1977). This method, relatively simple to use, considers such factors as rainfall, erosive forces of the rainfall, soil erodibility, slope, vegetative cover, and erosion control practices. Since this method is used primarily to estimate soil loss and, when modified, sediment yields from non-urban, agricultural areas, it is less applicable to the problems addressed in this handbook than other methods discussed.

The Universal Soil Loss Equation is:

$$E = A \times R \times K \times LS \times C \times P$$

where:

- E = soil loss by water erosion in rill and inter-rill areas, tons/yr
- A = area, ac
- R = rainfall factor, accounting for erosive forces of rainfall and runoff, erosion index units/yr
- K = soil erodibility factor reflecting the physical and chemical properties of a particular soil, tons/ac/erosion unit index
- LS = slope length or topographic factor reflecting the influence of vegetation and mulch, dimensionless
- C = cover and management factor reflecting the influence of vegetation and mulch, dimensionless
- P = erosion control practice factor that is similar to the cover-management factor, but accounts for practices on the land surface such as contouring, terracing, compacting, sedimentation basins and control structures, dimensionless

In order to estimate sediment yield (as opposed to soil loss), the equation is modified by adding a sediment delivery ratio (S_d) as follows:

$$Y(S)_E = A \times R \times K \times LS \times C \times P \times S_d$$

where:

- $Y(S)_E$ = sediment loading to stream, tons/yr
- S_d = sediment delivery ratio, dimensionless

The sediment delivery ratio is a function of the amount of attenuation of gross erosive soil loss in the watershed. This ratio depends on factors such as soil characteristics, slopes, lengths, and watershed area and is estimated using empirical data. Estimates for this and the other parameters should be made only after consulting more detailed references (i.e., SCS, 1977; U.S. EPA, 1976b).

Regression-Rating Curve Approaches

Rating curve or regression models, such as the 31 storm runoff load models developed by the USGS for metropolitan areas throughout the United States (Driver and Tasker, 1990; Tasker and Driver, 1988), use site-specific rainfall, runoff, and source concentration data, such as the data collected for NURP and similar studies, to relate concentrations and loads of pollutants to flow rates and volumes. The regression model for estimation of storm runoff loads and volumes is given by the equation (Driver and Tasker, 1990):

$$\hat{Y} = \beta_0 \times X_1^{(\beta 1)} \times X_2^{(\beta 2)} \ldots X_n^{(\beta n)} \times BCF$$

where:

- $\hat{Y}$ = estimated storm-runoff load or volume, response variable
- $\beta_0, \beta_1, \beta_2, \beta_n$ = regression coefficients, provided by Driver and Tasker, 1990
- X_0, X_1, X_2, X_3 = physical, land use, or climatic characteristics, explanatory variables
- BCF = bias-correction factor, calculated by Driver and Tasker, 1990

Hydrologic and Pollutant Buildup-Washoff Models

For larger and more complex programs, it may be desirable to use hydrologic and pollutant buildup-washoff models. These models address the accumulation of pollutants during dry-weather periods and the washing off of these pollutants during rainfall events. Of the many models available, some of the more widely used models that use a buildup-washoff mechanism include Hydrological Simulation Program—Fortran, HSPF (U.S. EPA, 1981); Storm Water Management Model, SWMM (U.S. EPA, 1988b); Storage, Treatment, Overflow, Runoff Model, STORM; and Source Loading and Management Model, SLAMM (Pitt, 1989). These models are described below. Table 6-6 compares these urban hydrologic and pollutant buildup-washoff models and the EPA statistical method as implemented by the FHWA. Many other models are available which are not described here.

HSPF, available from EPA, simulates movement and storage of water in the hydrologic budget of a watershed or drainage basin, from rainfall to streamflow to ground-water storage. HSPF is useful when large watersheds comprising multiple pollutants and land uses are to be modeled and/or when issues such as sediment erosion, pollutant interaction, and ground-water quality of the system are of concern. Input data requirements of this model are extensive and include time series inputs of hydrologic and meteorologic data, and input of characteristics describing pollutants, topography, storage, response, and evapotranspiration. HSPF can simulate receiving waters and pervious and

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Table 6-6. Comparison of Urban Runoff Models (U.S. EPA, 1981c; Pitt, 1986)

Attribute	Model				
	Storm Water Management Model (SWMM)	Hydrological Simulation Program—Fortran (HSPF)	Storage, Treatment, Overflow, Runoff Model (STORM)	Source Loading and Management Model (SLAMM)	Statistical
Sponsoring Agency	EPA	EPA	Hydrologic Engineering Center (HEC)	Pitt[a]	EPA
Type of Method					
Surface water—simple	X	X	X		
Surface water—refined	X			X	
Soil ground water—simple					
Soil ground water—refined		X			
Surface water—statistical					X
Simulation Type					
Continuous	X	X	X		N/A
Single event	X	X		X	N/A
Hydraulic/Hydrologic Features					
Rainfall/runoff analysis	X	X	X	X	[b]
Sewer system flow routing	X	X			
Full, dynamic flow routing	X[c]				
Surcharge	X[c]				
Regulators, overflow structures	X		X		
Storage analysis	X	X	X	X	X[d]
Predicted Pollutant Concentrations In:					
Runoff water	X	X	X	X	X
Surface water	X	X			
Ground water	X	X			
Predicted Pollutants					
Conventional	X	X	X	X	X
Organic	X	X		X	X
Metals	X				
Number of pollutants	10	10	8	10	Any
Source/Release Types					
Continuous	X	X	X	X	
Intermittent	X	X			
Single	X	X			
Multiple	X	X			
Diffuse	X	X	X	X	X
Unique Features					
Special solids routines	X	X	X	X	
Treatment analysis	X	X			
Degradation products	X	X			X[e]
Data base	X	X			
Uncertainty analysis	X		X		
Input/execution manager		X			
Level of Application					
Screening	X	X	X	X	X
Intermediate	X	X		X	
Detailed (suitable for design)	X	X		X	
Data and Personnel Requirements[a]	High	High	Low	High	Moderate
Overall Model Complexity[f]	High	High	Moderate	High	Moderate
Available on Microcomputer	X	X		X	X

[a] SLAMM is a proprietary model owned by R. Pitt, Ph.D., Department of Civil Engineering, University of Alabama.
[b] Runoff coefficient used to obtain runoff volumes.
[c] Full dynamic equations and surcharge calculations only in EXTRAN block of SWMM.
[d] Storage and treatment analyzed analytically.
[e] General interpretation based on requirements for model installation, familiarization, data requirements, etc.
[f] Reflection of model size and capabilities; complex models can be used to simulate simple systems with minimal data requirements.

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impervious lands and soils. Although it is complicated, model documentation is available from EPA, including copies of the model, user assistance, and periodic training sessions (U.S. EPA, 1991d).

SWMM is a complex model using finite-difference approaches that can be used to simulate urban storm water runoff and combined sewer overflows. Input data requirements are extensive and involve information such as precipitation, air temperature, channel and pipe networks, land use patterns, and storage and treatment facilities (U.S EPA, 1991d). SWMM can be used during both the planning and design phases of a program. Its output consists of hydrographs, pollutographs, and control options and cost (U.S. EPA, 1991d). Model documentation is available from EPA.

While the use of SWMM and HSPF requires a high level of effort and expertise, the models also lend themselves to more simplified treatment and simplified versions are available. For example, in SWMM, the buildup-washoff method of estimating pollutant contribution to a system can be substituted with constant pollutant concentrations. SWMM can also be run in a long-term mode using variable time steps so both event-specific and seasonal/annual conditions can be analyzed.

STORM contains simplified hydrologic and water quality routines for urban runoff modeling. While data requirements of the model are minimal, the model is less flexible than other, more complex models. Output of STORM includes storm event summaries of runoff volume, concentrations and loads, storage and treatment utilization, and total overflow loads and concentrations (U.S. EPA, 1991d). Although the simplicity of STORM makes it an attractive model for screening purposes, it has not been updated by its agency sponsor, the U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC), since 1977. While the model has been updated and refined by private entities and many applications of STORM exist, use of STORM has declined in recent years (U.S. EPA, 1991d).

SLAMM is a proprietary model which can be used to evaluate the effects of pollution control measures and development characteristics on urban runoff quality and quantity. Model input requirements include rainfall duration, depth of rainfall, areas of each pollution source type, SCS soil types, building density, land use, pavement texture, traffic density, and roof pitch (Pitt, 1989). The SLAMM model user manual incorporates a discussion of the hydrology of small storm events and its relationship to more "standard" hydrologic models. Investigations have shown the need to represent the rainfall-runoff processes correctly for the more frequent, smaller size storms since they often account for a major part of the pollution loading (Pitt, 1989). Output of the SLAMM model includes, for each rain and land use, matrices describing source area and outfall flow volumes, particulate residue mass and concentrations, and relative contributions from each rainfall event (Pitt, 1989).

While many other models are also available, some receive little or no support from their sponsoring parties and/or have not been widely used. Other widely used models can simulate hydrology but not pollutant buildup and washoff. Such models include TR20 (SCS, 1969) and HEC1 (Hydrologic Engineering Center, 1990). These hydrologic models are not discussed in detail here; model documentation and references contain the specific hydrologic calculations used.

Hydrologic models, such as TR20 and HEC1, can be used to generate time-varying runoff flows for one or more storm events using rainfall and watershed characteristics as model inputs. To generate urban runoff pollutant loads, the hydrologic output (flow versus time) from the models could be combined with estimated urban runoff concentrations. For some applications, for example sizing of BMPs such as detention ponds, only a hydrologic model is needed.

Transport Characteristics Determination

In addition to the magnitude of a pollutant load, the location of a pollution source with respect to the affected resource, the mode of transport to the resource and degradation of the pollutant should also be considered. For example, sources with a clear path to a waterway, such as pipes, ditches and gulleys, are more likely to cause adverse effects in a receiving water than similar sources that must travel through natural filters such as forested or grassy areas before entering a surface water body. Changes in loads, from the initial source discharge to the point where they affect the receptor, occur because of such factors as travel time, dilution, soil infiltration, and decay. Fate and transport of pollutants can be modeled using hydrologic and pollutant buildup-washoff models which attempt to account for these factors deterministically. Since the simpler methods (i.e., unit load or statistical) can only empirically estimate these factors, the level of uncertainty and error is likely to be higher. The level of uncertainty is high even with the deterministic models, though. Site-specific data is thus important to validate any tool which is used.

Resource Assessments

Resource assessments address the impact of pollutant sources on the resources of interest—taking the results of the pollutant source assessments (described in the previous section of this chapter) and determining the effect of these pollutant sources on water resources. Assessments, however, can be conducted on other ecological aspects of a watershed, as well. Water

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resources can include water quality as well as aquatic life, sediment, and other characteristics of the water bodies. Methods to perform resource assessments can range from evaluation of water quality data and comparison with criteria, to mathematical modeling of receiving waters. These methods are described further in this section.

Basic Data Evaluation

Urban runoff problems can be identified by evaluating available and newly collected data. Evaluation of available data is conducted with numerous tools, including spreadsheets, database management systems, GIS, statistical analysis (described in Chapter 5), and mathematical models (described in this chapter). The data are compared to acceptable resource criteria to determine the existence and severity of problems.

A useful measure of the condition of a specific water resource is comparing its water quality, sediment, or biological data with state water quality standards or EPA water quality criteria. State water quality standards define the quality of water that supports a particular designated use. EPA publishes water quality criteria that consists of scientific information regarding the concentrations of specific chemicals in water that protect species against adverse acute (short-term) effects on sensitive aquatic organisms, chronic (long-term) effects on aquatic organisms, and effects on human health from drinking water and eating fish (U.S. EPA, 1986). These criteria, often based on results of toxicity testing of sensitive species, are intended to be protective of all species. Section 304(a)(1) of the Clean Water Act requires EPA to publish and periodically update these criteria.

The Safe Drinking Water Act of 1974, established to protect public drinking-water supplies, requires EPA to publish maximum contaminant level goals (MCLGs), which are non-enforceable levels at which there are no known or anticipated health effects, and maximum contaminant levels (MCLs), which are enforceable levels, based on best technology, treatment techniques, and other factors including cost. Updates to federal criteria are announced in *Federal Register* notices.

States have surface water standards that classify surface water bodies into use categories, establish instream levels necessary to support these uses, and define policies regarding the protection and enhancement of these water resources. EPA can establish water quality standards (40 CFR 131) for toxic pollutants in states and territories that have not fully adopted their own standards. In addition, many states have ground-water standards that designate uses for various ground waters, and water quality levels necessary to sustain these uses and protect ground-water quality.

The interpretation of sediment chemistry results is not straightforward. A number of approaches have been used to evaluate the degree of contamination in sediments (Maughan, 1993). Many of these approaches have been developed to determine impacts associated with dredging activities (U.S. EPA and U.S. ACOE, 1991). EPA is developing criteria for sediment similar to those for water quality for certain organic compounds (U.S. EPA, 1988c). An important factor affecting the development of these criteria is the bioavailability or toxicity risk to aquatic organisms due to a contaminant in undisturbed sediment. Since this bioavailability is influenced by the physical and chemical nature of the sediment, toxic effects which might be seen at low concentrations in some sediment types might not be evident in others.

To take the variability due to sediment characteristics into account, contaminant concentrations are normalized through equilibrium partitioning between particulate and liquid (pore water) phases, after which EPA water quality criteria are used to assess environmental or human health risks. Further development of sediment criteria for inorganics, such as metals, is anticipated. Until sediment criteria are finalized, much of the evaluation of sediment chemistry data is accomplished on a relative basis by comparing the results from upstream and downstream stations to determine if elevated levels of contaminants exist, or by comparing results to other areas where data are available.

Ecological effects can be assessed by examining the biological community structure. Specific parameters to consider include the relative abundance of pollution-tolerant and pollution-sensitive species as well as common indices including, but not limited to, Shannon-Weiner diversity, Simpson's dominance, and evenness (Pielou, 1975) as discussed in Chapter 5. Various types of biological criteria or indices are available from the literature and can be used for comparative purposes. An example of the use of biocriteria to evaluate data is the State of Ohio biotic index, which has been used to assess the condition of the biota of rivers and streams since 1978 (U.S. EPA, 1991e). Ohio's use of biocriteria is described in the case study at the end of this chapter.

Receiving-Water Modeling

Receiving-water models are used to assess existing conditions and to simulate future conditions of a water resource under various pollution prevention and control scenarios. They can also be used to assess the impact of alternative BMPs (Chapter 8). These models receive input from runoff model results, field-measured

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parameters, and values of parameters found in the literature. The level of complexity of the receiving-water model chosen should parallel that of the model used to assess urban runoff flows and loads. Some commonly used receiving water models include the Enhanced Stream Water Quality Model (QUAL2E), the Water Quality Analysis Simulation Program (WASP4), and the Exposure Analysis Modeling System II (EXAMSII), as summarized in Table 6-7 and described in more detail below. In addition, HSPF, discussed above, has a receiving-water model component. These models, along with the SWMM model, are available from EPA's Center for Exposure Assessment Modeling, Environmental Research Laboratory, in Athens, Georgia.

QUAL2E can be used either as a steady-state or quasi-dynamic model to simulate conditions of rivers with multiple headwaters, waste discharges, tributaries, withdrawals, dams, and incremental inflows and outflows. The model can simulate 15 water quality constituents, including dissolved oxygen, biochemical oxygen demand, temperature, nitrogen and phosphorus species, coliforms, arbitrary nonconservative constituents, and conservative constituents (U.S. EPA, 1987c). QUAL2E-UNCAS is an enhancement to QUAL2E which allows the user to perform uncertainty analysis on the effects of model sensitivities and uncertain input data on model forecasts (U.S. EPA, 1987c). Three types of uncertainty analyses are available: sensitivity analysis, first-order error analysis, and Monte Carlo simulation. Using this model, the user can determine input factors that contribute the most to the model's uncertainty and the level of risk associated with model predictions. Both QUAL2E and QUAL2E-UNCAS are supported by EPA and are well documented.

The modeling framework of WASP4 provides a flexible-compartment modeling approach, applicable in one, two, and three dimensions, which can be used to simulate contaminant fate in surface water. WASP4 is structured to allow the easy substitution of user-written subroutines into the model. Thus, a range of water quality problems can be simulated by WASP4 using either one of the model's kinetic subroutines or a subroutine written by the user. The model can be used to simulate biochemical oxygen demand, dissolved oxygen, nutrients and eutrophication, bacterial contamination, and toxic chemicals in the sediment bed and in the overlying waters. In addition, WASP4 can be linked to other models, such as DYNHYD5, a simple model that simulates variable tidal cycles, wind and unsteady flows, and the Food Chain Model, which predicts pollutant uptake and distribution throughout an aquatic food chain (U.S. EPA, undated).

EXAMSII performs evaluations and error analyses of the fate of synthetic organic chemicals based on user-specified properties of chemicals and ecosystems, such as descriptions of a system's external loadings, transport processes and transformation processes. Model predictions include chemical exposure, consisting of long-term chronic, 24-hour acute, and 96-hour acute concentrations; fate, consisting of the distribution of chemicals in the system and the relative dominance of each transport and transformation process; and persistence, the time required for effective purification of the system once the loading has ended (U.S. EPA, undated).

Model Selection

Selection of receiving water models for resource assessments (or of urban runoff models for pollutant source assessments) depends on considerations such as available input data, project requirements, budget constraints, and user preference and familiarity. It is sometimes useful to choose a simple or screening level model at first to identify major pollutant impacts or loads for which preliminary control measures could be implemented. A more complex model can then be selected if more detailed analyses of the impact of pollutants and the effect of alternative corrective measures are required. Since model simulations can help in selecting pollution prevention and treatment measures (and thus, in allocating of limited funding), the user should have experience with the model to ensure that the model predictions are correct. An understanding of the selected model and its capabilities and limitations is critical.

In 1976, EPA compiled a list of questions and factors that should be considered when selecting a model (U.S. EPA, 1976b). These considerations, which can be used to select either urban runoff or receiving water models, are presented below.

To determine whether a model is required or could be used, one could consider the following issues:

1. What is the problem to be solved?
2. What temporal resolution is required? Depending on the type of water quality problem and receiving-water, single-event, seasonal, or long-term multiple-year calculations might be appropriate.
3. Is a model needed? If so, what approach is necessary (e.g., computer program, hand calculations)? Would a gross assessment of relative loads and impacts on water quality suffice?
4. What input, calibration, and verification data are available? The model selected must be calibrated and verified, and adequate input data must be collected. If data are not available, or if adequate funds for data collection are not provided, the use of a complicated model could be ruled out.

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Table 6-7. Comparison of Receiving-Water Models (U.S. EPA, 1983b, 1985a,b)

Attribute	Models			
	Enhanced Stream Water Quality Model (QUAL2E)	Water Quality Analysis Simulation Program (WASP4)	Exposure Analysis Modeling Systems II (EXAMS II)	Hydrological Simulation Program—Fortran (HSPF)
Application	River flow, well-mixed lakes	General—river flow, lakes, estuaries, oceans	Nontidal lakes	Unstratified lakes
Dimensionality	One-dimensional	Three-dimensional	Three-dimensional	One-dimensional
State	Steady-state Quasi-dynamic	Time-varying	Steady-state	Time-varying
Water column transport	Advective and dispersive	Advective and dispersive	Advective and dispersive	Advective
Sediment bed condition	Completely mixed	Completely mixed	Completely mixed Simplified exchange	Completely mixed, sedimentation
Sediment bed type	Stationary	Stationary	Stationary	Moving
Unique features	UNCAS—uncertainty analyses of input parameters on model forecasts	TOXIC—models dissolved and adsorbed chemical concentrations EUTRO—models DO, CBOD, nutrients, phytoplankton DYNHYDRO—models tidal cycles, wind, unsteady inflows Food Chain model—simulates uptake and distribution throughout a food chain	Contaminant transformation and transport processes	ARM—Agricultural runoff model NPS—nonpoint source model

If a model is determined to be necessary, other factors to consider include the following:

1. Regardless of the method selected, personnel qualified in water quality analysis should be available. Any model, simple or complicated, requires a considerable amount of expert judgment in its application. Without this expertise, model application likely will fail.
2. The major costs in applying any computer-based model are related to becoming familiar with the model, collecting basic data for model application (most of these data remain the same, regardless of the number of times the model is used), and setting up the model on the local computer system. Thus, availability of models that previously have been calibrated and applied locally should be considered.

Once it has been determined that a model will be used, the following questions should be considered in determining whether the model is suitable for the problem being studied.

1. What, if any, water quality constituents are to be modeled and can the model accommodate them?
2. Is the problem steady state or dynamic (i.e., do sources or conditions change over time)?
3. What are the spatial considerations? For streams, a one-dimensional model is adequate if homogeneous mixing across the river cross-section is an adequate assumption. For an estuary, a two- or three-dimensional model might be required.
4. Has a model under consideration been used and tested? Is good, user-oriented documentation available?
5. If a proprietary model is considered, how will continuity in planning be accommodated? The planning process is ongoing, and models are most economical when used repeatedly.
6. What are the costs of model application? Computer costs are relatively insignificant; the major costs of model use are personnel costs.

Model Validation

The input data file for a model used either for resource assessment or pollutant source assessment is calibrated using values of parameters measured during field investigations of the pollution sources and/or receiving-water system, depending on the type of modeling. Parameters to be included as model input, but that were not measured during field sampling, are estimated and adjusted to provide a close fit of model predictions to measured data. Values for parameters not easily or regularly measured can be obtained from engineering and scientific publications. Often, typical values, or "default values," for these parameters are presented in the model's user manual and can be used in the initial phases of model calibration.

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Model verification, the next step in the model validation process, often involves using a second data set to verify the accuracy of the calibrated model input. Measured parameters from the second data set are input to the model and simulated levels of parameters (such as dissolved oxygen concentration) are compared to actual values measured during the second field sampling survey. Verification may be conducted qualitatively, by visually comparing graphical representations of the model simulation and actual data. In addition, a quantitative verification can be conducted through the use of simple statistical comparisons. Calibrated parameters can be adjusted again, to ensure a good fit between model predictions and each data set. A detailed discussion of the model validation procedure was presented by U.S. EPA (1980).

Once the urban runoff or receiving-water model has been validated, it can be used to simulate various scenarios of storm events, pollutant loadings, and corrective measures. Graphical presentation of model results is an effective method for displaying model simulations during evaluation of results and in reports. While computer modeling is valuable for examining existing conditions and simulating impacts due to future changes, users should be aware that model predictions are only as accurate as the quality of the data used; some level of error is associated with even the best modeling techniques.

Institutional Assessments

Assessment of the institutional constraints of a program provides the managers with perspective concerning the nontechnical issues affecting the program. The institutional issues of a program are assessed by evaluating the program's potential and limitations and by reviewing the requirements of involved agencies and the public. One major institutional issue that must be addressed on an urban runoff program is determining the responsibilities of each involved party, especially for programs involving multiple agencies. Issues related to the control of the program (e.g., enforcement, maintenance, permitting, and funding) can affect the program's emphasis and the selection of its corrective measures. Another institutional issue involves the limitations of available technology. Implementability of controls can also be considered, particularly in areas involving limited access to private properties. The potential for eliminating or reducing an urban runoff problem or improving affected water resources can also be considered. Questions and concerns of the public might prove to be influential during the decision-making processes. Applicable regulations could force the sequencing of corrective measures so that those addressing compliance with the regulations are implemented first.

Goals and Objectives Assessments

The relative importance of an urban runoff problem can be assessed by comparing it to the program's resource and/or technology-based goals and the objectives of the program's sponsor, as discussed in Chapter 3. For example, one water resource goal might be to "provide improvements to water quality in areas where the most people will benefit." Comparison of the pollution problems to such a goal provides the program team with perspective on which problems to solve to achieve the goal. By comparing the pollution problems to the program's goals and objectives, the program team can identify and focus on problems that are compatible with these goals. The assessments conducted on pollutant sources, water resources, and institutional aspects provide input to these determinations.

Problem Ranking

Since funding to correct pollution problems is usually limited, the sources or impacts to be addressed should be prioritized to allow for targeting of limited resources. While ranking is a subjective process that requires the judgment of decision-makers, ranking systems can be used to help develop priorities. A ranking methodology can range from simple, descriptive methods (qualitative) to numerically complex (quantitative), depending on the urban runoff program objectives and funding constraints. Ranking methods can apply to a variety of geographic areas, ranging from counties or communities with multiple watersheds to individual water bodies or pollution sources. Criteria such as those presented in Table 6-1 can be used in problem ranking.

Ranking should be conducted following consultation with involved parties, including local, state, and federal agencies; local environmental groups; and concerned citizens. Public opinion can have a large influence on the ranking of pollution problems. For example, the public might give priority to controlling sources that discharge to a favorite pond used for swimming. Urban runoff control programs should consider public concerns and desires when prioritizing problems, no matter which type of ranking approach is employed.

Three types of ranking procedures, ranging from simple to complex, are discussed in this section.

Qualitative Ranking

The simplest ranking approach uses qualitative rankings (e.g., high, moderate, or low) to prioritize pollution problems such as in the example presented in Table 6-5. Other qualitative ranking methods use letters (e.g., A, B, C) or numbers (e.g., 1, 2, 3) to develop a relative scale for comparing problems. The qualitative rankings must then be interpreted to determine which problems should be of highest priority in developing

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controls. In the example in Table 6-5, the qualitative rank is based on estimated pollutant load. Other measures can also be used as a basis for qualitative rankings (e.g., level of public concern or the importance of the use to be protected).

Numerical Ranking

To perform numerical ranking, rating points are assigned to each ranking criterion for each problem. Each ranking criterion is assigned a weight based on its importance relative to the other criteria. The rating points are then multiplied by the relative weight. All of the products (i.e., criterion rating x relative weight) are summed for a given problem. This procedure is then repeated for all the problems being evaluated. The sums thus assigned are compared and the problems with the highest sums receive the highest priority during implementation of urban runoff controls.

In an example of a numerical ranking system for prioritizing pollution sources (Woodward-Clyde Consultants, 1990b), a hypothetical application of this weighted ranking methodology uses the following criteria: water body importance (as reflected by stream or lake size), type of use (ranging from urban drainage to recreational contact), status of use (impaired versus denied), level of use (low, moderate or high), pollutant loads (not actual loads but estimates for comparative purposes), and implementability of controls (based on institutional factors, existing ordinances, or technical considerations). These criteria are similar to some identified in Table 6-1. The relative importance of each criterion is designated by assigning a weight appropriate for the site-specific conditions of the watershed under consideration. The sum of all weights used to rank the problems equals 100. Next, for each problem, the criteria are ranked using a suggested range of 1 to 9, with a higher numerical ranking indicating a higher need for corrective action. This listing allows relative comparisons to be made among problems with respect to a single criterion.

A hypothetical urban watershed, consisting of three streams and several types of land use, illustrates this numerical ranking method for prioritizing pollution problems (Figure 6-1). Information describing the system is presented in Tables 6-8 and 6-9. Typical sources for these data include site-specific pollutant loading data, model results, and literature values from data bases such as those identified earlier in this chapter. There are four criteria of equal weight: stream size, beneficial use, pollutant load, and ability to implement (Table 6-10). The three "use" criteria are clustered together as subcriteria of the "beneficial use" criterion.

Ranking for "stream size" is determined based on the total drainage area of each of the three streams. Consistent with the goals for the hypothetical watershed, Stream C is ranked highest with respect to "type of use" because of its recreational uses in the city park; because it is used mainly as an urban drain, Stream B receives the lowest ranking; and Stream A is ranked between the other two streams because it is used to support aquatic life. With respect to "status of use," Stream A ranks highest because although somewhat impaired, it has the potential to be improved by control of pollution sources. Stream B receives a low ranking for use status because its water quality is poor and its function as part of an urban drainage system has long been accepted. Stream C also receives a low ranking for use status since the water is of high quality. Rankings for "level of use" reflect the number of people using or affected by each stream.

Mass pollutant loadings are calculated based on runoff coefficients (functions of the amount of impervious area), runoff concentrations of pollutants, and the amount of land use type in each stream's drainage area. Each stream is ranked based on the proportion of pollutant load from its watershed (in this example, total suspended solids is used). The watershed of Stream B is judged easiest to implement controls because it is predominantly industrial. Based on the method presented in this example, Stream C's watershed should receive priority during implementation of controls, followed by Stream A's and then Stream B's.

Quantitative Ranking

A fully quantitative ranking of urban runoff problems also could be performed using pollutant source assessment methods such as urban runoff models and resource assessment methods such as receiving-water models. Quantitative ranking requires the greatest amount of resources. For this approach, the models would be used to determine which pollution sources contribute the greatest impacts by testing various load reduction scenarios. Through such evaluations, critical problem sources or impacts could be prioritized. Chapter 8, which concerns selection of BMPs, discusses this type of approach further.

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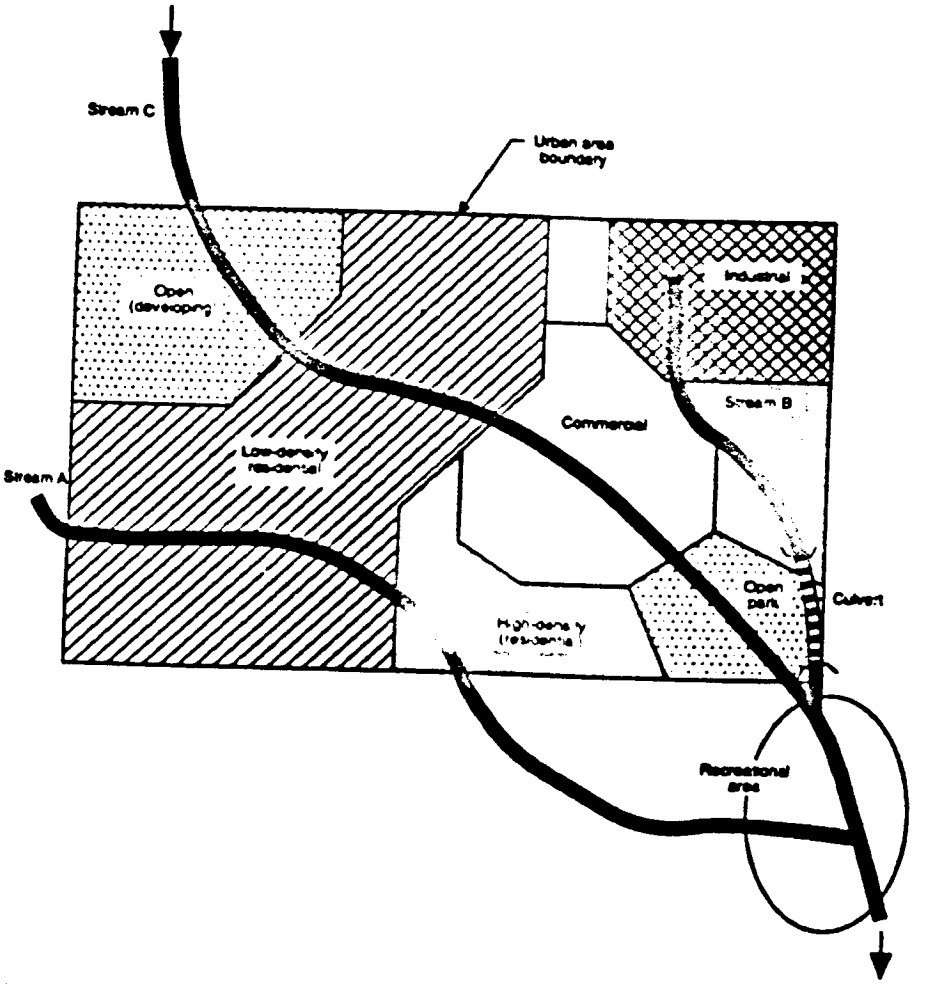

Figure 6-1. Schematic representation of watershed (Woodward-Clyde Consultants, 1980b).

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Table 6-8. Characteristics of the Targeted Areas and Estimated Concentration Loads (Woodward-Clyde Consultants, 1990b)

Land Use Category	Runoff Coefficient	Average Concentration in Runoff, mg/L				Drainage Area, ac			
		Total Suspended Solids	Oil and Grease	Total Petroleum	Copper	Stream A	Stream B	Stream C	Urban Total
Industrial	0.6	120	20	0.20	0.05	0	150	0	150
Commercial	0.8	80	15	0.20	0.05	10	80	110	200
Residential (high density)	0.4	90	10	0.40	0.04	100	100	50	250
Residential (low density)	0.2	100	5	0.60	0.03	200	0	200	400
Open—developing	0.1	150	0	0.80	0.01	0	0	150	150
Open—urban park	0.1	50	0	0.80	0.01	0	0	50	50
Total urban area						310	330	560	1,200
Upstream drainage area						600	0	20,000	20,600
Total drainage area						910	330	20,560	21,800

Table 6-9. Estimated Total Suspended Solids Loads for Targeted Areas (Woodward-Clyde Consultants, 1990b)

Land Use Category	Total Suspended Solids, lb/in of rain			
	Stream A	Stream B	Stream C	Urban Total
Industrial	0	2,452	0	2,452
Commercial	145	1,162	1,598	2,906
Residential (high density)	817	817	409	2,043
Residential (low density)	908	0	908	1,816
Open—developing	0	0	511	511
Open—urban park	0	0	57	57
Watershed total	1,870	4,431	3,482	9,784
Watershed rank value	1.7	4.1	3.2	9.0

Table 6-10. Prioritization Analysis for Urban Area Targeting (Woodward-Clyde Consultants, 1990b)

Urban Watershed	Stream Size	Beneficial Use			Pollutant Load (TSS)	Ability to Implement	Target Score*
		Type	Status	Level			
Weights	25	10	10	5	25	25	100
Watershed A	4	5	7	4	1.7	5	4.08
Watershed B	2	2	2	1	4.1	7	3.73
Watershed C	8	8	2	8	3.2	3	4.85
Total urban watershed	8	8	5	8	9.0	2	6.45

* Target score = weighted average of rank points = sum (rank score x weight)/sum (weight)

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Case Study:
Ohio Environmental Protection Agency
Biological Criteria for the Protection of Aquatic Life

Background

Since 1978, the Ohio Environmental Protection Agency (Ohio EPA) has been assessing the biota of rivers and streams as part of its basic monitoring strategy. This biomonitoring program was developed for Ohio's fishable waters in response to aquatic life goals of the Clean Water Act. Originally, biocriteria were used to assess the effects of wastewater treatment plant discharges on aquatic life throughout the state. Then, with the increased emphasis on addressing storm water runoff and NPS pollution sources, the Ohio EPA has begun using biomonitoring for these sources.

The use of biocriteria to assess a water body's overall health has several advantages over more common chemical analysis of receiving waters, including (Ohio EPA, 1987):

- The fish and macroinvertebrates sampled inhabit the receiving water continuously.
- The effects of past events (e.g., floods and droughts) are considered.
- Cumulative impacts can be seen.
- The species used have a long life span.
- The species allow a direct measure of CWA's biological goals.

The traditional approach of water chemistry analysis results in a snapshot of the receiving-water body at the time of sampling. For a more complete picture, numerous sampling events are required, which can be very costly. Biocriteria analysis, however, gives a cost-effective assessment, although somewhat qualitative, of the water body and its ability to support aquatic life.

Analysis Methods

In developing biocriteria, the state was divided into five different ecoregions with generally homogeneous characteristics. Within each ecoregion, water bodies were selected as "regional reference sites" to represent "least impacted" conditions. Rather than represent pristine conditions, these sites were selected based on the amount of stream channel modification, the condition of the vegetative riparian buffer, water volume, obvious color/odor problems, and general representativeness. Once these sites were selected, fish and macroinvertebrate sampling programs were implemented to determine water body characteristics and to obtain information required to develop quantifiable criteria to compare with the health of other water bodies. Three water body health indices were developed from the sampling data:

- Index of biotic integrity (IBI)
- Modified index of well being (Mlwb)
- Invertebrate community index (ICI)

The IBI and Mlwb are used to assess fish community health, and the ICI is used in the assessment of macroinvertebrate communities. Each index is developed by assessing a number of criteria for the water body of interest, as described below.

Index of Biotic Integrity

Used as a measure of the health of fish communities, the IBI consists of 12 criteria, or metrics, designed to give an overall assessment of the biota. The metrics are developed depending on the type of water resource being analyzed. The three types of sites include headwaters sites (drainage areas less than 20 square miles), wading sites (drainage areas greater than 20 square miles sampled by wading), and

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boat sites (drainage areas greater than 20 square miles sampled from a boat). Each of these types has its own set of metrics for use in determining the IBI, as shown in Table 6-11.

Table 6-11. Index of Biotic Integrity (IBI) Metrics

IBI Metric	Headwaters Sites	Wading Sites	Boat Sites
1. Total number of species	X	X	X
2. Number of darter species	X	X	
Round-bodied suckers, %			X
3. Number of sunfish species		X	X
Number of headwaters species	X		
4. Number of sucker species		X	X
Number of minnow species	X		
5. Number of intolerant species		X	X
Number of sensitive species	X		
6. Tolerant species, %	X	X	X
7. Omnivores, %	X	X	X
8. Insectivorous species, %	X	X	X
9. Top carnivores, %		X	X
Pioneering species, %	X		
10. Number of individuals	X	X	X
11. Simple lithophils, %		X	X
Number of simple lithophilic species	X		
12. Diseased individuals, %			
DELT anomalies, %	X	X	X

Data for each of these metrics were collected and plotted against drainage area for each of the "least affected reference sites" in each ecoregion. The plot showing the relationship between the metric and drainage area was then divided into three equal regions as shown in Figure 6-2. These plots form the basis for determining the IBI for the water body of concern. When determining the IBI, data for the water body are compared with the "least affected reference site" plots, and each metric is rated according to whether it approximates (5), deviates somewhat from (3), or strongly deviates (1) from the value expected at a reference site. For example, looking at the number of species example shown in Figure 6-2, a water body with a drainage area of 10 square miles and 10 species collected during a sampling run would be given a rating of 3 for that metric. Similar ratings are given for all 12 metrics making up the IBI. After all ratings for a water body are given, they are added up; the sum represents the water body's IBI. Because of the rating scales used, the IBI for a water body will range from 12 (very poor biotic integrity) to 60 (very good biotic integrity). Ranges of IBI values and their respective qualitative assessments are shown in Table 6-12.

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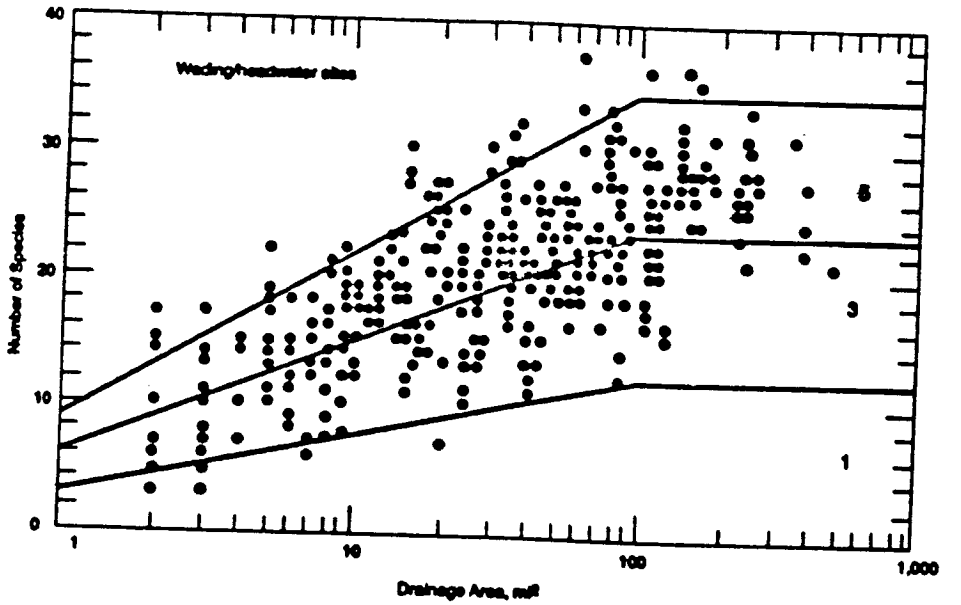

Figure 6-2. Number of species vs. drainage area for determining 5, 3, and 1 index of biotic integrity (IBI) scoring.

Table 6-12. Qualitative Assessment of Index of Biotic Integrity (IBI) Values

	Exceptional	Good	Fair	Poor	Very Poor
Wading sites	50-60	36-48	26-34	18-26	<18
Boat sites	50-60	36-48	26-34	16-24	<16
Headwaters sites	50-60	40-48	26-38	16-24	<16

Modified Index of Well Being

The MIwb is the second index used to describe the quality of fish populations in water bodies throughout the state. A more traditional index, the MIwb takes into consideration the fact that healthy systems support a larger variety and abundance of fish than stressed systems. This index incorporates four measures of fish community health:

- Numbers of individuals
- Total biomass
- Shannon diversity index based on numbers
- Shannon diversity index based on weight

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The formulas used to calculate MIwb are:

$$MIwb = 0.5 \ln N + 0.5 \ln B + H(no.) + H(wt.)$$

where:

N = relative numbers of all species (excluding species designated highly tolerant)
B = relative weights of all species (excluding species designated highly tolerant)
H(no.) = Shannon diversity index based on numbers
H(wt.) = Shannon diversity index based on weight

The Shannon diversity index is defined by the following formula:

$$H = -\Sigma[(n_i/N) \times \ln(n_i/N)]$$

where:
n_i = relative numbers or weight of the ith species
N = total number or weight of the sample

Ranges of MIwb values and their respective qualitative assessments are shown in Table 6-13.

Table 6-13. Qualitative Assessment of Modified Index of Well Being (MIwb) Values

	Exceptional	Good	Fair	Poor	Very Poor
Wading sites	≥8.4	6.0-8.3	5.9-7.9	4.6-5.9	≤4.5
Boat sites	≥9.5	6.3-9.4	6.4-6.7	5.0-6.4	≤5.0

Invertebrate Community Index

The ICI is used to measure the health of the invertebrate community. Invertebrates are useful as indicators of environmental quality because they (Ohio EPA, 1987):

- Form permanent and relatively immobile communities
- Can be easily collected in large numbers even in small water bodies
- Can be sampled at relatively low cost per sample
- React quickly to environmental change
- Occupy all stream habitats
- Inhabit the middle of the aquatic food web

The method used to determine the ICI is similar to that for the IBI. A number of "least affected reference sites" were identified and sampled to develop criteria. The ICI consists of 10 invertebrate community metrics each with four rating categories (0, 2, 4, and 6). The 10 metrics used to calculate the ICI are:

- Total number of taxa
- Total number of mayfly taxa
- Total number of caddisfly taxa
- Total number of dipteran taxa
- Percent mayfly composition
- Percent caddisfly composition

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- Percent tribe tanytarsini midge composition
- Percent other dipteran and non-insect composition
- Percent tolerant organisms
- Total number of qualitative EPT taxa [EPT = *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), *Trichoptera* (caddisflies)]

The rating involves giving 6 points to sites of exceptional quality, 4 points for those representing typical good communities, 2 points for slightly affected communities, and 0 points for highly affected communities. As shown in Figure 6-3, plots have been developed to determine the range of values for each metric. For example, a stream sample that has a drainage area of 100 square miles and a total of 30 taxa would receive a rating of 4. A similar analysis is performed for each metric and the 10 values are summed to obtain the final ICI value. This value, which ranges from 0 to 60, represents the health of the water body with respect to the invertebrate community. Ranges of ICI values and their respective qualitative assessments are shown in Table 6-14.

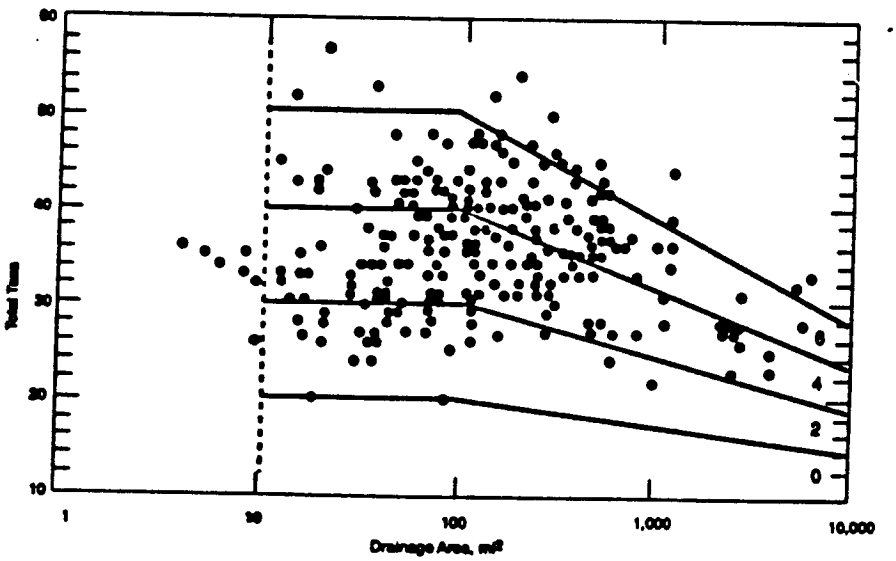

Figure 6-3. Total taxa vs. drainage area for determining 6, 4, 2, and 0 invertebrate community index (ICI) scoring.

Table 6-14. Qualitative Assessment of Invertebrate Community Index (ICI) Values

	Exceptional	Good	Fair	Poor	Very Poor
All sites	48-60	34-46	14-32	2-12	0

Example of Biocriteria Implementation

Taken from the upper Hocking River in Ohio, the calculation of IBI values for fish habitat at two different river headwater stations are shown in Table 6-15. In this example, the fish habitat at Station 2 is significantly better than at Station 1. As indicated by Table 6-12, the index for Station 1 (14) ranks it as very poor for fish habitat, while the rating for Station 2 (34) ranks it as fair for fish habitat. In order to

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compare these habitats effectively, strict controls had to be kept over the methods used to obtain the fish and analyze the results. To implement similar programs in other areas, the necessary background studies and tests must be conducted because of the site-specific nature of the criteria used to develop the IBI.

Table 6-15. Indices of Biotic Integrity for Two Headwater Stations in Hocking River, Ohio

	Station 1		Station 2	
	Value	Ranking	Value	Ranking
Numbers of				
Total species	5	1	14	3
Total individuals	12	1	130	1
Sunfish species	1	1	4	5
Sucker species	1	1	3	3
Intolerant species	0	1	0	1
Proportion of individuals, %				
Round-bodied suckers	0	1	34	3
Omnivores	67	1	38	1
Insectivores	19	1	50	3
Tolerant species	86	1	42	1
Top carnivores	7	3	10	3
Simple lithophils	7	1	57	5
Anomalies	0	1	0	5
Totals		14		34

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National Technical Information Service
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Springfield, VA 22161
703-487-4650

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Chapter 7
Screen Best Management Practices

Selecting BMPs for preventing and controlling urban runoff pollution is a two-step process. First, a comprehensive list of BMPs should be compiled and screened to eliminate those that are inappropriate for the area. Based on appropriate BMPs, alternatives are then developed and assessed. Finally, the BMPs to be implemented are selected.

This chapter addresses the first step in this process—initial screening. First, a general overview of the categories of BMPs addressed in this handbook is given. The chapter then describes methods of screening the list of potential BMPs. The remainder of the chapter defines BMPs used for urban runoff pollution prevention and control, along with a brief description of their characteristics and sources of additional information. This chapter's contents assist in compiling a list of BMPs for consideration in the screening process.

Best Management Practice Overview

Urban runoff pollution problems are more difficult to control than steady-state, dry-weather point source discharges because of the intermittent nature of rainfall and runoff, the number of diffuse discharge points, the large variety of pollutant source types, and the variable nature of the source loadings. Since the expense of constructing facilities to collect and treat urban runoff is often prohibitive, the emphasis of storm water pollution control should be on developing a least cost approach which includes nonstructural controls and low-cost structural controls.

Nonstructural controls include regulatory controls that prevent pollution problems by controlling land development and land use. They also include source controls that reduce pollutant buildup or lessen its availability for washoff during rainfall. A case study at the end of this chapter discusses the extensive nonstructural regulatory urban runoff controls used by Austin, Texas.

Low-cost structural controls include the use of facilities that encourage uptake of pollutants by vegetation, settling, or filtering. Because of the variability of pollutant removal, these controls can be used in series or in parallel combinations. The concept of implementing a "treatment train" might, for example, include initial pretreatment, primary pollutant removal, and final effluent polishing practices to be constructed in series.

All sources, both point and nonpoint, in a program area or watershed should be addressed. For urban areas, such sources often include urban runoff as well as CSOs. Practices for controlling both storm water and CSO pollution are described in this chapter. The practices discussed for urban runoff control are also applicable to storm water before it enters a combined sewer collection system. In addition, this chapter describes various types of storage and treatment facilities also commonly used to address CSOs.

Depending on the pollutant control mechanisms used, urban runoff pollution control practices can be divided into several categories:

- Regulatory controls
- Source controls
- Detention facilities
- Infiltration facilities
- Vegetative practices
- Filtration practices
- Water quality inlets

CSO-specific control practices are also divided into several categories:

- Source controls
- Collection system controls
- Storage
- Physical treatment
- Chemical precipitation
- Disinfection

While these lists do not include all urban runoff and CSO control practices, these categories are convenient ones for purposes of presentation and discussion.

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Table 7-1 lists commonly used urban runoff and CSO BMPs based on the categories provided. The next section describes methods of BMP screening. The remainder of the chapter then gives a brief overview of some of the more important characteristics of these BMPs, including the types of pollutants controlled, the pollution removal mechanisms employed, limitations on their use, maintenance requirements, and general design considerations.

Best Management Practice Screening

The goal of BMP screening is to reduce the comprehensive list of BMPs to a more manageable list for final selection. Because this step is an initial screening, methods used are generally qualitative and require professional judgment. While extensive knowledge about specific design criteria is not necessary at this stage in the screening process, understanding the BMP's effectiveness and applicability to the program area's problems is crucial.

For this discussion, the BMPs are divided into two general categories: nonstructural and structural. Nonstructural BMPs—which include regulatory practices, such as those that limit impervious area or protect natural resources, and source controls, such as street sweeping or solid waste management—are typically implemented throughout an entire community, watershed, or special area. While structural BMPs, such as detention ponds or infiltration practices, may be designed to address specific pollutants from known sources, they also can be implemented throughout an area. In addition, structural BMPs can be required in new developments or redevelopments.

Comprehensive plans addressing urban runoff pollution prevention and control rely on both nonstructural and structural practices. While plans addressing specific

Table 7-1. Urban Runoff Pollution Control BMPs

Urban Runoff Controls	CSO Controls
Regulatory Controls	**Source Controls**
Land use regulations	Water conservation programs
Comprehensive runoff control regulations	Pretreatment programs
Land acquisition	**Collection System Controls**
Source Controls	Sewer separation
Cross-connection identification and removal	Infiltration control
Proper construction activities	Inflow control
Street sweeping	Regulator and system maintenance
Catch basin cleaning	Insystem modifications
Industrial/commercial runoff control	Sewer flushing
Solid waste management	**Storage**
Animal waste removal	Inline storage
Toxic and hazardous pollution prevention	Offline storage
Reduced fertilizer, pesticide, and herbicide use	Flow balance method
Reduced roadway sanding and salting	**Physical Treatment**
Detention Facilities	Bar racks and screens
Extended detention dry ponds	Swirl concentrators/vortex solids separators
Wet ponds	Dissolved air flotation
Constructed wetlands	Fine screens and microstrainers
Infiltration Facilities	Filtration
Infiltration basins	**Chemical Precipitation**
Infiltration trenches/dry wells	**Biological Treatment**
Porous pavement	**Disinfection**
Vegetative Practices	Chlorine treatment
Grassed swales	UV radiation
Filter strips	
Filtration Practices	
Filtration basins	
Sand filters	
Other	
Water quality inlets	

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problems in small watersheds might tend to focus on structural practices, urban runoff pollution prevention and control programs should include implementation of nonstructural as well as structural control approaches. Methods for screening both nonstructural and structural practices are outlined below.

Nonstructural Practices

Since the number of potential nonstructural BMPs to be implemented is very large, initial screening is useful before the final selection process. The regulatory and source control BMP descriptions contained later in this chapter focus on the most commonly implemented practices; other, less commonly used practices, however, also could be considered. In addition, each practice (e.g., solid waste management) can be divided into numerous subpractices (e.g., management of leaf litter, rubbish, garbage, and lawn clippings). An urban runoff management plan for the Santa Clara Valley, for example, identified more than 100 separate potential nonstructural BMPs used throughout the country (Woodward-Clyde Consultants, 1989). Municipalities, therefore, have to screen regulatory and source control BMPs based on their particular watershed. The Santa Clara Valley program and the BMP screening and selection method are discussed in the case study at the end of Chapter 8.

One screening method involves applying screening criteria to each nonstructural practice to determine its applicability to the conditions in the watershed. The screening criteria, which are specific to the watershed and depend on the program goals, include:

- *Pollutant removal:* Since different regulations and source control practices are designed to address different pollutants, the program team should ensure that the screened list of controls includes practices designed to address the pollutants of primary concern. In addition, some practices might not provide sufficient pollutant removal.
- *Existing government structure:* Some practices implemented throughout the country require a specific government structure. For example, while a strong county government might be important for implementing a specific regulatory control, the role of county governments can vary from one section of the country to another. Practices requiring specific government structures that do not exist in the area of concern therefore could be eliminated from the list.
- *Legal authority:* For regulatory controls to be effective, the legal authority to implement and enforce the regulations must exist. If municipal boards and officials lack this authority, they could be required to obtain it through local action.
- *Public or municipal acceptance:* Implementing certain practices could be difficult because of resistance from the public or an involved municipal agency. These practices can be eliminated from the list.
- *Technical feasibility:* The municipal BMPs that require large expenditures and extensive efforts might not be suitable for small municipalities that lack the required resources.

Additional screening criteria may also be used, as shown in the Santa Clara Valley case study at the end of Chapter 8.

Another method of screening involves use of a comparative summary matrix. Figure 7-1 shows an example of such a matrix that can be used to screen nonstructural control practices. Though developed for screening nonstructural control practices in coastal areas, this matrix is at least in part applicable to inland areas as well. In this matrix, various regulatory and source control practices are listed and their abilities to meet various criteria are compared. The criteria listed include ability to remove specific pollutants, such as nutrients and sediments, maintenance requirements, longevity, community acceptance, secondary environmental impacts, costs, and site requirements. Other criteria are also listed, some of which are applicable only in coastal areas. For each practice and criterion, an assessment of effectiveness is indicated: solid circles indicate high effectiveness and open circles, low effectiveness. This type of matrix can provide a basis for an initial assessment of practices and their applicability to the program.

Structural Practices

Because structural practices generally are more site specific and have more restrictions on their use than nonstructural practices, the initial screening step for these practices can be more precise than for nonstructural practices. Table 7-2 outlines some of the more important criteria for the screening of structural BMPs, including their typical pollutant removal efficiencies, land requirements, the drainage area that each BMP can effectively treat, the desired soil conditions, and the desired ground-water elevation. By using these criteria and the information obtained during data collection and analysis and problem identification and ranking, the program team can narrow the list of BMPs to be further assessed in the BMP selection step.

The initial screening criteria for structural control practices include the following:

- *Pollutant removal:* The municipality should ensure that BMPs selected address the primary pollutants of concern to the level of removal desired.

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	Nutrient Control	Shellfish	Estuarine Habitat Protection	Sedimentation	Sediment Toxics	Stormwater Control	Feasibility in Coastal Areas	Maintenance Burdens	Longevity	Community Acceptance	Secondary Environmental Impacts	Cost to Developers	Cost to Local Governments	Difficulty in Local Implementation	Site Data Required	Water-Dependent Use
Coastal Density Zones																
Intense zones	○	○	○	○	○	○	●	⊘	⊘	○	○	○	◐	○	◐	
Rural zones	○	◐	◐	●	◐	◐	●	⊘	⊘	○	◐	◐	◐	○	◐	
Protection zones	◐	●	●	●	●	●	●	⊘	⊘	○	●	●	◐	◐	◐	
Overlay zones	◐	●	●	◐	◐	◐	●	⊘	⊘	○	○	○	◐	◐	◐	
Performance zoning	◐	◐	◐	◐	◐	●	●	⊘	⊘	○	◐	◐	◐	◐	○	
Environmental Reserves																
Stream buffers	◐	◐	●	◐	○	○	●	●	●	●	●	○	●	○	●	○
Wetland buffers	◐	○	●	◐	○	○	●	●	●	●	●	○	●	●	●	●
Coastal buffers	●	●	●	◐	○	○	●	●	●	●	●	○	○	○	●	●
Expanded buffers	◐	○	●	○	○	○	●	●	●	○	●	○	●	○	○	●
Floodplain limits	◐	○	○	●	○	◐	●	●	●	◐	●	○	●	○	○	○
Steep soils limits	○	○	◐	●	○	◐	●	●	●	◐	●	○	●	○	○	○
Septic limits	◐	●	○	○	○	⊘	●	●	●	◐	●	○	●	●	●	○
Wetland protection	●	◐	●	●	○	◐	●	●	●	◐	●	○	○	○	○	○
Forest protection	○	◐	◐	◐	○	○	●	●	●	●	●	○	●	●	○	●
Habitat protection	○	○	●	○	○	○	●	●	●	●	●	○	●	○	○	●
Open space protection	○	○	◐	○	○	○	●	●	●	●	●	○	●	○	○	●

● 0 - 40% High level of control
◐ 30 - 40% Moderate level of control
○ 0 - 20% Low level of control
⊘ Ineffective

● Highly effective
◐ Moderately effective
○ Low effectiveness
⊘ Ineffective

● Directly protects
◐ Indirectly protects
○ No protection
⊘ Not related

● 60% High
◐ 30 - 60% Moderate
○ 0 - 30% Low
⊘ Ineffective

● Highly effective
◐ Moderately effective
○ Low effectiveness
⊘ Ineffective

● Highly effective
◐ Moderately effective
○ Low effectiveness
⊘ Ineffective

● Widely applicable
◐ Applicable depending on site
○ Seldom applicable
⊘ Not applicable

● Low burden
◐ Moderate burden
○ High burden
⊘ Not applicable

● Long lived
◐ Long lived with maintenance
○ Short lived
⊘ Not applicable

● Positive
◐ Neutral
○ Negative
⊘ Mixed

● None or positive
◐ Slight negative impacts
○ Strong negative impacts at some sites
⊘ Prohibited

● Low
◐ Moderate
○ High
⊘ Very high

● Low
◐ Moderate
○ High
⊘ Very high

● Easy
◐ Moderate
○ Tough
⊘ Very tough

● Simple
◐ Moderate
○ Complex
⊘ None

● Can be used moderately in these areas
◐ Sometimes can be used
○ Seldom used
⊘ Not used

Figure 7-1. Sample nonstructural control screening matrix (U.S. EPA, 1991a).

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Figure 7-1. Sample nonstructural control screening matrix (continued).

	Household hazardous waste	Septic maintenance	Fertilizer control	Urban housekeeping	Postdevelopment	Time/area disturbance	Erosion & Sediment Control	Minimize imperviousness	Performance criteria	Cluster	Site Planning
● 0 - 40% High level of control ◐ 30 - 40% Moderate level of control ○ 0 - 20% Low level of control ⊘ Ineffective	○	◐	◐	○		◐		○	●	○	Nutrient Control
● Highly effective ◐ Moderately effective ○ Low effectiveness ⊘ Ineffective	⊘	●	○	◐		○		○	●	◐	Shellfish
● Directly protects ◐ Indirectly protects ○ No protection ⊘ Not related	○	○	⊘	○		●		○	●	○	Estuarine Habitat Protection
● 80% High ◐ 30 - 60% Moderate ○ 0 - 30% Low ⊘ Ineffective	⊘	⊘	⊘	◐		●		○	●	○	Sedimentation
● Highly effective ◐ Moderately effective ○ Low effectiveness ⊘ Ineffective	●	⊘	⊘	◐		⊘		○	●	○	Sediment Toxics
● Highly effective ◐ Moderately effective ○ Low effectiveness ⊘ Ineffective	⊘	⊘	⊘	⊘		○		◐	●	○	Stormwater Control
● Widely applicable ◐ Applicable depending on site ○ Seldom applicable ● Not applicable	●	●	◐	●		●		●	●	●	Feasibility in Coastal Areas
● Low burden ◐ Moderate burden ○ High burden ⊘ Not applicable	○	○	○	◐		●			○	●	Maintenance Burdens
● Long lived ◐ Long lived with maintenance ○ Short lived ⊘ Not applicable	○	◐	○	○		●			○	●	Longevity
● Positive ◐ Neutral ○ Negative ⊘ Mixed	◐	◐	◐	◐		●			○	◐	Community Acceptance
● None or positive ◐ Slight negative impacts ○ Strong negative impacts at some sites ⊘ Prohibited	◐	◐	●	◐		●			○	●	Secondary Environmental Impacts
● Low ◐ Moderate ○ High ⊘ Very high						●			○	●	Cost to Developers
● Low ◐ Moderate ○ High ⊘ Very high	◐	◐	◐	●		○			○	●	Cost to Local Governments
● Easy ◐ Moderate ○ Tough ⊘ Very tough	◐	◐	◐	●		●			○	○	Difficulty in Local Implementation
● Simple ◐ Moderate ○ Complex ⊘ None	○	○	○	●		○			○	○	Site Data Required
● Can be used moderately in these areas ◐ Sometimes can be used ○ Seldom used ⊘ Not used	◐	◐	○	●		●			●	●	Water-Dependent Use

Table 7-2. Structural BMP Initial Screening Criteria

Structural BMPs	Typical Pollutant Removals[a]					Relative Land Requirements	Drainage Area[b]	Desired Soil Conditions	Ground-Water Elevation
	Suspended Solids	Nitrogen	Phosphorus	Pathogens	Metals				
Detention Facilities									
Extended detention dry ponds	Medium	Low-medium	Low-medium	Low	Low-medium	Large	Medium-large	Permeable	Below facility
Wet ponds	Medium-high	Medium	Medium	Low	Medium-high	Large	Medium-large	Impermeable	Near surface
Constructed wetlands	Medium-high	Low	Low-medium	Low	Medium-high	Large	Large	Impermeable	Near surface
Infiltration Facilities									
Infiltration basins	Medium-high	Medium-high	Medium-high	High	Medium-high	Large	Small-medium	Permeable	Below facility
Infiltration trenches/dry wells	Medium-high	Medium-high	Low-medium	High	Medium-high	Small	Small	Permeable	Below facility
Porous pavement	High	High	Medium	High	High	N/A	Small-medium	Permeable	Below facility
Vegetative Practices									
Grassed swales	Medium	Low-medium	Low-medium	Low	Low-medium	Small	Small	Permeable	Below facility
Filter strips	Medium-high	Medium-high	Medium-high	Low	Medium	Varies	Small	Depends on type	Depends on type
Filtration Practices									
Filtration basins	Medium-high	Low	Medium-high	Low	Medium-high	Large	Medium-large	Permeable	Below facility
Sand filters	High	Low-medium	Low	Low	Medium-high	Varies	Low-medium	Depends on type	Depends on type
Other									
Water quality inlets	Low-medium	Low	Low	Low	Low	N/A	Small	N/A	N/A

[a] Low = <30%, Medium = 30-65%, High = 65-100%.
[b] Small = <10 acres, Medium = 10-40 acres, Large = >40 acres.

- *Land requirements:* Large land requirements for some of the aboveground structural BMPs can often restrict their use in highly developed urban areas. Land requirements vary depending on the BMP.
- *Drainage area:* The structural BMPs listed in Table 7-2 are used primarily to treat runoff from watersheds up to 50 or 60 acres, and the optimum drainage area to be served varies for each practice and according to the land use (connected impervious area, for example). Drainage areas above this size might have to be treated by locating BMPs in subwatersheds.
- *Soil characteristics:* Structural BMPs have differing requirements for soil conditions. Infiltration facilities generally require permeable soils, while detention BMPs generally require impermeable soils. The municipality must become familiar with soil conditions in the watershed.
- *Ground-water elevation:* The ground-water elevation in the watershed can be a limiting factor in siting and implementing structural BMPs. Generally, high ground-water elevation can restrict the use of infiltration facilities and filtration practices; but it is necessary for constructed wetlands and may be desirable for detention facilities.
- *Public acceptance:* Since a municipality could have difficulty implementing a structural BMP without public approval, public acceptance of the BMPs should be considered in the screening step.

Of the screening criteria listed, the pollutant removal, land requirements, and drainage area served are usually absolute restrictions. Soil condition and ground-water elevation, on the other hand, impose restrictions that could be overcome by such means as importing soil or constructing facilities with clay liners to

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restrict ground-water inflow. Such modifications, however, can add significantly to the BMP costs.

Best Management Practice Descriptions

This section provides a brief overview of the BMPs discussed, based on the categories presented in Table 7-1. Additional references should be consulted before selecting, designing, and implementing BMPs (see Appendix A). Appendix B lists widely available and helpful documents that provide more detailed information on designing, constructing, and maintaining urban runoff and CSO BMPs. There are a host of other BMPs that address specific pollution sources, such as landfills, industrial sites, salt storage facilities, marinas, and numerous others. As mentioned earlier, agricultural BMPs are not discussed in depth in this handbook.

Urban Runoff Control Practices

This section addresses regulatory controls, source controls, and several types of commonly used structural controls.

Regulatory Controls

Urbanization increases the amount of impervious land area, which in turn increases storm water runoff with its associated pollutants (see Chapter 1). Municipalities can prevent or reduce many of these pollution problems by implementing regulatory controls to limit the amount of impervious area and to protect valuable resources. These regulatory controls can prevent or limit the quantity of runoff as well as its pollution load. Regulatory controls typically implemented by municipalities include:

- Land use regulations, such as:
  - zoning ordinances,
  - subdivision regulations,
  - site plan review procedures, and
  - natural resource protection.
- Comprehensive runoff control regulations.
- Land acquisition.

Local government regulations can require storm runoff controls, reduce the level of impervious area, require the preservation of natural features, reduce erosion, or require other important practices. The major aspects of storm water prevention and control—including runoff quantity control, solids control, and other pollution control—are illustrated in the case study at the end of this chapter on the regulatory practices implemented by Austin, Texas.

Runoff Quantity Control. Regulations addressing runoff quantity control can be used to reduce the effects of land development on watershed hydrology. Hydrologic control in turn results in pollution control, and can be accomplished through requirements such as:

- *Open space:* By maintaining specified levels of open space on a development site, the total area of impervious surface is reduced and infiltration of precipitation is increased. This leads to decreases in total pollutant discharge and potential downstream erosion by reducing total and peak runoff flows.
- *Postdevelopment flow control:* Many development regulations require that peak runoff conditions from a site be calculated before and after construction. These requirements specify that conditions after construction must reflect conditions before construction. This control is typically accomplished through the use of detention facilities, which can reduce peak runoff discharge rates, thereby decreasing downstream erosion problems. These regulations specify the desired outcome; the approach for ensuring that outcome, however, is determined by the developer.
- *Runoff recharge:* Regulations may specify that storm water runoff be recharged on site. Such regulations can reduce the runoff leaving a site, thereby reducing development-induced hydrologic changes and pollutant transport. By directly promoting infiltration, peak and total runoff rates can be decreased and pollutant discharges and downstream erosion can be reduced. Such runoff recharge also might help maintain surficial aquifer levels.

Solids Control. Regulations addressing solids control could include requirements for control practices during and after construction, since such activity has been shown to be a major contributor of solids. Construction activities can greatly increase the level of suspended solids in storm water runoff by removing vegetation and exposing the topsoil to erosion during wet weather. Yet while communities have requirements for implementing erosion control practices on construction sites, fewer communities require erosion control after construction is complete. Since many other land uses can contribute solids loadings, regulatory requirements can cover various types of industrial and commercial activities.

Other Pollution Control. Land development increases the concentrations of nutrients, pathogens, oxygen demanding substances, toxic contaminants, and salt in storm water runoff. Development regulations, therefore, can be used to address some of these specific pollutants. These regulations can take the form of special requirements for limiting nutrient export in special protection districts or setting performance standards for known problem pollutants.

While many of the regulatory controls outlined in this section are used by municipalities, few communities

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have used these regulations systematically to prevent urban runoff pollution problems. The regulations, developed over a number of years, have had purposes largely unrelated to urban runoff pollution prevention and control. By reexamining and amending these regulations and ordinances to reflect water resource goals, however, communities can improve their ability to prevent and control urban runoff pollution.

Land Use Regulations. Land use regulations can include zoning ordinances, subdivision and site plan regulations and review requirements, and environmental resource regulations such as wetlands protection. These practices are used as tools to promote development patterns that are compatible with control of urban runoff discharges.

Zoning. Most communities have residential, commercial, industrial, and other zoning districts that specify the types of development allowed and dictate requirements, including:

- Specifying the density and type of development allowed in a given area, thereby maintaining pervious areas.
- Controlling acreage requirements for certain land uses and associated setback, buffer, and lot coverage requirements.
- Directly and indirectly affecting the types of materials that can be stored or used on sites.
- Not allowing potentially damaging uses (e.g., underground chemical storage or pesticide application) in sensitive watersheds.

Examples of types of zoning controls that can be used to protect water bodies include:

- *Cluster development:* Allowing structures in developments to be constructed close together to preserve open space.
- *Down-zoning:* Changing an established zone to a use that allows a lower level of density.
- *Phase-in zoning:* Changing the zoning of a specific area over time, usually as inappropriate sites reach the end of their useful life.
- *Large lot zoning:* Requiring greater minimum acreage for development in certain locations.
- *Conditional zoning:* Allowing certain activities only under specified conditions that protect water quality.
- *Overlay zoning:* Placing additional zoning requirements on an area that is already zoned for a specific activity or use.
- *Open space preservation:* Protecting open space and buffer zones in the community near water bodies.
- *Performance standards:* Permitting certain land uses, usually industrial activities, only if they meet specific performance criteria.

These practices can be used by communities to ensure that land uses in each area are appropriate for that area's water resources. Such controls are especially useful in sensitive areas, such as water supply watersheds, and can serve to reduce or control development.

Subdivision Regulations. Subdivision review deals with land that is divided into separately owned parcels for residential development. Municipalities have the authority to review the plans for such subdivisions and to restrict development options via requirements for drainage, grading, and erosion control, as well as provisions for buffer areas, open spaces, and maintenance. Through this review, municipalities can ensure that proper practices are designed into the development.

Site Plan Review. Site plan review ensures compliance with zoning, environmental, health, and safety requirements. Municipalities can require developers to consider how construction activities will affect drainage on site and to design plans for reducing urban runoff pollution problems. Developers usually are required to submit information to a municipality on the natural drainage characteristics of the site, plans for erosion control, retention and protection of wetlands and water resources, and disposal of construction-related wastes.

Natural Resource Protection. Municipalities can also protect water resources by protecting lands, such as floodplains, wetlands, stream buffers, steep slopes, and wellhead areas. By use of resource overlay zones that restrict high pollution activities in these areas, development can be controlled and the potential for urban runoff pollution can be reduced.

Comprehensive Runoff Control Regulations. In addition to strengthening and broadening existing local regulatory control practices, states and municipalities can implement runoff pollution control through comprehensive regulations. While still relatively rare, comprehensive plans to address urban runoff pollution exist in various states and communities. They are designed to fully address urban runoff pollution problems by identifying specific land use categories and water resources that deserve special attention, and outlining methods for implementing source control and structural BMPs. While the form that these comprehensive regulations take is very specific to the needs of a state or community, reviewing the regulatory approaches that have been tried by others is useful in developing options. Examples include (Pitt, 1989):

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- *Austin, TX:* Comprehensive Watersheds Ordinance, 1986; Urban Watersheds Ordinance, 1991 (see the case study at the end of this chapter).
- *Birmingham, AL:* Proposed Watershed Protection Ordinance.
- *State of Maryland:* Model Stormwater Management Ordinance, 1988.
- *State of Wisconsin:* Model Construction Site Erosion Control Ordinance, 1987.

Land Acquisition. To protect valuable resources from the effects of development, municipalities can purchase land within the watershed to control land development. Municipalities can acquire land to convert to parks or to maintain as open space; this approach, however, can be very expensive.

Source Control Practices

Source controls include the nonstructural practices designed to reduce the availability of pollutants. Many of these practices tie directly into EPA's Pollution Prevention strategy discussed in Chapter 2, which focuses on preventing pollution sources from entering the system rather than on treatment. Some of the more common practices used by municipalities throughout the country include:

- Cross-connection identification and removal
- Proper construction activities
- Street sweeping and catch basin cleaning
- Industrial/commercial runoff control
- Solid waste management
- Animal waste removal
- Toxic and hazardous waste management
- Reduced fertilizer, pesticide, and herbicide use
- Reduced roadway sanding and salting

Cross-Connection Identification and Removal. Within the NPDES storm water regulations, EPA has specifically emphasized the importance of implementing a program to identify and remove inappropriate sanitary and industrial wastewater connections to municipal storm water drainage systems—a problem in many urban areas. For example, a study of the storm drainage system in the Humber River watershed in Toronto indicated that about 10 percent of the outfalls from the system had dry-weather flows considered to be significant pollutant sources. This study found that more than 50 percent of the annual discharges of water volume, total suspended solids, chlorides, and bacteria from the monitored industrial, residential and commercial areas were associated with dry-weather discharges from the storm drainage system (U.S. EPA, 1993a).

Dry-weather discharges, such as from illegal wastewater discharges to the storm drainage system, can cause serious water resource degradation. The addition of sanitary wastes increases the concentrations of organics, solids, nutrients, and bacteria in the storm water runoff. Industrial wastes can be highly variable but can substantially increase the concentrations of heavy metals and other related pollutants in runoff (U.S. EPA, 1993a).

Unauthorized and inappropriate connections to drainage systems can exist for many reasons. In the past, connector pipes between sanitary sewers and storm drains could have been installed to relieve surcharging of the sewer system and prevent backups of sewage into homes and businesses. Connections from residential sanitary sewers or commercial and industrial floor drains also exist.

Cross-connections are common in municipalities that have undergone sewer separation. During separation, a new pipe system is often constructed to act as a separate sanitary sewer, and the old combined system is converted to operate as a separate storm drain because of its large size and carrying capacity. To complete the separation, existing connections to the combined sewer must be plugged and reconnected to the new sanitary sewer. If sewer connections to the newly created storm drain continue to exist with no written record or are not located on plans, they can be missed during the reconnection. In addition, as new construction occurs, accidental connections to the storm drainage system can occur.

Because cross-connections typically are not documented, pollution from these connections can often be difficult to locate. Municipalities, however, can develop a program to locate and eliminate these connections. This program should be designed to identify dry-weather discharges and to determine the flow sources by developing updated drainage system maps, conducting dry-weather inspections, and sampling dry-weather discharges. In some instances, discharge results from ground-water infiltration to the drainage system and might not be a pollution concern. If the analyses conducted on dry-weather flows indicate the presence of pollutants, however, the system should be traced to locate the source of the pollutants.

Locating cross-connections to storm drainage systems is similar to conducting the infiltration and inflow (I/I) and sanitary sewer evaluation survey (SSES) investigations that many municipalities regularly conduct. These investigations can be done through successive visual inspections, dye testing, or TV investigations. Once located, cross-connections must be removed so that

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industrial and sanitary wastes are discharged to a municipal sewerage system. Routine drainage system inspections should continue in order to avoid problems from inadvertent cross-connections from new development.

Detailed information is available in an EPA guidance document entitled *Investigation of Inappropriate Pollution Entries into Storm Drainage Systems* (U.S. EPA, 1993a).

Proper Construction Activities. Construction activities have been cited in numerous water quality assessments as a major source of sediment to surface waters. During construction, natural vegetation is removed from a site, exposing the topsoil. If the soil remains bare and exposed for extended periods, rainfall can cause erosion and transport the soil to nearby water bodies. After the soil enters a water body, decreases in water velocity cause the suspended solids to settle out of the water column and accumulate as sediment on the bottom of the water body. This sediment can smother benthic organisms and carry pollutants, such as petroleum products and metals. Construction-induced erosion therefore should be minimized. This section addresses some of the planning practices and controls that can be used at construction sites to reduce erosion and subsequent soil transport.

While the practices discussed in this section are general and can be applied at construction sites throughout the country, most state environmental offices have developed soil and erosion control handbooks tailored to the specific needs of the state. These documents provide more detailed guidance for developing and implementing programs to address construction site pollution problems. In addition, some municipalities, such as Birmingham, Alabama (Pitt, 1989), have developed ordinances to address construction-site erosion controls.

On construction sites, areas to be maintained in their preconstruction condition should remain undisturbed during construction; existing vegetation to be incorporated into the final site should be maintained. The planned roads and parking areas should be used for construction traffic and other construction-related activities; these areas can be treated with crushed stone during construction and paved after construction has been completed. Planned open areas at a site should be seeded immediately after clearing, and open areas not in use for construction should be covered with crushed stone or seeded with a temporary cover crop.

The planning, sequencing, and timing of construction activities are also important to reduce soil transport. Phasing and limiting of clearing activities so that one area of a site is complete and stabilized before beginning work on other areas can also reduce the potential for erosion.

On large construction sites with extensive grading and vegetation removal, structural erosion control practices are required. During construction activities, temporary berms or weirs can divert runoff away from disturbed areas of the site. Runoff diversion or slope modifications should be incorporated into the final site design; during construction, these diversion structures should be protected by crushed stone or blankets to reduce erosion.

Since construction site runoff contains high levels of suspended solids, temporary structures that filter out or settle out solids should be incorporated into the site. Straw bales, silt fences, dewatering filters, and sedimentation basins are often used to control erosion. Straw bales can be placed across a sloped area to intercept runoff from the slope and trap sediment. They can also be used around storm water inlets and catch basins to reduce the transport of sediment to nearby drainage systems. In addition, straw bales can be placed at intervals along long slopes to reduce runoff velocity to control erosion. Straw bales need to be replaced every few months; the old bales can be broken up and used for ground cover if properly installed and maintained. Silt fences can be used for many of the same functions as straw bales and usually have a longer life.

In addition to these temporary, inexpensive erosion-control devices, storm water runoff from larger construction sites should be directed to sedimentation basins, designed to intercept runoff and hold it for an extended period to allow suspended solids to settle out. Sedimentation basins, which require periodic cleaning, already might be incorporated into the final site design as permanent storm water attenuation/treatment controls. When construction is completed, they should be cleaned out and the bottoms regraded.

To ensure that construction site erosion control practices are properly implemented and that regulations are followed, plans must be reviewed prior to construction activities and inspections must be conducted. Municipalities or responsible agencies must provide for erosion control plan review, site review, and enforcement.

Street Sweeping and Catch Basin Cleaning. Frequent street sweeping can limit the accumulation of dirt, debris, and associated pollutants, and the subsequent deposition of these pollutants in storm drains and waterways. Regular cleaning of catch basins can also remove accumulated sediment and debris that ultimately could be discharged from storm drains and combined sewers. In most municipalities, these tasks are conducted at scheduled intervals and have been shown to result in significant pollutant reductions only if an intensive schedule is followed. A study performed in San Jose, California, showed that

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50 percent of the total solids and heavy metals could be removed from urban runoff when city streets were cleaned once or twice a day. When the streets were cleaned only once or twice a month, the removal rate dropped to less than 5 percent (U.S. EPA, 1979). Increased frequency also could result in increased fugitive air emissions. Regular street sweeping and catch basin cleaning can, in any case, remove some of the large floatable litter that is unsightly in urban surface waters. Street sweeping twice a week and catch basin cleaning once or twice a year have been found effective in removing these large floatable pollutants (U.S. EPA, 1983). Determining the effectiveness of street sweeping programs, however, is difficult because of variations in pollutant buildup and storm events. In addition, studies have shown that the choice of sweeping equipment can significantly affect the effectiveness of cleaning programs (Pitt, 1989).

Commercial/Industrial Runoff Control. Certain commercial and industrial sites can be responsible for disproportionate contributions of some pollutants (e.g., grit, oils, grease, and toxic materials) to the drainage system. Typical sources of potential concern include gasoline stations, railroad yards, freight loading areas, and parking lots. In specific cases where significant pollutant loadings to the system are contributed by well-defined locations of limited area, pretreatment of the runoff from these areas could be a practical and effective control measure. Pretreatment measures can be required as part of a community's regulations. Examples of pretreatment measures include oil/water separators for gasoline stations, or the use of modified catch basin designs to enhance the retention of oil and grease or solids. Procedures for the detection and location of illicit connections to separate storm drains by testing for specific chemical tracers could be applied to identify commercial or industrial sources contributing substantial levels of problem pollutants.

Solid Waste Management. Most communities have programs to collect and dispose of solid waste in an effort to maintain clean streets and provide a service for local residents and businesses. Some communities provide added services during times of particularly high waste generation. For example, some municipalities in the northern United States provide extra collection services during the fall to collect leaves—an added service that helps keep leaves from blowing into surface waters. A study of storm water runoff into Minneapolis lakes found that phosphorus levels were reduced by 30 to 40 percent when street gutters were kept free of leaves and lawn clippings (MPCA, 1989). Actual reductions of pollutant loads, however, are difficult to predict. In general, any solid waste that is picked up and disposed of in a controlled manner will be less likely to enter a drainage system.

Animal Waste Removal. Domesticated and wild animal wastes represent a source of bacteria and other pollutants that can be washed into surface waters by urban runoff. These pollutants can be reduced by reducing the animal waste on paved surfaces. Municipalities often enact and enforce leash laws and pet waste cleanup ordinances. The effectiveness of these programs in reducing pollutant loads is unknown, however, and usually depends on voluntary actions by private citizens.

Toxic and Hazardous Waste Management. Improper dumping of household and automotive toxic and hazardous wastes into municipal storm inlets, catch basins, and other storm drainage system entry points can result in significant discharges of pollutants to surface waters during rainstorms. This dumping can be a particular problem in urban areas where individuals change the oil or antifreeze in their cars and dispose of the wastes in nearby catch basins. In addition, homeowners and small businesses sometimes dispose of products such as waste paints and solvents in storm water inlets and catch basins. To address the problem, municipalities can educate residents on the consequences of dumping these wastes into storm drainage system entry points. In addition, communities can develop hazardous- and toxic-waste collection days to dispose of or recycle these wastes properly. Also, storm drain systems can be labeled with warnings about the pollution problems associated with dumping wastes. The effectiveness of such programs, however, cannot be determined in advance because of the voluntary nature of compliance. For business and industry, an inspection, testing, and enforcement program (similar to an industrial pretreatment program) can be developed.

Reduced Fertilizer, Pesticide, and Herbicide Use. Fertilizers, pesticides, and herbicides washed off the ground during storms can contribute to water pollution. Agricultural, park land, and other land uses can be sources of these pollutants. Many communities use these chemicals on park lands, and homeowners utilize them on their lawns. Controlling the use of these chemicals on municipal lands and educating the public can help reduce nutrient and toxic pollutant concentrations in urban runoff.

Reduced Roadway Sanding and Salting. In areas of the United States with freezing road conditions, sand and salt are used in the winter to improve driving conditions. Salt and sand can be washed off roadways, however, and pollute receiving waters. The problem is exacerbated during spring snowmelt and early spring rainstorms when most of these pollutants are available for transport. These problems can be reduced by minimizing the use of chemicals for snow and ice control to the minimum necessary for public safety and

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by utilizing proper equipment. In addition, salt storage sites have been shown to be persistent and frequent sources of contamination, especially during rainfall (U.S. EPA, 1973); sand and salt piles therefore should be covered. Also, deicing alternatives, such as calcium magnesium acetate (CMA), can be used in some cases (U.S. EPA, 1974a,b).

Detention Facilities

One of the most common structural methods for controlling urban runoff and reducing pollution loading is through the construction of ponds or wetlands to collect runoff, detain it, and release it to receiving waters in a controlled manner. Pollution reduction during the period of temporary runoff storage results primarily from settling of solids. Detention facilities, therefore, are most effective at reducing the concentrations of solids and the pollutants that typically adhere to solids, and less effective at removing dissolved pollutants.

Currently, the three types of detention facilities commonly used to remove pollutants from storm water runoff are extended detention dry ponds, wet ponds, and constructed wetlands; each is discussed below. For more detailed design information, the references listed in Appendix B should be consulted.

Extended Detention Dry Ponds. Most municipalities are familiar with the concept of constructing dry ponds to control peak runoff. When used as water quality BMPs, dry ponds are designed with orifices or other structures that restrict the velocity and volume of the discharges (see Figure 7-2). Dry ponds thereby detain the runoff before discharging it to surface waters.

Pollutant Removal. During the storage period, heavier particles settle out of the runoff, removing suspended solids and pollutants, such as metals, that attach to the particles or precipitate out. Some dry ponds also include vegetated areas that can provide pollutant removal through filtering and vegetative uptake. Dry ponds are, therefore, most effective at removing suspended solids and some nutrients and metals, and less effective at removing dissolved pollutants and microorganisms. Overall, the pollutant removal effectiveness of dry ponds has been shown to be less than for wet ponds and constructed wetlands (see Table 7-2).

Design Considerations. Retrofitting existing dry ponds with new outlet structures can sometimes enhance a municipal flood-control structure to increase its pollution control effectiveness. Care must be taken, however, to ensure that the overflow capacity of the pond is maintained, so that it continues to fulfill its original flood-control function. Study of the hydraulic characteristics of the dry pond will be necessary before retrofitting. Temporary storage also can be provided for runoff from smaller storms by building a small berm around an existing outlet structure.

For water quality dry ponds, important design criteria include the desired detention time and the volume of runoff to be detained. These factors dictate the pond's size and affect the pollutant removal efficiency of the structures. Most dry-pond sizing criteria specify a

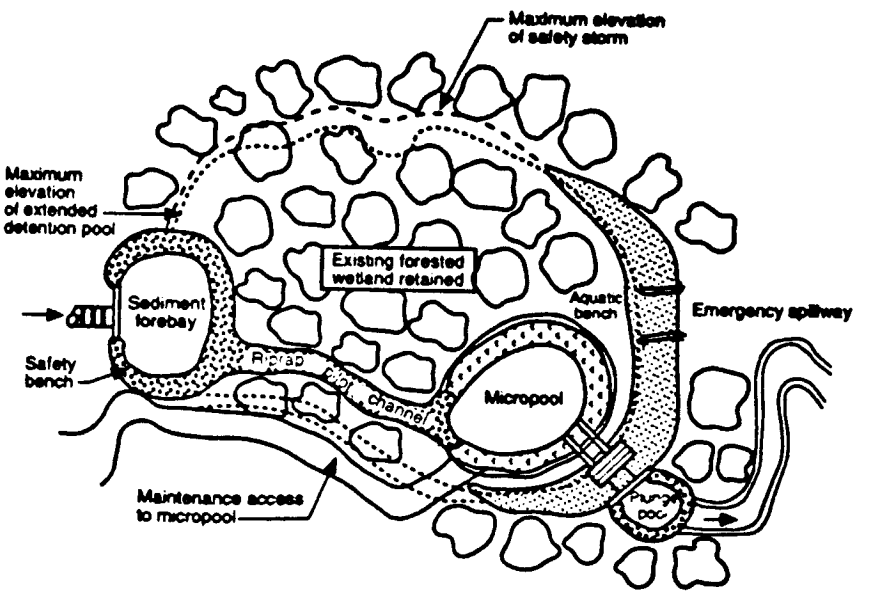

Figure 7-2. Extended detention pond (U.S. EPA, 1991a).

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certain detention time for a given design storm. For example, the Maryland Water Resources Authority specifies that water quality dry ponds must be large enough to accommodate the runoff volume generated by the 1-year, 24-hour storm to be released over a minimum of 24 hours (Schueler, 1987). In contrast, the Washington State Department of Ecology (WA DOE) specifies that dry ponds must be large enough to accommodate the runoff volume generated by the 2-year, 24-hour storm and release it over a period of 40 hours (WA DOE, 1991).

Dry ponds should also include some form of low-flow channel designed to reduce erosion; vegetation on the bottom of the pond to promote filtering, sedimentation, and uptake of pollutants; and an outlet structure designed to remove pollutants and withstand clogging. In addition, dry pond designs typically include upstream structures to remove coarse sediments and reduce sedimentation and clogging of the outlet. Also, outlets might be connected to grassed swales (biofilters) to provide additional pollutant removal (WA DOE, 1991). Each of these components of a dry pond design either enhances pollutant removal or reduces operation and maintenance costs for the structure.

Maintenance Requirements. Maintenance of water quality dry ponds is important. Regular mowing, inspection, erosion control, and debris and litter removal, are necessary to prevent significant sediment buildup and vegetative overgrowth (Schueler, 1987). Also, periodic nuisance and pest control could be required. Dry-pond design should recognize these maintenance requirements. The pond slopes should allow for mowing, and access roads should be provided.

Limitations on Use. Like other storm water treatment structures used in large watersheds, a primary physical constraint on the construction of water quality dry ponds is their large land requirements. For this reason, locating dry ponds in new developments is usually more practical than constructing them in already developed areas. Other physical constraints include the topography and the depth to bedrock.

Wet Ponds. The design of wet ponds is similar to that of dry ponds and constructed wetlands. In wet ponds, storm water runoff is directed into an constructed pond or enhanced natural pond, in which a permanent pool of water is maintained until being replaced with runoff as shown in Figure 7-3. Once the capacity of a wet pond is exceeded, collected runoff is discharged through an outlet structure or an emergency spillway.

Pollutant Removal. The primary pollutant removal mechanism in wet ponds is settling. The ponds are designed to collect storm water runoff during rainfall and to detain it until additional storm water enters the pond and displaces it. While the runoff is detained, settling of particulates and associated pollutants takes place in the pond.

Wet ponds can also remove pollutants from runoff through vegetative uptake. Wet ponds should be vegetated with native emergent aquatic plant species, which can remove dissolved pollutants such as nutrients from the runoff before it is discharged to the receiving water.

Design Considerations. Wet ponds typically are designed with a number of different water levels. One level of the pond has a permanent pool of water. The next level periodically is inundated with water during storms; this area should be vegetated and relatively flat to promote settling and filtering of sediments and vegetative uptake of nutrients. The highest level will be inundated only during extremely heavy rainfall; this area also should be vegetated to prevent soil erosion. At least 30 percent of the surface area of a wet pond should be a vegetated zone (Livingston et al., 1988). Typically, this vegetation is concentrated at the outlet as a final "polishing" biofilter.

The sizing of wet ponds is similar to that of dry ponds in that a number of different "sizing rules" provide varying levels of pollution control. Generally, these rules specify the volume of runoff to be detained in the wet pond during a storm. For example, the Maryland Water Resources Authority specifies that the permanent pool of a wet pond should be large enough to contain one-half inch of runoff distributed over the impervious portion of the contributing watershed (MD WRA, 1986). In Florida, storage volume for 1 inch of runoff above the normal pool elevation is recommended. This volume must be released at a slow rate; no more than half should be discharged within 60 hours after the event, and all the volume must be released after 120 hours. A hydraulic retention time of 14 days for the permanent pool volume is recommended (Livingston et al., 1988).

The design of water quality wet ponds must also take into consideration the possibility of large storms. Emergency spillways should be included in the design to prevent flooding difficulties. In addition, the pond's inlet and outlet structures should be separated and constructed at either end of the pond to maximize full mixing when large flows occur and avoid short-circuiting. By separating the inlet from the outlet, the detention time of the pond can also be increased. A forebay or other system for pretreatment also might be advisable. Further design guidelines for wet ponds can be found in the references in Appendix B.

Maintenance Requirements. Like many other BMPs, wet ponds require routine maintenance to be effective. Wet ponds are designed to allow for settling of suspended solids; therefore, periodic removal of the accumulated sediment must be performed (perhaps

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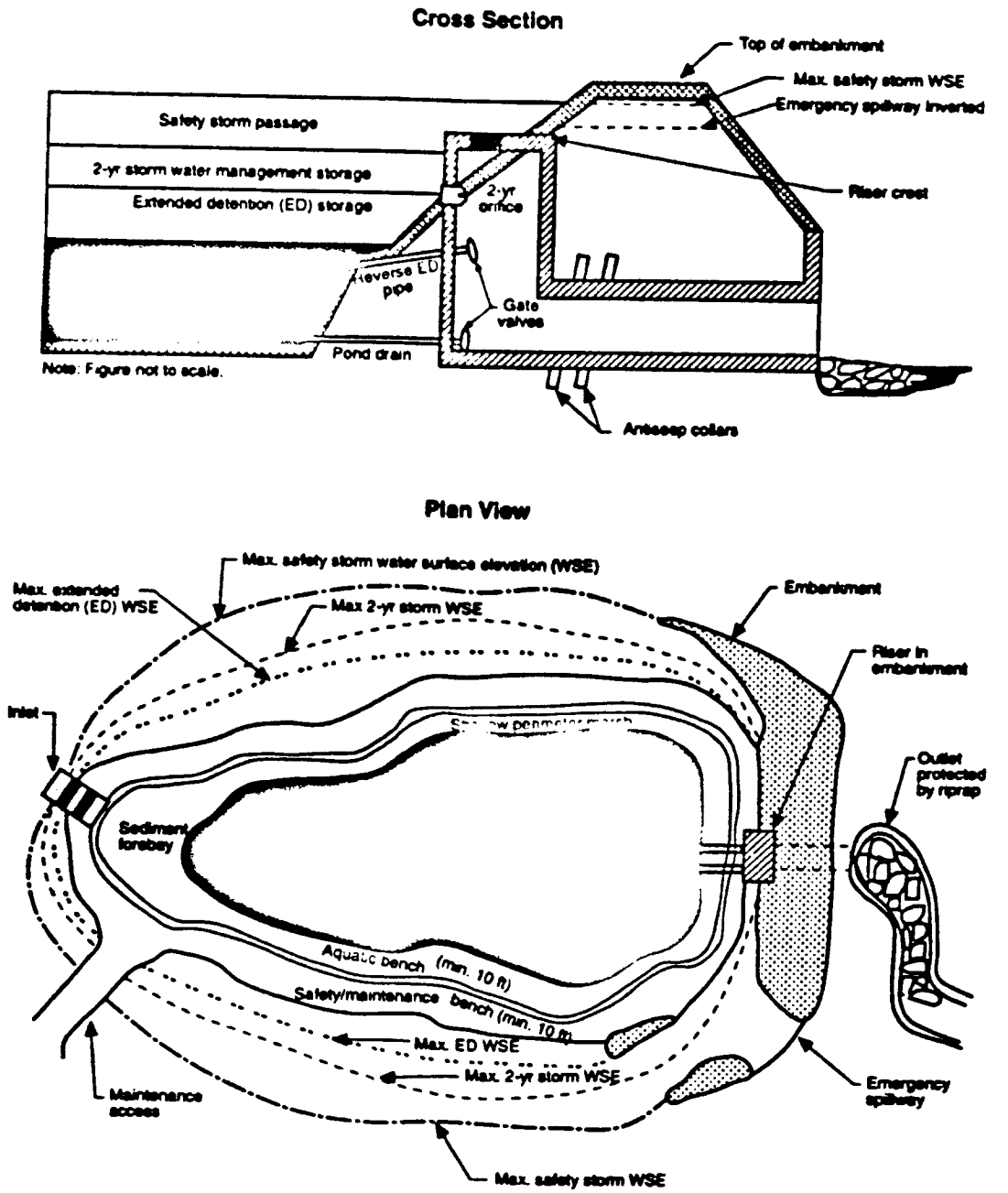

Figure 7-3. Wet detention system (Roesner et al., 1988).

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every 10 to 20 years). Removed sediment must be disposed of in accordance with appropriate regulations, which could include testing and special handling requirements for contaminated material. In addition, the pond slopes should be regularly mowed to make the sediment removal process easier and to enhance the aesthetic qualities of the area. Inlet and outlet structures should be inspected periodically for damage and accumulated litter, and the pond bottom should be inspected for potential erosion. Erosion of the pond bottom from high velocity flows can result in increased sediment transport and overall reduction in the pollutant removal capabilities of the pond.

Limitations on Use. Water quality wet ponds have large land requirements and usually are more suited to new development projects where they can be designed into the site. In addition, wet ponds are not suitable for use in areas with porous soils or low ground-water levels because a pool of water in the bottom is key to their design. Wet ponds should be built into the ground water with their control elevation set above the level of seasonal high water tables. Synthetic impermeable materials or clay can be used to prevent seepage. Wet ponds also have physical limitations related to the site topography; since locating wet ponds in areas with extreme slopes is often difficult, relatively flat locations are preferable.

Constructed Wetlands. Constructed wetlands are effective in removing many urban storm water pollutants. Two prevalent types of systems are shallow-constructed wetlands (Figure 7-4) and wet detention systems (Figure 7-5). The wet detention system is a wet pond with extensive shoreline shallow wetland areas. Wetland systems combine the pollutant removal capabilities of structural storm water controls with the flood attenuation provided by natural wetlands. Proper design of constructed wetlands—including their configuration, proper use of pretreatment techniques to remove sediments and petroleum products, and choice of vegetation—is crucial to the functioning of the system.

Pollutant Removal. Constructed wetland systems perform a series of pollutant removal mechanisms including sedimentation, filtration, adsorption, microbial

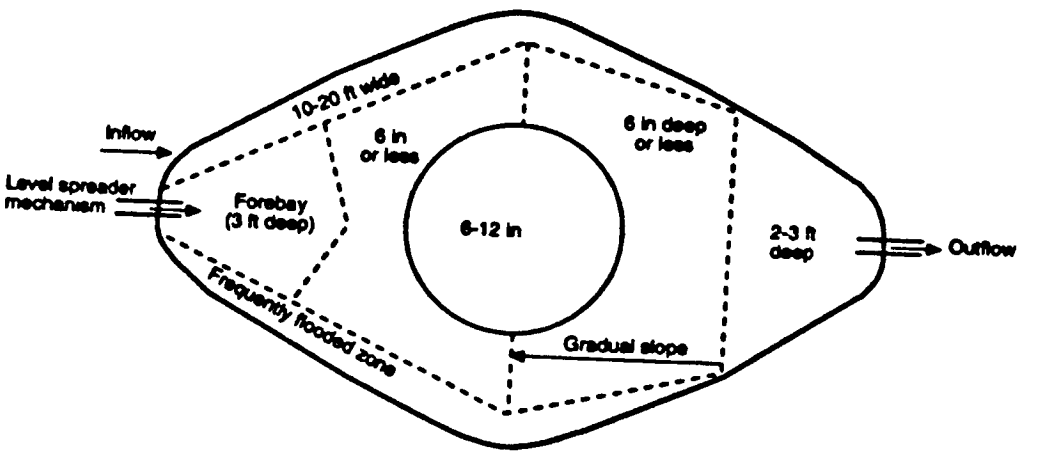

Figure 7-4. Example shallow-constructed wetland system design for storm water treatment (Maryland DNR, 1987).

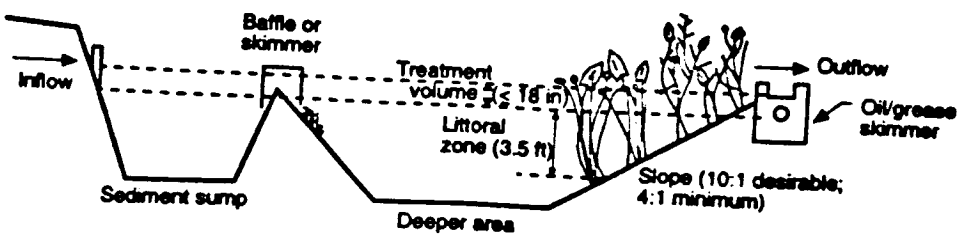

Figure 7-5. Example wet detention system design for storm water treatment (Livingston et al., 1988).

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decomposition, and vegetative uptake to remove sediment, nutrients, oil and grease, bacteria, and metals. Wetland systems reduce runoff velocity, thereby promoting settling of suspended solids. Plant uptake accounts for removal of dissolved constituents. In addition, plant material can serve as an effective filter medium, and denitrification in the wetland can remove nitrogen. A review of pollutant removal effectiveness data for 15 constructed wetlands and 11 natural wetland systems designed to treat storm water found high removals of total suspended solids and lead and only fair removal of ammonia, total phosphorus, and zinc (U.S. EPA, 1992a). In addition, constructed wetlands were found to have higher average removal rates and less variability than natural systems (U.S. EPA, 1992a). Specific wetland vegetation species remove specific pollutants from storm water runoff (RIDEM, 1989). Some of the most commonly used wetland vegetation includes cattails, bulrushes, and canary grass.

Design Considerations. Because the use of wetland systems for storm water runoff control is a relatively new technology, generally accepted design criteria do not exist. Some general guidelines, however, are recognized as important in the design of wetland systems. These guidelines include maximizing the detention time of runoff in the wetland system, maximizing the distance between the inlet and outlet, and providing some form of pretreatment for sediment removal.

Maximizing the travel time of runoff through a wetland system allows for greater opportunity for sediments to settle out of the water and for wetland plants to take up nutrients and other pollutants. Travel time can be increased in a wetland by reducing the gradient over which the flow travels or by making the flow travel over a greater distance before being discharged. In either case, some designers recommend a 24-hour detention time during the 1-year, 24-hour storm (RIDEM, 1989). If the distance separating the inlet from the outlet in a wetland system is not sufficient, flow might enter the wetland system and not become fully mixed during large rainstorms (see also the wet pond discussion). This phenomenon, known as short-circuiting, can greatly reduce the wetland system's level of treatment. Short-circuiting can be reduced by careful design of the wetland system. Wetland design should also take into account that sediment accumulation in wetland systems can greatly shorten their effective life and that some suspended solids should be removed from the runoff before it enters the wetland system. The design should include sloped sides to allow easy removal of accumulated sediments and harvesting of plants. Recommendations for constructed wetland systems are expected to evolve as more research is conducted.

Maintenance Requirements. Like most storm water quality controls, constructed wetlands require regular maintenance. In addition to regularly scheduled sediment removal, wetland systems should be periodically cleared of dead vegetation. Harvesting of plants in the wetland might be appropriate for pollutant removal purposes; if so, disposal of removed material must be planned.

Limitations on Use. While constructed wetland systems can treat storm water runoff effectively, they do require large areas of undeveloped land, which can make siting of wetland systems difficult especially in urban areas. For this reason, incorporating wetland systems into new development is usually more feasible than retrofitting them into existing developments. Existing wetlands occasionally can be retrofitted for pollutant removal if not prohibited by local or state regulations. Achieving proper soil conditions and ground-water levels can also present difficulties. To maintain a wetland environment, soils must be resistant to infiltration (i.e., have low permeability) and a water supply must be constant. In general, soils in the system must be saturated throughout the growing season so the desired vegetation will survive. Since natural wetlands are protected resources, diverting storm water to them for treatment will likely be prohibited. Finally, created wetlands become a resource area that may be subject to protection under federal, state, and local laws.

Infiltration Facilities

Unlike detention facilities that capture and eventually release storm water runoff to a surface water body, infiltration facilities permanently capture runoff so that it soaks into the ground water. Because they do not release the runoff to a surface water, infiltration facilities are sometimes called retention facilities. Pollutant removal in these BMPs occurs primarily through infiltration, which eliminates the runoff volume or lowers it by the capacity of the facility. Since the infiltrated flow can travel through the ground water and still be released to surface waters, dissolved pollutants such as some nutrients and metals could be reintroduced to the surface water with minimal pollutant removal. Currently, the three different types of facilities commonly used to promote infiltration and remove pollutants from storm water runoff are infiltration basins, infiltration trenches/dry wells, and porous pavement (grassed swales, which also promote infiltration, are addressed later under vegetative practices). Each of these BMPs is discussed in this section. For detailed design information, the references listed in Appendix B should be consulted.

Infiltration Basins. Infiltration basins are similar to dry ponds, except that infiltration basins have only an emergency spillway and no standard outlet structure.

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All flow entering an infiltration basin (up to the capacity of the basin) is, therefore, retained and allowed to infiltrate into the soil (see Figure 7-6).

Pollutant Removal. Infiltration is the major pollutant removal mechanism. Infiltration basins, like dry and wet ponds, receive storm water runoff from drainage systems and provide storage up to a designed volume. Unlike dry detention ponds which eventually release stored runoff through a drainage system, or wet ponds which maintain a permanent pool of water, infiltration basins release stored runoff through the basin's underlying soil. Infiltration basins provide storm water pollutant removal through volume reduction and filtration and settling. Infiltration basins are particularly effective in removing bacteria, suspended solids, insoluble nutrients, oil and grease, and floating wastes. They are less effective in removing dissolved nutrients, some toxic pollutants, and chlorides. Therefore infiltration basins should not be used when the ground-water quality itself is a concern or when these pollutants can be reintroduced through ground-water flow to surface waters.

Design Considerations. The most important consideration in the design of infiltration basins is calculating the basin's size for the drainage area and the soil type involved. Some designers recommend off-line basins to capture and infiltrate the first one-half inch of rainfall from the contributing drainage area (MD WRA, 1987). The appropriate amount of flow must be diverted to the system, and soil tests need to be performed to estimate the infiltration rates and appropriately size the basin. Also related to the proper size of infiltration basins is the amount of time necessary for the basin bottom to dry between rainstorms. Designers generally specify that infiltration basins should be designed to be dry for at least 3 days between storms (Schueler, 1987). This interval allows the soil to dry, thereby increasing its pollutant removal capacity. Basin shape is also important. It should have gently sloping sides to allow for easy access to mow the bottom vegetation. An emergency spillway must also be incorporated into the basin design. Finally, some form of pretreatment is recommended to remove suspended sediments from runoff before it is discharged to the basin. This pretreatment will reduce the need for periodic removal of accumulated sediment which can clog the soil pores and reduce the level of infiltration.

Maintenance Requirements. Infiltration basins require moderate to high levels of periodic maintenance. Most are designed with vegetated bottoms to provide stabilization and promote some vegetative uptake of nutrients. Periodically, the bottom of the basin must be mowed and accumulated sediments must be removed to maintain desired infiltration rates.

Limitations on Use. Infiltration basins often have relatively large land requirements and are better suited for location in developing areas than in already developed areas. Infiltration basins also require suitable soil to be effective. Accumulating runoff must be able to infiltrate the soil in the bottom of the basin. Typically, sand and loam, with infiltration rates greater than or equal to 0.27 in/hr (WA DOE, 1991), are the preferred soils for infiltration systems. The use of infiltration basins can be restricted by high ground-water elevations. For infiltration to occur, ground-water levels should be located at least 2 to 4 feet below the bottom of the basin.

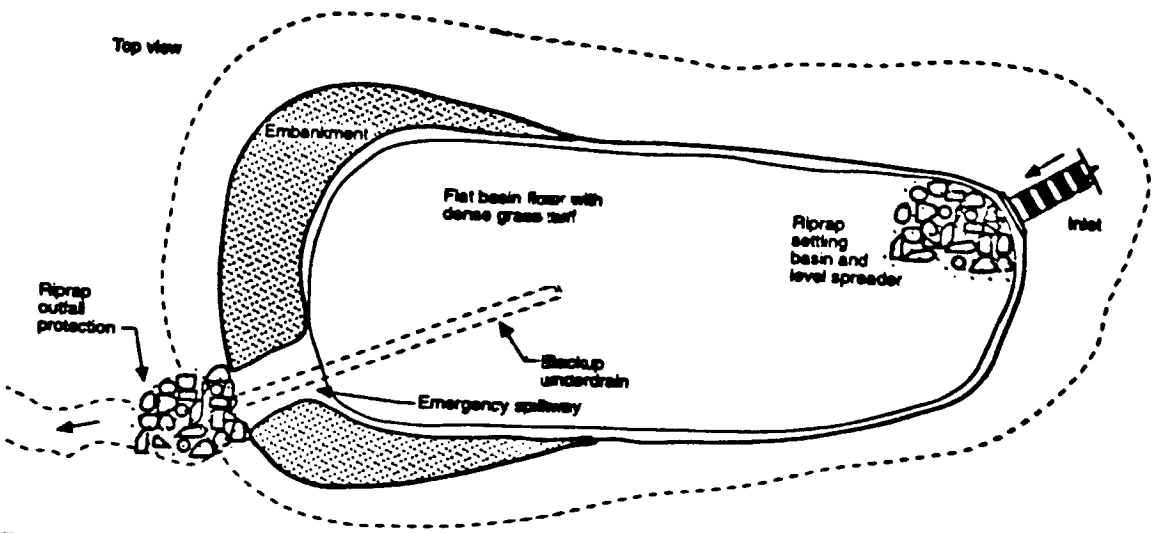

Figure 7-6. Sample infiltration basin.

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Infiltration Trenches/Dry Wells. Subsurface infiltration practices, such as infiltration trenches or dry wells, force runoff into the soil to recharge ground water and remove pollutants. These infiltration structures are located below ground and usually must be built "off line" because of their limited storage area (see Figure 7-7). Subsurface infiltration systems generally consist of precast concrete structures with holes in the sides and bottom surrounded by 2 to 4 feet of washed stone. Storm water runoff is directed into these structures and infiltration takes place.

Pollutant Removal. The structural controls described in this section use filtration as the primary pollutant removal mechanism, much like onsite wastewater treatment systems commonly used in many small communities. These controls effectively remove suspended sediments and floating debris, as well as bacteria which are difficult to remove without disinfection. Infiltration practices are generally less effective at removing dissolved nutrients, such as nitrogen or other soluble contaminants, which can travel through ground water and be discharged to the receiving water.

Design Considerations. The soil infiltration rate is probably the most important consideration in the design of infiltration structures. The soils underlying the structure must be tested to determine their suitability for infiltration. Some authorities specify the types of soils acceptable for infiltration as noted above for infiltration basins. Structure size is another primary consideration. The structures must be large enough to handle the desired design storms. Also, the structures must be designed to allow larger storms to bypass them. Because subsurface infiltration structures do not have outlets, they usually have to be designed off line of the regular drainage system. Runoff can then enter the infiltration structure until it is full; additional runoff is directed away from the structure. A diversion structure upstream of the infiltration structure is normally part of the design. The flow entering this structure (which could be a simple manhole) is directed to the subsurface infiltration structure until it is full; then additional flow is directed away from the structure and along the drainage system. A typical sizing rule for subsurface infiltration structures is they should store the runoff from the first one-half inch of rainfall on the site (Livingston et al., 1988).

Infiltration structures must also be designed to empty in a reasonable length of time. The underlying soils, to remove pollutants from runoff effectively, must be allowed to dry between rainstorms. Most experts specify that infiltration structures should contain a reservoir of runoff for no more than 3 days after rainfall (Shaver, 1986).

Maintenance Requirements. Infiltration structures require periodic cleaning to remove accumulated sediment and petroleum products. Often the need for this maintenance can be reduced by incorporating into the design a pretreatment structure that removes sediments and petroleum products from the runoff. These pretreatment

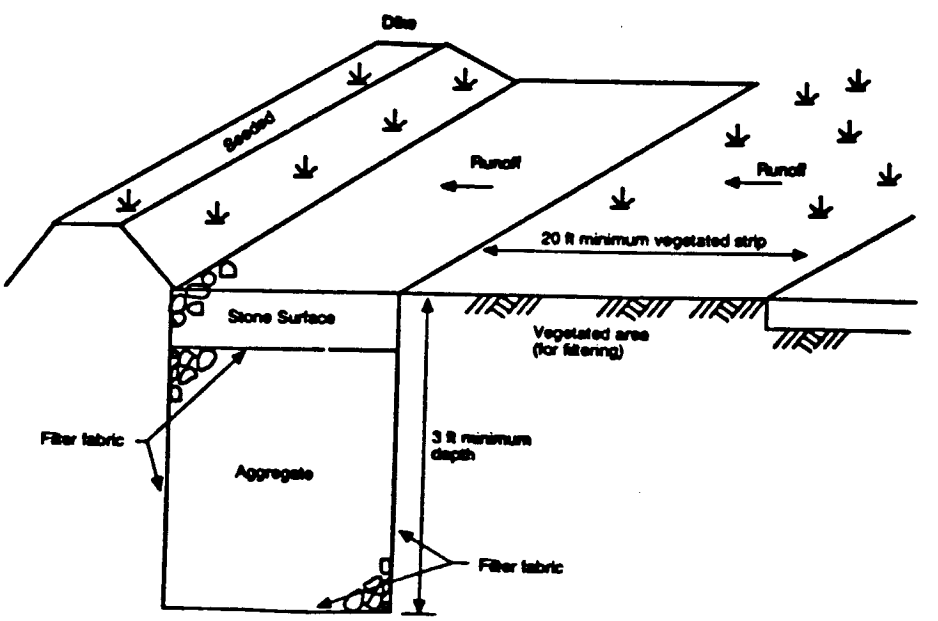

Figure 7-7. Sample infiltration trench (Livingston et al., 1988).

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structures can also minimize the discharge to ground water of some pollutants, such as solids. While addressing these issues in the design of infiltration structures can reduce routine maintenance requirements, the design still should include an observation well that allows inspectors to determine sediment deposition.

Limitations on Use. Subsurface infiltration structures can be used for end-of-pipe treatment as well as be located at different points in the drainage system. If located at the downstream end of a drainage system, infiltration structures can have large land requirements. Subsurface infiltration structures, because they are located underground, can be located in areas such as parking lots and access roads.

The primary physical limitation to locating infiltration structures, other than land requirements, is the suitability of soil, which must be neither too impermeable to runoff (e.g., clay, silt, or till) nor too rapidly permeated (e.g., sand). Another potential physical limitation is the depth to ground water. To provide proper treatment and reduce the possibility of ground-water contamination, a distance of at least 2 feet should be maintained between the bottom of the infiltration structure and the mean high ground-water elevation.

Porous Pavement. Paved roads and parking areas, because they increase watershed imperviousness, are major contributors to storm water runoff problems in urban areas. Porous pavement, however, allows water to flow through a porous asphalt layer and into an underground gravel bed. Porous concrete pavement can also be used. Use of this porous pavement can thereby reduce runoff volume and pollutant discharge. This practice, used in areas with gentle slopes, is generally designed into parking areas that receive light vehicle traffic.

Pollutant Removal. Field studies have shown that porous pavement systems can remove significant levels of both soluble and particulate pollutants (Schueler, 1987). Porous pavement is primarily designed to remove pollutants deposited from the atmosphere, as coarse solids can clog the pavement pores. In these systems, pollutant removal occurs primarily after the runoff has infiltrated into the underlying soils. Pollutant removal is accomplished by trapping of sediments, and infiltration through the underlying soils which can remove pollutants such as bacteria. The removal efficiency depends on the storage volume of the pavement, the basin surface area, and the soil percolation rate (U.S. EPA, 1991b).

Design Considerations. Porous asphalt pavement generally is designed with an upper pavement layer 2- to 4-inches thick, a 1- to 2-inch layer of coarse sand, a stone reservoir to provide storage, and a bottom filter fabric as shown in Figure 7-8. Other types of porous pavement include poured-in-place concrete slabs, pre-cast concrete grids, and modular units of brick or cast concrete (Livingston et al., 1988). The differences in pavement design result in different ways that the collected runoff is discharged. Some systems let all the runoff discharge through the underlying soils and into

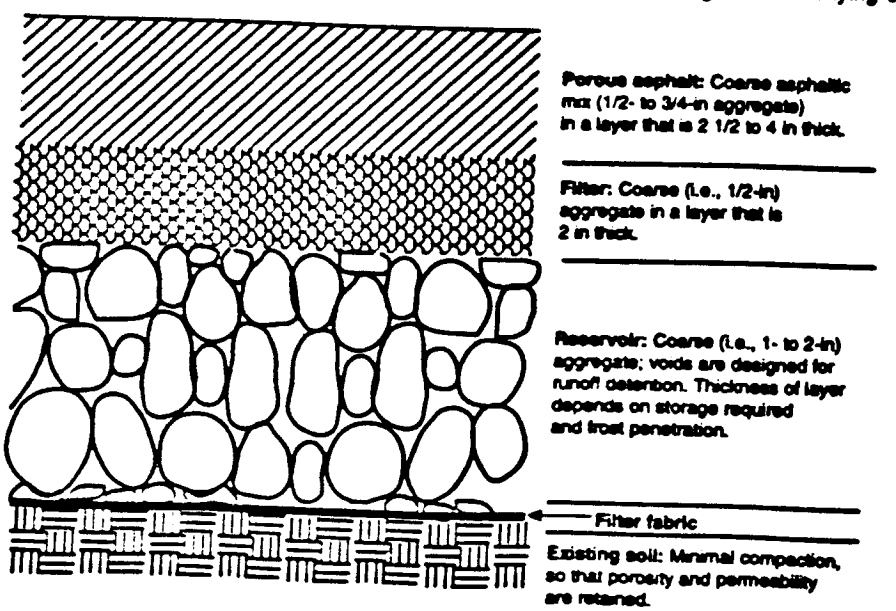

Figure 7-8. Porous pavement cross section (WA DOE, 1991).

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the ground water. While these systems provide good pollutant removal, they can result in ground-water contamination. Other systems include perforated pipes to collect the runoff and discharge it directly to a surface water; while these systems protect the ground water below the pavement, they do not provide the same level of pollution removal as the full infiltration systems.

Porous pavement is designed so that a certain amount of runoff is collected and stored in the stone reservoir. The design criteria, therefore, determines the depth of the stone reservoir. The maximum depth of the stone reservoir also is affected by the infiltration rate of the underlying soils. Runoff should be completely drained within a maximum of 3 days after the maximum design storm event to allow the underlying soils to dry, maintaining aerobic conditions that improve pollutant removal (Schueler, 1987).

Maintenance Requirements. Porous pavement can have extensive maintenance requirements. The pavement must be kept free of coarse particles that can clog the pavement and prevent runoff from collecting. The pavement must, therefore, be regularly inspected and cleaned with a vacuum sweeper and high pressure jet. The state of Maryland, by reviewing its porous pavement practices, found that after 4 years of use only two of the 13 systems were functioning as designed (Lindsey et al., 1991). The 11 malfunctioning sites were affected primarily by clogging and excessive sediment and debris.

Limitations on Use. Because porous pavement is expensive to replace or repair, it is generally only used on parking areas that receive moderate to low traffic. The area to be paved also should be relatively flat with a depth of 2 to 4 feet from the bottom of the stone reservoir to the high water table. In addition, the soils under the pavement must allow for infiltration.

Vegetative Practices

Urbanization results in the elimination of vegetation and increases in impervious area. Vegetative practices in urban areas decrease the impervious area and promote runoff infiltration and solids capture. These practices generally provide moderate to low pollutant removal and are therefore used as pretreatment for the removal of suspended solids from runoff prior to more intensive treatment by other practices. The two major types of vegetative practices commonly used in urban areas are grassed swales and filter strips (both sometimes referred to as biofilters). Native vegetation is recommended since it requires less site preparation and maintenance.

Grassed Swales. Grassed swales are channels covered with vegetation to reduce erosion of soil during storms (see Figure 7-9). They are used to replace conventional catch basin and pipe network systems for transporting runoff to surface waters. Storm water runoff flows through the grassed swale reducing runoff velocity and promoting the removal of suspended solids.

Pollutant Removal. Infiltration of the runoff and associated pollutants is the most important pollutant removal process accomplished by grassed swales. Grassed swales also remove pollutants through filtering by the vegetation and settling of solids in low-flow areas. Because of these pollutant removal mechanisms, swales are most effective at removing suspended solids and associated pollutants, such as metals. The mechanism of infiltration also allows removal of bacteria.

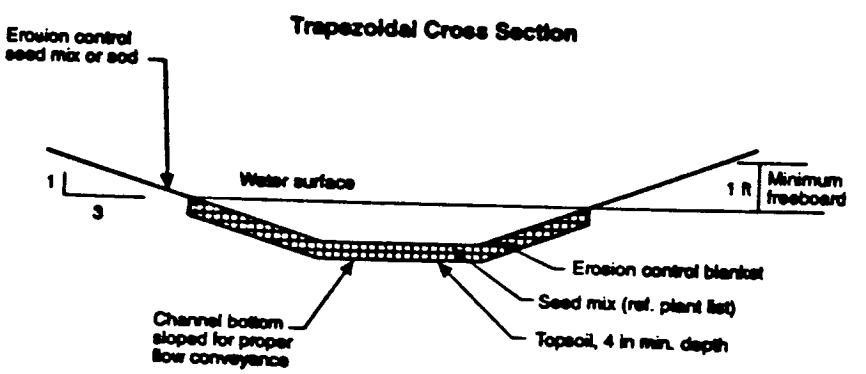

Figure 7-9. Sample grass-lined swale (Horner, 1988).

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Grassed swales provide little removal of dissolved pollutants, such as nutrients. Based on many studies of grassed swale effectiveness, removal rates are high for metals and particulates (Pitt, 1989).

Design Considerations. Pollutant removal in grassed swales can be increased by reducing runoff velocity—reducing the slope, increasing the vegetation density, and installing check dams to promote ponding. Also, the underlying soils should have a high permeability to help promote infiltration.

Maintenance Requirements. Grassed swale maintenance is aimed at preserving dense vegetation and preventing erosion of underlying soils. This maintenance includes regular mowing, weed removal, and watering during drought periods and after initial seeding. In conjunction with mowing, the cut material should be removed.

Limitations on Use. Grassed swales might be difficult to retrofit in already developed areas. They can replace curb and gutter drainage systems, but work best in low-slope areas with soil that is not susceptible to erosion.

Filter Strips. Filter strips, shown in Figure 7-10, are similar to grassed swales. Runoff entering these systems, however, generally is sheet flow, is evenly distributed across the filter strip, and flows perpendicular to the filter strip. Because these systems can accept only overland sheet flow, level spreading devices are used so that water is not ponded.

Pollutant Removal. Pollutant removal in filter strips depends on the filter strip's length, size, slope, and soil permeability; the size of the watershed; and the runoff velocity (Horner, 1988). Filter strips are most effective at removing pollutants such as sediment, organic material, and some trace metals, and less effective at removing dissolved pollutants such as nutrients.

Design Considerations. The major design aspects of filter strips that can be effectively changed are the length, width, slope, and vegetative cover of the strip. Greater pollutant removal results from filter strips that are long and flat. A level spreading device must also be incorporated in the design of a filter strip to ensure that concentrated flow does not enter and create a channel. If concentrated flows enter a filter strip, they can cause erosion of the vegetation and soil and reduce the structure's pollutant removal efficiencies. In addition to these considerations, filter strips should be constructed in areas with porous soil to promote infiltration.

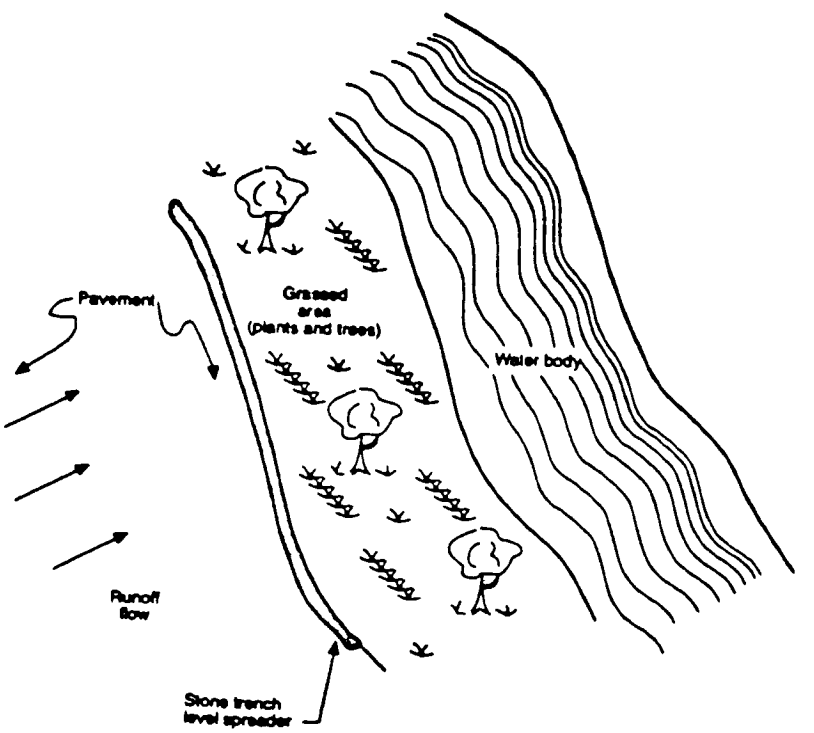

Figure 7-10. Schematic design of a filter strip.

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Maintenance Requirements. Filter strips must be mowed and weeded regularly—the same maintenance practices as grassed swales. In addition, the strip must be watered after initial seeding. In some cases, however, large filter strips can be "left on their own" so that large vegetation can grow and create a natural filter strip. This option reduces the level of maintenance required and can enhance the pollution removal of the strip.

Limitations on Use. The major limitation on the use of filter strips is the slope of the land; these strips operate best when placed on flat surfaces that have permeable soils. Also, filter strips treating large watersheds can have large land requirements that preclude their location in urban areas.

Filtration Practices

Filtration practices provide runoff treatment through settling and filtering using a specially placed layer of sand or other filtration medium. Flow enters the structure, ponds for a period of time, and filters through the media to an underdrain that discharges to a surface water. These practices attempt to simulate the pollutant removal of infiltration practices using less land area. Two different types of filtration practices currently in use are filtration basins and sand filters.

Filtration Basins. Storm water runoff diverted to a filtration basin can be detained, allowed to percolate through filter media, and collected in perforated pipes as shown in Figure 7-11. These perforated pipes then transport the filtered runoff to the receiving water. These systems have been used extensively in Austin, Texas, showing good pollutant removal efficiencies and low failure rates (City of Austin, TX, 1990). Communities in other regions might experience some initial problems in importing the technology (U.S. EPA, 1991a). One major question regarding filtration basins is the effect of cold temperature and freezing conditions on the operation of these systems.

Pollutant Removal. Pollutant removal in filtration basins occurs because of settling during the initial ponding time and filtering through the soil media. Removal efficiencies in filtration basins depend on several factors, including the storage volume, detention time, and filter media used. In general, longer detention times increase the system's pollutant removal efficiency. Increasing the detention time usually requires increasing the overall size of the filtration basin.

Initial settling of suspended solids occurs in filtration basins during the initial ponding of the runoff. Increasing detention time therefore promotes settling and increases the pollutant removal efficiency. Reducing the size of the perforated pipe, increasing the depth of filter medium, or decreasing the percolation rate of the filter medium can be used to increase the detention time. Changes in the filter medium also affect the pollutant removal efficiency of filtration basins. To date, filtration basins have primarily used sand as the filtering medium. Recent studies, however, have investigated the use of a combination of sand and peat, taking advantage of the adsorptive properties of peat to increase pollutant removal efficiencies (Galli, 1990). These sand-peat systems, however, are generally untested and their pollutant removal efficiencies are only theoretical.

Design Considerations. In Austin, Texas, sand filtration basins are typically designed to provide a detention time of 4 to 6 hours and have been used to treat runoff from drainage areas from three to 80 acres (City of Austin, TX, 1990). An experimental storm water sand-peat filtration basin to be constructed in Montgomery County, Maryland, is being designed to store the first one-half inch of rainfall from the impervious land in the watershed. In the Maryland area, this sizing criterion results in the treatment of 50 to 60 percent of the annual storm runoff volume (Galli, 1990). Runoff from larger storms will exceed the capacity of these filtration systems and will be diverted away from the filtration basin or discharged through an emergency spillway. To improve the longevity of sand and sand-peat filtration basins, runoff entering the systems is typically pretreated to remove suspended solids. Such pretreatment techniques as the use of a wet pool or

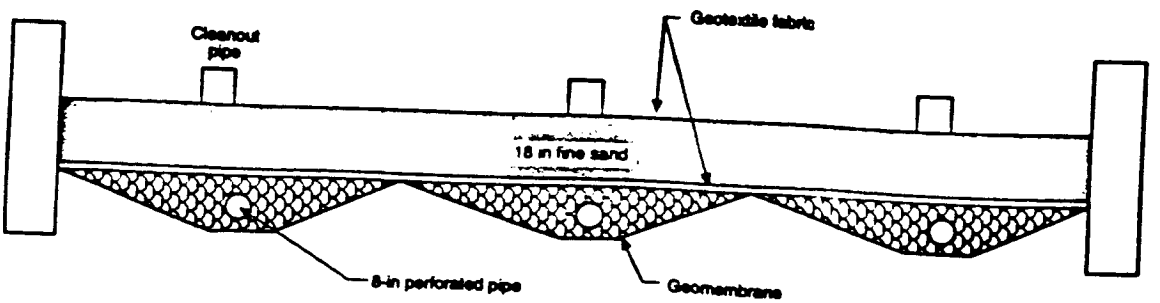

Figure 7-11. Conceptual design of a filtration basin (City of Austin, TX, 1990).

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water quality inlets can be used in conjunction with filtration basins.

Maintenance Requirements. Storm water runoff filtration basins require extensive maintenance to remove accumulated sediments and prevent clogging of the filtering medium. Maintenance requirements include inspecting the basin after every major storm event for the first few months after construction and annually thereafter; removing litter and debris; and revegetating eroded areas. In addition, the accumulated sediment should be removed periodically and the filter medium, when clogged with sediment deposits, should be removed and replaced (U.S. EPA, 1991b).

Limitations on Use. Filtration basins can often be difficult to locate in highly urbanized areas because of their large land requirements. In addition, high ground-water levels can restrict their use. Finally, they have not been widely used throughout the country and might not be considered a proven technology.

Sand Filters. Sand filters are similar to the filtration basins outlined above but can be built underground to reduce the amount of land required. These systems consist of a catch basin for settling of heavy solids and a filtration chamber (see Figure 7-12). Runoff enters the catch basin and collects to the basin capacity, overflows into a sand-filled chamber that provides filtration, and is discharged through an outlet pipe in the bottom of the filtration chamber. Other types of systems can be designed in conjunction with wet ponds or other practices, using natural or imported soil banks or bottoms, to increase their pollutant removal capability. The use of sand filters for storm water runoff treatment has been demonstrated in Maryland (Shaver, 1991).

Pollutant Removal. Sand filters use the same pollution removal mechanisms as filtration basins and provide similar pollutant removal. Initial removal of heavy solids occurs through settling in the catch basin and further treatment is provided by filtration through the sand-filled

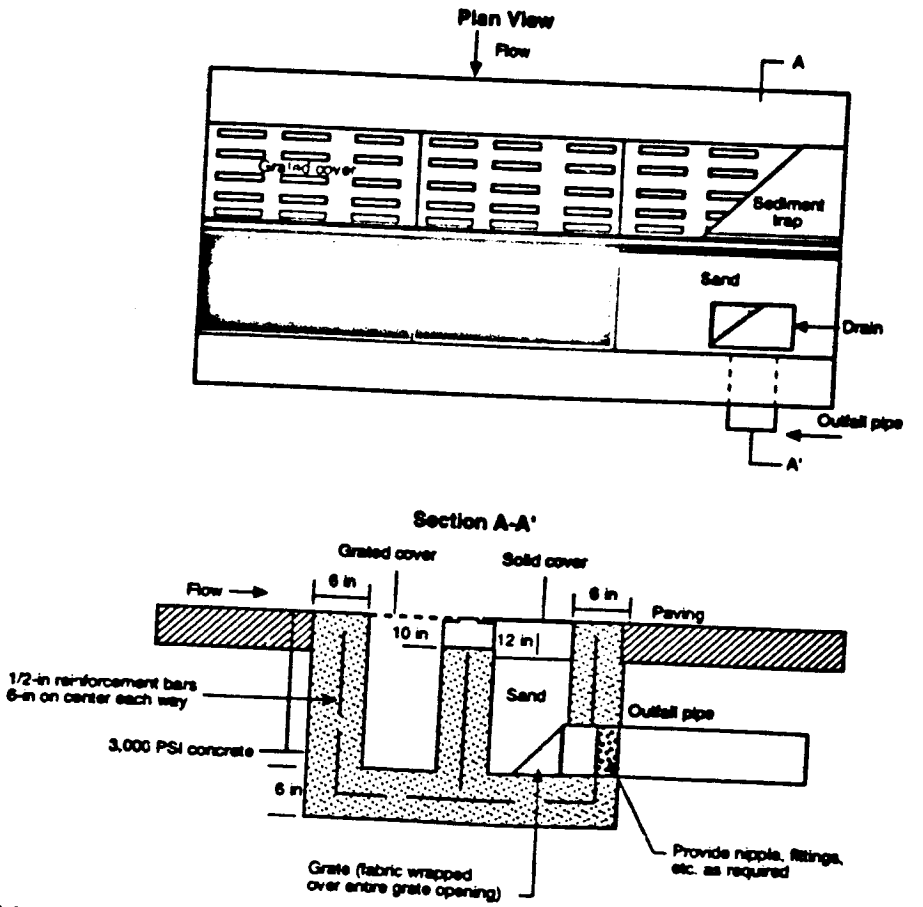

Figure 7-12. Schematic design of sand filter (Shaver, 1991).

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chamber. Sand filters are particularly effective at removing suspended solids and pollutants that attach to suspended solids, such as metals. Moderate removal of bacteria can be expected, but these systems cannot provide removal of soluble pollutants such as nitrogen and phosphorus.

Design Considerations. Because this BMP has not been widely used, there are few generally accepted design criteria for sand filters. The catch basin section must be designed to provide some sediment removal and to ensure that flow enters the filtration chamber as sheet flow to prevent scouring of the sand. The maximum drainage area that can be treated by a sand filter has been reported as about 5 acres (Shaver, 1991). Sand filters generally are used to treat impervious areas, such as parking lots, so that smaller sediment particles typical of pervious areas will not clog the sand filter.

Maintenance Requirements. Sand filters require minimal maintenance, consisting of periodically removing accumulated sediment and the top layer of sand from the filtration chamber and removing accumulated sediment and floatables from the catch basin. Regular inspections of the filter system can indicate when this maintenance is required.

Limitations on Use. Because of their small size, sand filters are designed to be used for pretreatment in large watersheds or full treatment in small watersheds. They cannot provide sufficient treatment for large watersheds (Shaver, 1991).

Water Quality Inlets

Water quality inlets, also known as oil and grit separators, are similar to septic tanks used for removing floatable wastes in onsite wastewater disposal systems. These inlets provide removal of floatable wastes and suspended solids through the use of a series of settling chambers and separation baffles as shown in Figure 7-13. These systems have been designed and used for many years, but storm water pollutant removal efficiencies are generally unknown.

Given the limited pollutant removal expected from water quality inlets, they are usually used in conjunction with other BMPs. Fairly effective at removing coarse sediments and floating wastes, water quality inlets can be used to pretreat runoff before it is discharged to infiltration systems or detention facilities. In this way, some of the routine maintenance other BMPs require (e.g., sediment removal and unclogging of outlet structures) can be reduced. Water quality inlets also can serve to capture petroleum spills that could enter other treatment structures or surface waters.

Pollutant Removal. The primary pollutant removal mechanisms of water quality inlets are separation and settling. The use of three chambers in these inlets serves to increase the detention time of the runoff in the tank, allowing settling to occur. In this way, suspended solids, and the attached pollutants, are removed from the runoff. In addition, the use of baffles and inverted elbows helps to remove floating litter and petroleum products from the storm water. The level of removal of these pollutants depends on the volume of water permanently detained in the tank, the velocity of flow through the tank, and the depth of the baffles and inverted elbows in the tank. By increasing detention time and decreasing flow velocity, the level of sediment and floatables expected to be removed from water quality inlets can be improved.

Design Considerations. There are few generally accepted design criteria for water quality inlets. Their design depends on the size of the watershed being treated and the detention time required. Since suggested detention times are usually measured in terms of minutes rather than days, water quality inlets generally do not remove pollutants from storm water runoff as effectively as some of the more intensive detention facilities discussed in this section. Water quality inlets have the advantage of being relatively small so they can be placed throughout a drainage system rather than just at the downstream end of the system.

In water quality inlet design, provisions should be made to reduce the entering flow velocity. Sediment and petroleum products collect in the water quality inlets. If entering flow has a sufficiently high velocity, the accumulated pollutants can be resuspended and discharged from the inlet. The flow and velocity of the entering runoff can be hydraulically restricted by limiting the size of the inlet pipe. Flows greater than the maximum design flow should be diverted away from the water quality inlet by a diversion structure in an upstream manhole.

Maintenance Requirements. Water quality inlets require periodic maintenance to remove accumulated pollutants; in general, these inlets should be cleaned about twice a year. Cleaning can be performed with a vacuum truck similar to those used to clean catch basins. The waste removed from water quality inlets, which includes petroleum products as well as sediments that have accumulated in the bottom, should be tested to determine proper disposal requirements, though their characteristics are similar to those of catch basin wastes. Periodic inspections between scheduled maintenance are also required to determine the level of accumulated pollutants.

Limitations on Use. There are few physical site limitations on the use of water quality inlets. The inlets are generally designed as belowground structures and do not require large amounts of land. Given their small size, however, large watersheds cannot be drained into

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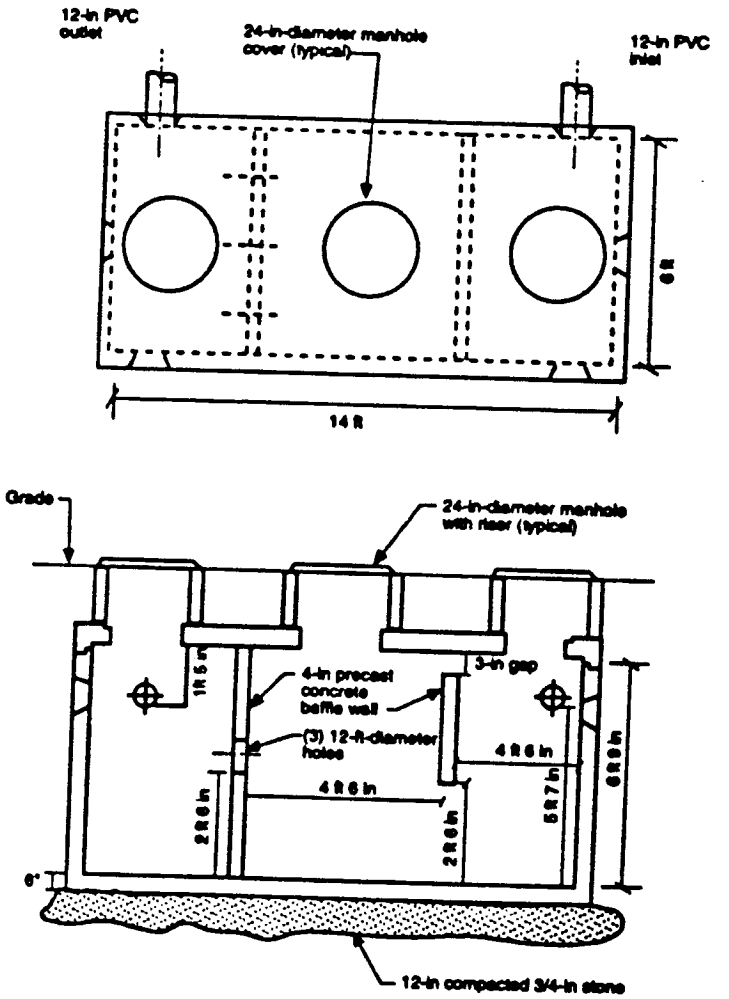

Figure 7-13. Conceptual water quality inlet (U.S. EPA, 1992b).

a water quality inlet. Removal efficiencies depend on the detention time in the water quality inlets. Their use is usually restricted to small watersheds of less than 2 acres. Another restriction on the use of water quality inlets is dry-weather base flow. If dry-weather base flow cannot easily be removed from a drainage system, a larger water quality inlet and more frequent maintenance are needed to accommodate this flow as well as the flow resulting from a rainfall event.

Combined Sewer Overflow Control Practices

Some of the urban runoff BMPs discussed above are applicable to CSO control. Additional control practices commonly used for CSO control are described in this section, including a general discussion of each practice's applicability, its pollutant removal effectiveness, and its maintenance requirements. More detailed references on CSO control are presented in Appendix B. Because CSOs contain sanitary sewage and other waste streams, the primary pollutants of concern in CSO control are suspended solids, biochemical oxygen demand, and pathogens. CSOs, however, also contain nutrients, metals, and other toxic substances.

Source Controls

Many of the source control practices that address urban runoff pollution are applicable to CSOs because they address contaminants that can enter any storm water collection system, whether separate or combined. Additional source control measures include water conservation and pretreatment programs.

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Water Conservation Programs. One way of reducing the amount of sewage in a combined system is to attempt to control the amount of water used by homes and businesses that is then converted to wastewater. Typical programs and practices for control include:

- *Plumbing retrofit:* Using low-flush toilets, flush dams, faucet aerators, and other water-saving devices.
- *Plumbing code changes:* Requiring implementation of water-saving devices in new construction or as they are replaced.
- *Education programs:* Encouraging water conservation in businesses and homes by providing information on its benefits.
- *Technical assistance:* Providing water-use audits or case studies demonstrating potential savings to businesses.
- *Rate system modifications:* Adjusting rate systems to promote or reward water savings.

While these programs might require minor changes in personal habits, they can be cost effective compared to end-of-pipe treatment. There are limits, however, to the reductions in water use that can be achieved reasonably.

Pretreatment Programs. These programs are implemented at the local level to control industrial and commercial sources of wastewater discharging to a municipal sewer system. The goals of a local pretreatment program are to stop or prevent industrial and commercial pollutants from passing through a municipal wastewater treatment plant, thereby violating state water quality standards; to stop or prevent disruption of treatment plant operations caused by industrial and commercial pollutants, including the contamination of municipal treatment plant residuals; and to ensure the safety of municipal sewer system and treatment plant workers by minimizing their exposure to potentially dangerous or toxic pollutants. While pretreatment programs historically have controlled large industrial wastewater sources, programs increasingly are focusing on controlling the discharges from small businesses and households. Local pretreatment programs typically include the following activities:

- *Development of sewer-use regulations:* To establish requirements on the quality and quantity of nondomestic wastewater that can be discharged to a municipal sewer system and to provide the municipality with legal authority to ensure compliance with pretreatment requirements.
- *Monitoring and surveillance:* To sample and analyze industrial and commercial discharges and to conduct onsite inspections of industrial and commercial facilities to determine the compliance with pretreatment requirements.
- *Permitting and enforcement:* To issue permits to individual industrial and commercial wastewater discharges that establish site-specific pretreatment requirements and to take all necessary actions to ensure compliance with those requirements.
- *Technical assistance and education programs:* To provide assistance to the regulated industries and commercial facilities, including encouragement to use pollution prevention measures to address wastewater control problems and to educate the general public on the effects of common household products and wastes that are discharged to the sewer system.

A pretreatment program implemented in a municipality with combined sewers can help control industrial and commercial pollutants discharged from CSOs during storm events. The level to which a pretreatment program can control the quality of CSO discharges, however, is very difficult to determine. Nonetheless, as part of an overall program to decrease the deleterious effects of CSOs, a pretreatment program can provide positive results.

Collection System Controls

Many collection system controls exist for addressing pollution from CSO discharges. These controls focus on modifying the sewer system to reduce CSO flow, volume, and contaminant load.

Sewer Separation. One method for addressing CSO pollution is to convert the combined collection system to separate storm water and sanitary sewer systems by constructing a new separate sanitary sewer. Sewer laterals from homes and businesses are then connected into the new system. Inappropriate connections to the old system from buildings are plugged. This conversion eliminates the possibility of sanitary wastes entering the drainage system and being discharged to a surface water. Sewer separation, however, can be very expensive and disruptive. A municipality implementing this practice likely has to address urban runoff pollution problems. In systems that consist of both combined and separate drainage areas, partial separation (i.e., separation of some combined areas) could be cost-effective.

Infiltration Control. Sources of infiltration include ground water entering the collection system through defective pipe joints, cracked or broken pipes, and manholes as well as footing drains and springs. Infiltration flow rates tend to be relatively constant, and result in lower volumes than inflow contributions. Infiltration problems are usually not isolated, and often reflect a more general sewer (or drainage) system deterioration. Extensive rehabilitation is typically required

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to remove infiltration effectively. The rehabilitation effort often must include house laterals, which are normally a significant source. Except in very large drainage systems, control of infiltration generally has a much smaller impact on CSO reduction than control applied to inflow.

Inflow Control. CSO control can be achieved by diverting some of the surface runoff inflows from the combined sewer system, or by retarding the rate at which these flows are permitted to enter the system. Inflow of surface runoff can be retarded by using special gratings, restricted outlet pipes, or hydrobrakes (or comparable commercial devices) to modify catch basin inlets to restrict the rate at which surface runoff is permitted to enter the conveyance system. Inlet flow restrictions can be designed to produce acceptable levels of temporary ponding on streets or parking lot surfaces, allowing runoff to enter the system eventually at the inflow point, but reducing the peak flow rates that the combined sewer system experiences. Flow detention to delay the entry of runoff into the collection system by storing it temporarily and releasing it at a controlled rate can also be accomplished by rooftop storage under appropriate conditions. Elimination of the direct connection of roof drains to the CSO collection system and causing this runoff to reach the system inlets by overland flow patterns (preferably via unpaved or vegetated areas) is another method of retarding inflows.

When site conditions permit, some surface runoff flows can be prevented from entering the combined system, by diverting them via overland flow to pervious areas or to separate storm drains. When these outlets are not available, excess surface runoff flows can be diverted to more favorable locations in the combined system (called flow-slipping).

Regulator and System Maintenance. Malfunctioning regulators are a common problem for combined sewer systems and can result in dry-weather overflows to receiving waters or in system backups and flooding. Static regulators often malfunction because of plugging or interference by debris in the sewer system. Mechanical regulators tend to require frequent maintenance. Municipalities should, therefore, develop an inspection and maintenance program designed to keep these regulators operating as designed. The expected reduction in CSO flows and loads resulting from this maintenance is site specific and depends on the existing conditions in the system.

In-System Modifications. These practices are designed to reduce CSO discharges by modifying the system to store more flow and allow it to be carried to the treatment plant. Possible modifications include adjusting regulator control features, such as weir elevation; installing new regulators; or installing new relief conduits. The effectiveness and applicability of these practices is site specific and depends on the existing capacity of the system and the treatment plant. These practices can be cost effective in locations where excess capacity exists.

Sewer Flushing. Sewer flushing is an additional practice to address CSO pollution problems. In this practice, water is used to flush deposited solids from the combined system to the treatment plant during dry weather. This practice is typically used in flat areas of the collection system where solids are most likely to settle out. The effectiveness of this practice is site specific and depends on the flush volume; flush discharge rate; wastewater flow; and sewer length, slope, and diameter. Though not currently a widely used practice, sewer flushing has been tested in selected areas (WPCF, 1989).

Storage

CSO discharges occur when the flow in a combined system exceeds the capacity of the sewer system or the treatment plant. Storing all or a portion of the CSO discharges for treatment during dry weather can effectively reduce these overflows. Storage techniques include in-line and off-line storage.

In-Line Storage. In-line storage uses existing capacity in major combined sewer trunk lines or interceptors to store combined flows. During storms, regulators are used to cause flow to back up in the system allowing it to be stored in the system. While not all flow can be stored in the sewer system, this practice can reduce overflow volumes during large storms and eliminate overflow volumes during small storms. After a storm, stored flow proceeds to the treatment plant for treatment. The overall pollutant removal in this practice depends on the level of storage space available in the existing system. Care must be taken to ensure that flows do not back up onto streets or into homes.

Off-Line Storage. Off-line storage consists of constructed near-surface or deep tunnel detention facilities. Near-surface facilities usually consist of concrete tanks or, in some cases, large conduits which also convey flow to a treatment facility. Tunnels can provide large storage volumes with relatively minimal disturbance to the ground surface, which can be very beneficial in congested urban areas. Overflows are directed to the storage facility, held during the storm, and pumped to the POTW after the storm, thus reducing the overflow quantity and frequency. The overall pollutant removal in this practice depends on the design capacity of the storage facility and the percentage of overflows that can be stored.

Flow Balance Method. The in-receiving water flow balance method involves using floating pontoons and

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flexible curtains to create an in-receiving water storage facility. CSO flows fill the facility by displacing the receiving water that normally occupies the storage facility. The CSO flows are then pumped to the collection system following a storm. The technology has been used for CSO control in Brooklyn, New York. This alternative involves permanently installing the floating pontoons in the receiving water near the CSO outlets. The feasibility of this technology, therefore, depends in part on whether the storage facility would have a significant impact on the aesthetic value of the surrounding area, and whether the structure would be a hindrance to navigation. Other site-specific concerns include the availability of volume due to tidal variations in coastal waters and the need for protection from damage due to high winds or wave action.

Physical Treatment

Most of the urban runoff BMPs previously discussed employ physical processes to reduce pollution. Physical treatment practices can also be used to reduce pollutant discharges from CSOs. The practices discussed in this section include bar racks and screens and swirl concentrators/vortex solids separators.

Bar Racks and Screens. These practices use screening technologies to reduce the flow of solids in combined systems. They are typically used as a preliminary treatment step to remove floatables upstream of other processes. Different screens have different size openings to provide various levels of solids removal. Bar racks have the largest openings (typically 1 inch or more) and microstrainers have the smallest openings (typically as small as 15 microns). All these practices require periodic and regular cleaning to prevent the accumulation of solids. Typically only the smaller screens provide significant pollutant removal. Screens are most effective at removing floatables and, depending on screen size, can remove suspended solids and can provide some BOD removal.

Swirl Concentrators/Vortex Solids Separators. These technologies are designed to provide flow regulation and remove solids from combined flow by forcing flow into a vortex path, so that solids and nonsolids can be separated. The resulting underflow containing separated solids can then be conveyed to a treatment facility. One advantage of these structures is that they have no moving parts and thus require less maintenance than other structures. The effectiveness of swirl concentrators and vortex solids separators depends on the settling characteristics of the CSO solids, the amount of turbulence created in the structure, and the flow rate. Data have shown that these practices can provide up to 60-percent removal of solids and BOD, with the greatest removal occurring during the first flush washoff (WPCF, 1989). They are, however, most effective in removing larger solids; their performance is highly dependent on the influent solids particle size distribution and specific gravity.

Dissolved Air Floatation. Dissolved air floatation (DAF) removes solids from wastewater by introducing fine air bubbles which attach to solid particles suspended in the liquid, causing the solids to float to the surface where they can be skimmed off. While this technology has been tested in CSO applications, it has not been widely applied. Because of its relatively high overflow rate and short detention time, DAF does not require as large a facility as conventional sedimentation. Oil and grease are also more readily removed by dissolved air floatation. The high operating costs for DAF are due to large energy demand; skilled operators are required for its operation.

Fine Screens and Microstrainers. These devices remove solids through capture on screen media. The most common fine-screening devices include rotary drum and rotary disk devices. In the rotary drum screen, media is mounted on a rotating drum. Flow enters the end of the drum, and passes out through the filter media. Drum rotational speed is usually adjustable. Solids retained on the inside of the drum are backwashed to a collection trough. Filter media aperture size typically ranges from 15 to 600 microns. The rotary disk screen has the screening media mounted on a circular frame placed perpendicular to the flow. Flow passes through the bottom half of the rotating disk, which is submerged. Solids retained on the disk are directed to a discharge launder using spray water.

One form of static screens features wedge-shaped steel bars, with the flat part of the wedge facing the flow. These wedge-wire screens typically have openings ranging from 0.01 to 0.05 in. These screens require daily maintenance to prevent clogging (Metcalf & Eddy, Inc., 1991). Screens are subject to blinding from grease and first-flush solids loads; a high-pressure backwash, as well as the collection and conveyance of backwash solids, are typically required. Effective cleaning of screens after storm events using high pressure steam or cleaning agents is typically required to maintain performance. Removal efficiencies can be increased by decreasing media aperture size, but smaller apertures are more likely to blind. Coarse screening and disinfection facilities are often provided in conjunction with microstrainers.

Filtration. Dual-media high-rate filtration has been piloted for treatment of CSO flows using a two-layer bed, consisting of coarse anthracite particles on top of less coarse sand. After backwash, the less dense anthracite remains on top of the sand. Filtration rates of 8 gal/ft^2/min or more result in substantially smaller area requirements compared with sedimentation.

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Demonstration test systems include pretreatment by microstrainers. The use of chemical coagulants improves performance considerably. A disadvantage to filtration is the filters' tendency to clog during use in treating wastewater, thus limiting hydraulic capacity and effectiveness of solids removal. Filtration is more appropriately applied after sedimentation or fine screening to provide pretreatment. While operation can be automated, filtration tends to be O&M intensive.

Chemical Precipitation

Chemical precipitation facilities store and use polymer, alum, or ferric chloride to cause solids to precipitate. Chemical precipitation can increase the pollution removal that generally occurs from other settling practices, thereby allowing for the design of smaller sedimentation tanks. Chemical precipitation generates more sludge than other settling techniques. Pollutant removal depends on the types of chemicals used and the characteristics of the combined flow. Removal rates for these practices are up to 70 percent for BOD and 85 percent for suspended solids. Because CSO treatment facilities are intermittently operated, however, sludge buildup and handling can become a major problem.

Biological Treatment

While biological treatment processes have the potential to provide a high quality effluent, disadvantages of biological treatment of CSOs include:

- The biomass used to break down the organic material and assimilate nutrients in the combined sewage must be kept alive during dry weather, which can be difficult except at an existing treatment plant; biological processes are subject to upset when exposed to intermittent and highly variable loading conditions.
- The land requirements for these types of processes can preclude their use in urban areas.
- Operation and maintenance can be costly and the process requires highly skilled operators.

Some biological treatment technologies are utilized in CSO control as elements of a wastewater treatment plant. Pump-back flows from CSO storage facilities commonly receive secondary treatment at the treatment plant, once wet-weather flows have subsided. In a treatment plant that has maximized the wet-weather flows it accepts, flows are sometimes split, with only a portion of the primary treated flows receiving secondary treatment, to avoid process upset. The split flows are blended and disinfected for discharge.

Disinfection

Because pathogens are the primary pollutant of concern in CSO control, practices focusing on disinfection are commonly used.

Chlorination. Combined flows can be treated with dissolved or gaseous chlorine to reduce the level of pathogens in the flow. Chlorination is typically used in conjunction with upstream solids removal. Chlorination, however, is not effective at addressing aesthetic or other water quality impacts of CSOs. Dissolved chlorine (hypochlorite) is currently more commonly used than gaseous chlorine because the equipment is more reliable and storage of the chemicals is safer. Dechlorination might be necessary to minimize the adverse effects of chlorine on aquatic life. Effectiveness of disinfection depends on the amount of chlorine used and the contact time between the chlorine and the wastewater. With sufficient dosage and mixing, close to 100-percent destruction of pathogens is possible. These facilities require regular inspection and maintenance.

UV Radiation. Introduction of ultraviolet radiation to combined wastewater is designed to provide disinfection without the addition of harmful chemicals. This practice uses an ultraviolet lamp submerged in a baffled channel located downstream of an effective solids removal process. The effectiveness of this practice depends on the lamp intensity, the contact time between the lamp and the wastewater, the distance between the wastewater and the lamp, and the level of solids in the wastewater. This system provides disinfection only and does not contribute to removing other pollutants. The high amount of solids in CSO flows limits the performance of UV radiation unless the solids can first be reduced.

An overview of urban runoff and CSO BMPs is given to help develop a list of BMPs to be screened. As noted earlier, many references also can be used (see Appendix B). After the BMPs have been screened, BMP selection is the next step of the planning approach.

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Case Study:
City of Austin, Texas,
Local Watersheds Ordinances

Austin, a highly urbanized city bisected by the Colorado River, contains a number of high quality lakes, aquifers, and streams. The major water resources in the area include three lakes—Lake Travis, Lake Austin, and Town Lake—which form a major drinking-water reservoir acting as the main water supply for the city; Edwards Aquifer and Barton Springs are the area's other major water resources. These water resources are potentially threatened by urban runoff pollution from urbanized areas; Town Lake already is affected significantly. To reduce and prevent urban runoff pollution problems in these resources, Austin has developed and passed three major watershed ordinances:

- The Comprehensive Watersheds Ordinance, 1986
- The Urban Watersheds Ordinance, 1991
- The Barton Springs Ordinance, 1992

The primary goal of these ordinances is to protect the water resources of the Austin area from degradation from nonpoint source pollution. Other goals include preventing the loss of recharge to the Edwards Aquifer, preventing adverse impacts from wastewater discharges, and protecting the natural and traditional character of the water resources in the Austin area. In addition, the city has implemented other ordinances that control NPS pollution.

Water pollution problems in the Austin area have been extensively studied since the mid-1970s. In 1981, the city participated in NURP and began implementing and monitoring the effectiveness of urban runoff structural controls. The city has been a leader in developing and implementing NPS regulatory controls. The city's first NPS control ordinance, the Lake Austin Watershed Ordinance in 1978, was followed by other watershed ordinances in 1981 and 1984 designed to protect additional sensitive watersheds and upgrade the level of protection. The experience and data gathered as a result of these ordinances led the city to propose and adopt a more complete set of protections for water resources as described in this summary.

The Comprehensive Watersheds Ordinance

The Comprehensive Watersheds Ordinance (CWO) is directed at preventing urban runoff pollution by placing requirements on proposed new developments within a 700-square-mile area of the city and its extraterritorial jurisdiction. It was developed in 1986 by a task force, appointed by the city council, with representatives from environmental groups, citizens, developers, and a council-appointed environmental board. The ordinance includes requirements for limiting impervious cover, using water quality buffer zones, protecting critical environmental features, limiting the disturbance of natural streams, implementing erosion control practices, constructing sedimentation and filtration basins, and restricting onsite wastewater disposal. The ordinance divides the city into four different watershed categories that each allow for different levels of development intensity: urban, suburban, water supply suburban, and water supply rural. While urban watersheds were not originally covered by the CWO, they are addressed in the Urban Watersheds Ordinance which is described later. Requirements for all the applicable watershed categories are shown in Table 7-3.

The waterways located in each watershed category are classified as minor, intermediate, or major depending on the total drainage area contributory to the waterway (see Table 7-3). Each waterway classification has an associated critical water quality (WQ) zone which encompasses the 100-year floodplain boundary and is located 50 to 100 feet from minor waterways, 100 to 200 feet from intermediate waterways, and 200 to 400 feet from major waterways. No development is allowed in this critical WQ zone. Each waterway type also has an associated water quality buffer zone that begins at the end of the critical WQ zone and extends upland for a defined distance as shown in Table 7-3. Development in this zone is restricted by limits on the allowed percent imperviousness of the site. Areas outside the WQ buffer zone are considered upland areas and have less stringent percent imperviousness

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Table 7-3. Maximum Development Intensity

Watershed Category	Waterways: Minor	Waterways: Intermediate	Waterways: Major	Development Limits: Water Quality Buffer Zone	Development Limits: Area Type	Development Limits: Uplands Zone[a]	Development Limits: Transfer	Acceptable Structural Pollution Controls
Suburban								
						% Impervious Cover		
Drainage area:	320 ac	640 ac	1,280 ac	30-percent impervious cover	Residential:	50	60	Sedimentation
Critical WQ zone:	100 ft	200 ft	400 ft		Duplex:	55	60	Sedimentation
WQ buffer zone:	None	100 ft	150 ft		Multifamily:	60	70	Filtration
					Commercial:	60	80	Filtration
Water Supply Suburban—Class I								
						% Impervious Cover		
Drainage area:	128 ac	320 ac	640 ac	18-percent impervious cover; no development over recharge zone	Residential:	30	40	Filtration
Critical WQ zone:	100 ft	200 ft	400 ft		Multifamily:	40	55	Filtration
WQ buffer zone:	100 ft	200 ft	300 ft		Commercial:	40	55	Filtration
Water Supply Suburban—Class II								
						% Impervious Cover		
Drainage area:	128 ac	320 ac	640 ac	30-percent impervious cover; no development over recharge zone	Residential:	40	55	Filtration
Critical WQ zone:	100 ft	200 ft	400 ft		Multifamily:	60	65	Filtration
WQ buffer zone:	100 ft	200 ft	300 ft		Commercial:	60	70	Filtration
Water Supply Suburban—Class III								
						% Impervious Cover		
Drainage area:	320 ac	640 ac	1,280 ac	30-percent impervious cover	Single-family:	45	50	Filtration
Critical WQ zone:	100 ft	200 ft	400 ft		Duplex:	55	60	Filtration
WQ buffer zone:	100 ft	200 ft	300 ft		Multifamily:	60	65	Filtration
					Commercial:	65	70	Filtration
Water Supply Rural								
						Units/ac		
Drainage area:	64 ac	20 ac	640 ac	One unit per 3 acres; no development over recharge zone	Single-family:	0.5	1.0	—
Critical WQ zone:	100 ft	200 ft	400 ft		Cluster:	1.0	2.0	40% buffer[b]
WQ buffer zone:	100 ft	200 ft	300 ft					
						% Impervious Cover		
					Multifamily:	20	25	40% buffer
					Commercial:	20	25	40% buffer
					Planned:	50	50	40% buffer
					Retail:	50-60[c]	60-70	Filtration

[a] Net site area.
[b] Except in Lake Austin/Lake Travis, where filtration is required.
[c] Only at major intersections.

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restrictions. In this zone, the restrictions are tied to the type of development proposed for the site as shown in Table 7-3. Some development restrictions can be reduced if the developer transfers land located in the watershed to the city. In this way, development density can be increased by the developer in exchange for an increase in publicly held lands. For example, a multifamily development in suburban Class I water supply watershed is restricted to 40-percent impervious unless the developer is able to use development rights transfers (see Table 7-3). In this case, the development can reach 55-percent impervious and still meet the requirements of the ordinance.

In addition to the restrictions on site percent imperviousness, developments in these watersheds are required to incorporate structural control practices. The acceptable control practices are sedimentation basins, filtration basins, and vegetative buffers as outlined in Table 7-3. Basins must be designed to capture, isolate, and hold at least the first one-half inch of runoff from contributing drainage areas. Also, nonstructural requirements serve to prevent pollution. These include limitations on the depth of cuts and fills, limitations on construction on steep slopes (greater than 15 percent), and limitations on the disturbance of natural streams including restrictions on the number of stream crossings. Temporary erosion controls, such as silt fences and rock berms, are required during construction.

In Austin, proposed new development plans are reviewed by a separate environmental review staff, autonomous from other departments. This allows for a focused review that includes field surveys of projects in sensitive areas. Once the plans are approved, city inspectors monitor construction for compliance with the approved plans. Approximately 50 percent of the financing for reviews and inspections required by this ordinance comes from development permit fees. The fees vary depending on the development size and are higher in sensitive watersheds because of the increased review requirements. The rest of the expenses are covered through a drainage utility fund which consists of monthly service charges to the residents in the utility service area.

Since these requirements apply to new developments, the CWO is designed to prevent or reduce future increases in pollutant load to the target water bodies. The ordinance can be applied to a variety of watershed characteristics and water resource types.

Given the short time this ordinance has existed and its focus on prevention, assessing its effectiveness is difficult. These control measures, however, have been shown to reduce urban runoff pollution on a nationwide and a local level. The city's analysis of its nonpoint source monitoring program, completed in 1990, showed that pollutant loads increase with increased impervious cover. Figure 7-14, based on that 1990 report, compares total suspended solid loads from land with various levels of development as measured by percent impervious cover. This type of data was used to define the impervious land limitations in the ordinance.

Urban Watersheds Ordinance

In 1991, the city council approved task force recommendations to include urban area watersheds among those covered by development ordinances. This ordinance, created in response to increased pollution in Town Lake due to urban runoff discharges, focuses on the urban watersheds not previously covered by the CWO. It requires the implementation of structural controls in new developments undergoing site plan review. All new residential, multifamily, commercial, industrial, and civic development in the urban watersheds are required to construct water quality basins (either sedimentation or filtration basins) or provide a cash payment to the city for use in an Urban Watersheds Structural Control Fund. Structural controls must be used to capture the first one-half inch of runoff from all contributing areas. The Watersheds Structural Control Fund is used to retrofit and maintain structural controls where required in the urban watersheds. In addition to this requirement, new developments in the urban watersheds are required to provide for removal of floating materials from storm water runoff through the use of oil/water separators or other practices. Redevelopment projects in the urban watersheds are also included in this ordinance, where structural controls and the removal of floatable materials are required. For redevelopment projects, the city has developed a Cost Recovery Program Fund to provide 75 percent of the cost of structural controls. These funds will be allocated through the drainage utility fund.

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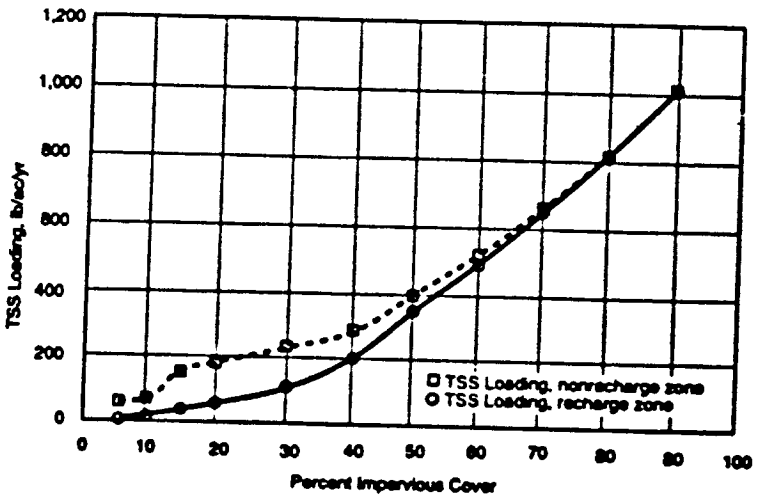

Figure 7-14. Total suspended solids loading vs. percent impervious cover.

In urban watersheds, the critical WQ zone is the boundary of the 100-year floodplain and is generally located 50 to 400 feet from the waterway. As with the Comprehensive Watersheds Ordinance, no development is allowed in the critical WQ zone.

Since this ordinance was passed only recently, there are no data concerning its effectiveness. Like the CWO, however, it focuses on using proven structural and nonstructural control measures that the city believes will effectively prevent urban runoff pollution.

Other Nonpoint Source Control Programs

In addition to the CWO and the Urban Watersheds Ordinance, Austin has developed other ordinances designed to reduce nonpoint source pollution from new developments and redevelopments. One of these, the Barton Springs Zone Ordinance, provides special protection to watersheds contributing to Barton Springs, a widely visited and used natural spring bathing area in Austin. This ordinance, created to be a nondegradation ordinance with specific performance requirements, includes definitions of waterways and development limits similar to those specified in the CWO. Only one- or two-family residential development with a density of 1 unit per 3 acres is allowed in the Barton Springs watershed transition zone, which extends up to 300 feet from the water body. In addition, new developments in the Barton Springs watershed must comply with the following requirements (see Table 7-4): reduce pollutant concentrations compared with the undeveloped conditions and discharge no greater than a specific maximum pollutant concentration after development. The city measures these requirements quarterly on each development through a developer-funded monitoring program.

Additional NPS control programs in Austin include:

- *Land Development Code:* Enforces landscaping regulations and protects trees and natural areas in the city.
- *Underground Storage Tank Program:* Develops guidelines for underground storage of hazardous materials, permitting and inspection of these underground storage tanks, and investigation of problems and response to emergency situations.
- *Water Quality Retrofit Program:* Involves engineering and building, with private sector participants, permanent controls for already developed areas and are producing storm water runoff pollution problems for the city's key receiving waters.

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Table 7-4. Barton Creek Development Requirements

Pollutant	Percent Reduction from Background	Maximum Discharge Concentration, mg/L
Total suspended solids	60%	144
Total phosphorus	15%	0.11
Total nitrogen	15%	0.95
Total organic carbon	50%	14

- *Water Quality Monitoring Program:* Monitors and characterizes pollutants from various land uses and structural controls, monitors surface and ground-water quality, and develops water quality models and data bases; also conducts specific studies on known nonpoint source problems.
- *Household Chemical Collection Program:* Provides for safe disposal of hazardous materials and other wastes generated from household use; conducted for the past 6 years, this program is currently located at a permanent site where collection events occur each year.
- *Storm Sewer Discharge Permit Program:* Involves permitting and regular inspection of industrial and commercial discharges to storm sewers and water courses.
- *Emergency and Pollution Incident Response Program:* Involves responding to emergency spills, general water pollution incidents, and citizen complaints related to water quality.
- *Street Cleaning and Litter Collection Program:* Provides regular street cleaning—nightly in the central business district, monthly on other major roads, and bimonthly in residential neighborhoods.
- *Integrated Pest Management Program:* Encourages application of the most environmentally safe pesticide techniques practicable for pest management in municipal operations.

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When an NTIS number is cited in a reference, that document is available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

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Chapter 8
Select Best Management Practices

Urban runoff problems, because of their diverse nature, need to be addressed through a combination of source control, regulatory, and structural BMPs. The selected combination needs to reflect the program goals (Chapter 3) and the priorities set during the assessment and ranking of existing problems (Chapter 6). The planning approach in this handbook recommends a two-step process for BMP selection. This chapter covers the second part of the BMP selection process, which uses the screened list of potentially applicable BMPs to develop and select the BMPs to be implemented.

To select BMPs, the alternatives typically are developed and compared to ensure that all options are considered and that the best possible plan is selected based on a predetermined set of selection criteria. While a specific problem caused by a specific source, might not require development of alternative BMP plans, for most programs which tend to deal with multiple sources and impacts, it is wise to investigate alternatives before selecting a final set of BMPs. This chapter first addresses development of alternative plans and then the selection of recommended BMPs. At the end of this chapter, two separate case studies on methods of BMP selection are presented.

Alternatives Development

Alternatives are developed using the BMPs still under consideration after the screening process (Chapter 7). The alternatives can include various combinations of source control, regulatory, and structural BMPs. Source control and regulatory BMPs are often implemented across entire regions or jurisdictions. Structural BMPs can be directed at specific pollutant sources or implemented across geographic areas, including both structural BMPs for new development in currently undeveloped areas or for retrofit in already developed areas. To address fully the urban runoff pollution problems in an area, BMPs from all these categories are often required.

Three commonly used methods for developing alternatives are discussed in this section. The first starts with known urban runoff problems and known pollutant reductions desired. The second develops a range of possible control levels for evaluation. The third involves applying specific BMPs throughout a project area. Any one or a combination of these methods can be used to develop an urban runoff pollution prevention and control plan.

In the first method, before developing the alternative plans, the problems to be addressed and desired level of control are decided. This information could be obtained from the problem assessment and ranking step described in Chapter 6. Various types or combinations of practices are then developed to meet the desired control level to address the known problems. For example, if a program goal is to reduce fecal coliform bacteria levels to below the criterion for safe consumption so that shellfishing beds can be opened, the level of control needed must reduce the bacteria counts to a known level. Information on the expected bacteria loadings from various sources is needed. Combinations of BMPs can then be developed to achieve the needed control level by focusing on BMPs that control the various sources. Criteria for developing alternative BMPs to meet the control level can include cost, pollutant removal efficiency, site characteristics, public acceptance, and others.

This alternative development method might lead to an emphasis on structural controls because these BMPs focus on addressing pollution problems from known sources, such as septic tanks, illicit cross-connections in storm water drains, and others. It has the advantage, however, of ensuring that known priority problems are addressed by each alternative. While this method can be used to develop alternatives for meeting either water quality or technology-based goals, it is especially applicable for meeting specific water resource or pollutant removal goals.

An example of this BMP selection method is shown in Table 8-1. In this example, multiple pollution problems, such as agricultural runoff, urban runoff, and failed onsite septic systems, were contributing to closed shellfish beds. Table 8-1 compares various urban runoff control practices for cost, level of expected improvement, public agency support, and other factors

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Table 8-1. Sample BMP Selection (Metcalf & Eddy, Inc., 1989)

BMP	Technical Feasibility	Monetary Factors			Water Quality Improvement	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
		Capital	O&M	Funding					
Urban Runoff									
Source controls	+	Low	Mod.	+	–	+	+	+	Does not achieve WQ goals
Infiltration	+	Mod.	Low	+	+	+	+	+	Soil and ground water might preclude its use Effective pollutant removal
Storage	+	High	High	–	–	–	–	–	No bacteria removal
Treatment	+	High	High	–	+	–	–	–	High capital cost Environmental impacts
Land Disposal									
Sewering	+	High	High	–	–	–	–	–	High capital cost
Alternative disposal	+	High	Low	–	–	–	–	–	High capital cost Likely public opposition
Nonstructural									
Regulation and enforcement	+	Low		–	–	–	–	–	Extensive public support required
Tax incentives	–			–	+	+	–	+	No programs in place
Local financing	–			–	+	–	–	+	Town funding not available
Beneficiaries financing	–			–	+	–	–	+	Complete organizational requirements
Public education	+	Mod.	Low	+	+	+	+	+	Builds public awareness and support

+ = Favorable or present
– = Unfavorable or not present

to determine the best mix of practices for implementation.

Based on this review, a combination of regulatory, educational, and structural runoff pollution prevention and control practices was recommended: enacting stricter local zoning and conservation bylaws oriented toward runoff pollution prevention, constructing an infiltration system along a stretch of roadway with known high pollution levels, conducting a public education program, and improving ongoing water resource monitoring efforts.

In the second method, alternatives representing a range of control levels are developed. For example, three levels of control could be formulated based on a range of pollutant removals (i.e., low, medium, and high). The low-level control alternative might consist of a minimum mix of BMPs designed to address priority problems. The medium-level control alternative might consist of the same practices as the low-level control alternative plus additional BMPs designed to address additional problems or to address more fully the same priority problems. The high-level control alternative might include the practices of the medium-level control alternative as well as additional practices. Each alternative plan therefore contains a subset of the BMPs included in the next higher level control alternative, allowing for a cost-effectiveness comparison among various control levels.

An example of this approach performed as part of the Santa Clara Valley NPS pollution control plan development is shown in Figure 8-1. Three BMP categories were considered: educational (E), regulatory (R), and public agency actions (P). Within each category, specific BMP practices were identified (e.g., E1, E2) and compared to evaluate the cost and benefit of each level. Some of the individual practices shown on Figure 8-1 were considered but not included. This approach is analogous to the screening step described in Chapter 7. The complete process used in the Santa Clara Valley study is described in the case study at the end of this chapter.

Another example of this approach which includes structural controls is shown in Figure 8-2 (Pitt, 1989). In this example, 10 different urban runoff pollution

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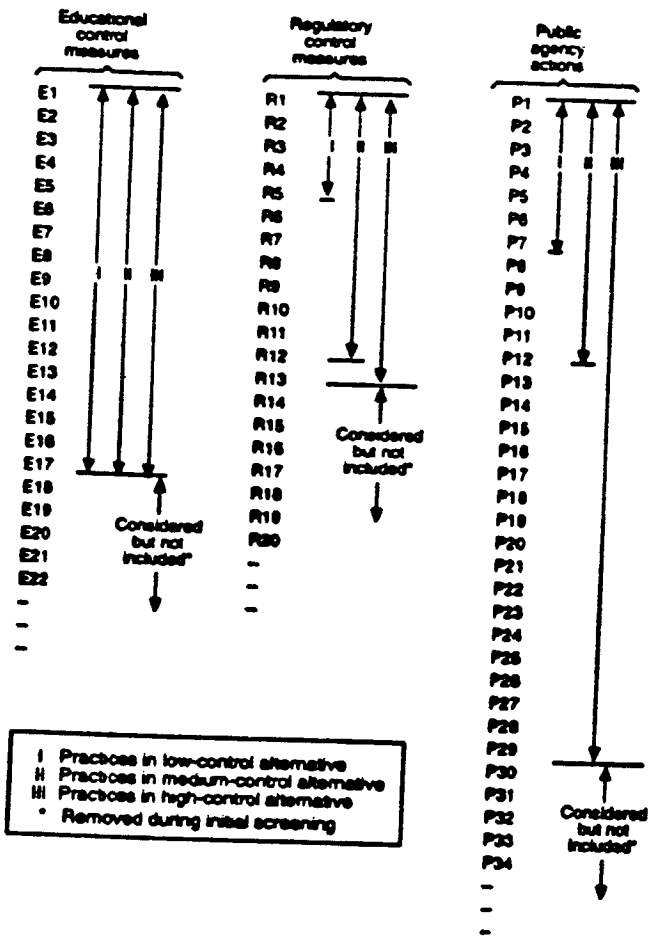

Figure 8-1. Example alternative development process (Woodward-Clyde Consultants, 1988).

prevention and control practices alternatives are plotted to compare phosphorus reduction with annual cost. The practices analyzed include various combinations of street sweeping, catch basin cleaning, construction of detention basins, and implementation of infiltration practices. Similar plots were also developed for solids and lead removal. Based on this analysis, Program 8 was recommended, a combination of infiltration and wet detention.

This second method is especially applicable for meeting general goals that do not include specific pollutant removal requirements. For example, if the goal is to reduce nitrogen discharges to a coastal embayment by the maximum extent practicable, then a series of alternatives can be developed covering a range of pollutant reduction levels and costs. These alternatives then can be compared on a cost-benefit and affordability basis.

The third method of developing alternatives begins with the screened list of appropriate control measures. Each BMP is then assessed for its ability to address the known and anticipated problems. As an example, preference might generally be given to BMPs that:

- Address more than one problem or lead to meeting more than one goal.
- Have lower construction and operating costs.
- Are most effective at removing the pollutants of concern.
- Emphasize pollution prevention rather than treatment.
- Are likely to address future problems.
- Concentrate on addressing the priority problems.

The assessment of individual BMPs results in alternatives based on implementing each BMP throughout the study

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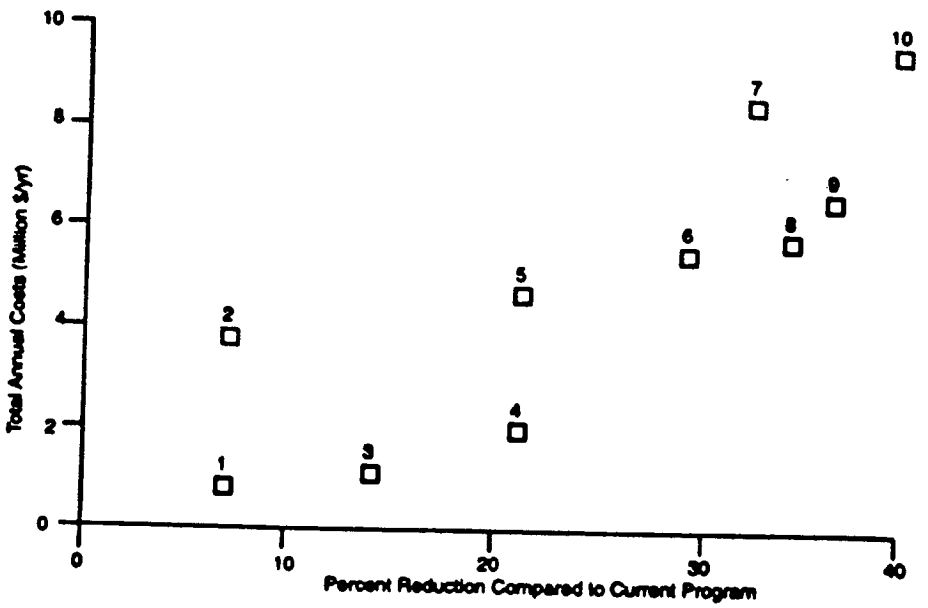

Figure 8-2. Phosphorus removal for candidate control programs (Pitt, 1989).

area. The comparison of alternatives is then in effect a comparison of different BMPs. This approach yields useful data on systemwide implementation of particular BMPs. While one type of BMP might not address the range of urban runoff problems or goals in a study area, an urban runoff pollution problem might exist which a particular BMP is well suited to control. In this case, implementation of that BMP on a regional basis, with the BMPs strategically located by the municipality, can be more effective and more easily controlled than requiring each developer to implement that BMP for individual developments.

An example of this method of alternative development is the Henrico County, Virginia, regional storm water detention program (George and Hartigan, 1992). Early in the process of developing a storm water management plan, it was decided that, given the conditions existing in the watershed, regional detention basins would be used to control runoff pollution. Regional detention basins were chosen because they provide both flood and pollution control, had fewer site restrictions than other pollution control structures, and can be designed to accommodate expected new developments. Therefore, the major remaining decision in the program was the number, location, and size of the detention basins.

All the above methods lead to the development of alternative plans to address the urban runoff pollution problems of concern. While the actual contents of each alternative plan are site specific and depend on the type of alternative evaluation to be conducted, some general guidelines for presenting the alternative plans can help in assessing them. Preliminary sketches, rough cost estimates, expected pollutant removals, and environmental effects can be included for each alternative so comparisons can be made.

BMP Selection Process

After the alternatives have been developed, they are compared using a decision process (Figure 8-3) that evaluates the relative merits of each plan. Because of the complexity of urban runoff control problems, a number of factors must be considered in assessing alternative plans. These alternatives are represented in Figure 8-3 as inputs to the decision process, and include analysis tools, design conditions, and decision factors. The analysis tools are those used to assess and rank the existing pollution problems (see Chapter 6). The design conditions are the set of conditions under which to compare the alternatives. The decision factors are the criteria used to compare the alternatives. All these inputs are then used to evaluate the alternatives using one or more decision analysis methods. This section first describes each input to the decision analysis, then describes the various decision analysis methodologies that can be used to select BMPs that will comprise the urban runoff pollution prevention and control plan.

Analysis Tools

These tools, described in detail in Chapter 6, can include watershed models, receiving-water models, and

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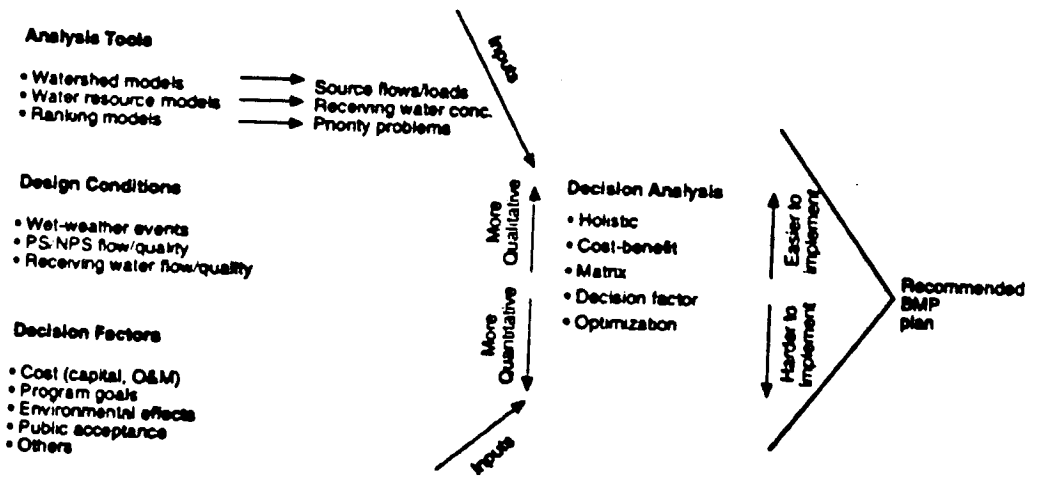

Figure 8-3. Conceptual diagram of BMP selection method.

ranking models. The numerous types of models range from simple to complex, and selection of appropriate models to use has been discussed. The analysis tools are used to project future conditions, given the alternatives being investigated. For example, the total pollutant loads for each alternative can be calculated (whether using a unit load method or complex models such as SWMM), yielding one item of input information as the alternatives are compared. Similarly, the impacts to receiving waters can be assessed using these tools, to compare these effects before making a decision.

In the Humber River drainage area in Toronto (Figure 8-2), for example, SLAMM was used to analyze 10 different control programs (Pitt, 1989) for program cost and pollutant removal. The final decision was based largely on the cost-effectiveness information determined for each of the alternatives using this analysis tool.

Design Conditions

One major consideration in BMP selection is to determine appropriate conditions under which to compare the alternatives. These so-called design conditions are generally set up to reflect various future conditions, including future no-action conditions which reflect future expected conditions with no new BMPs. Some important design conditions to be developed as part of an urban runoff pollution prevention and control plan include:

- Population
- Land use/expected development (i.e., buildout)
- Point source/NPS flows/concentrations
- Background receiving-water flows/concentrations

Each condition is defined for specific future planning periods (e.g., 20 years).

Part of the comparison involves the selection of worst-case or critical conditions. In the case of a receiving water, this condition could be a summer low-flow period. In the case of urban runoff flow and load estimation, it often involves selection of wet-weather design conditions. These wet-weather conditions are often in the form of design storms. For example, runoff from a new development site might be required to meet preexisting conditions up to a 25-year frequency design storm. A state CSO policy might require control up to a 1-year, 6-hour design storm. Two significant concerns exist when developing wet-weather design conditions. One is distinguishing between wet-weather design criteria used for pollution control and for flood control. The second is the use of individual design storms versus multiple storms, continuous simulation, or probabilistic methods.

Historically, design storms have been used to size structures for flood control purposes. These facilities were often sized to control storms of 5-year, 10-year, 25-year, or greater return periods. In contrast, BMPs used for wet-weather pollution control can be sized for much smaller storm events (e.g., 1-year storm or less), because most rainfall events (over 90 percent) are smaller than a 1-year storm. Thus, a BMP sized for a 1-year storm would control more than 90 percent of the total runoff volume. Of course, many other BMP design factors are important (e.g., retention time and peak flow capacity), but design criteria appropriate for pollution control should be kept in mind. This also points out the need to consider multiple design conditions for dual purpose (water quality and flood control) BMPs.

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Individual design storms have been and still are often used to size structural BMPs. They are also frequently specified in various federal, state, and local regulations. While use of a design storm is a simple, understandable criterion, deciding on the size storm is less clear cut. A review of wet-weather design conditions stresses the benefits of using continuous or probabilistic simulation rather than relying on a single design storm event (Freedman and Marr, 1992). The increasing power and speed of personal computers allows modeling of a long time series of rainfall-runoff conditions (using the watershed models, and in some cases receiving water models, described in Chapter 6) at a reasonable cost. This method allows investigations of a large number of storm events and the ability to develop a frequency distribution of values of concern (i.e., number of overflows, amount of pollutant load, or number of water quality violations) for the range of rainfall conditions.

An example (Figure 8-4) of the use of continuous simulation (Freedman and Marr, 1992) indicates a frequency distribution of bacteria concentrations with and without CSOs at a particular location. Such results frame the range of possible CSO control effects and help determine appropriate control goals and level of desired reduction for a range of conditions rather than for one event.

Decision Factors

An important step in BMP plan selection is to determine the important decision factors. The selection of these factors is site specific and needs to be determined by the program team based on the characteristics of the watershed and the financial and personnel resources available. Typical decision factors are discussed below.

Cost

One of the most important decision factors is the relative cost of each alternative. In cost assessment, costs of development and implementation for nonstructural BMPs, as well as of construction and operation for structural BMPs, need to be considered. The program benefits such as those associated with restored resources also need to be considered. Costs should generally reflect the life-cycle cost of an alternative over the planning period and are usually easy to derive. The cost benefits associated with the implementation of a control plan, however, are usually more difficult to determine. For example, if an urban runoff control plan is designed to reduce the discharge of fecal coliform to a closed shellfish area, monetary benefits are derived from opening these beds. While analysis of these benefits can be difficult, they should be included in determining total program costs.

Meeting Program Goals

Alternatives are also assessed on their ability to meet program goals, including the control of major sources and effects on priority watersheds. Since at this stage in a program, the goals have been reassessed and expanded upon a number of times, a large number of specific goals might exist, and each alternative might not meet all the program goals. Preference generally is given to alternatives that address the most goals or the most important goals. Priority resources and pollution sources should be the focus of the selected alternative.

Operability

The decision factors included here take into consideration the reliability of structural controls, the reliance of the alternative plan on existing structures, and the number

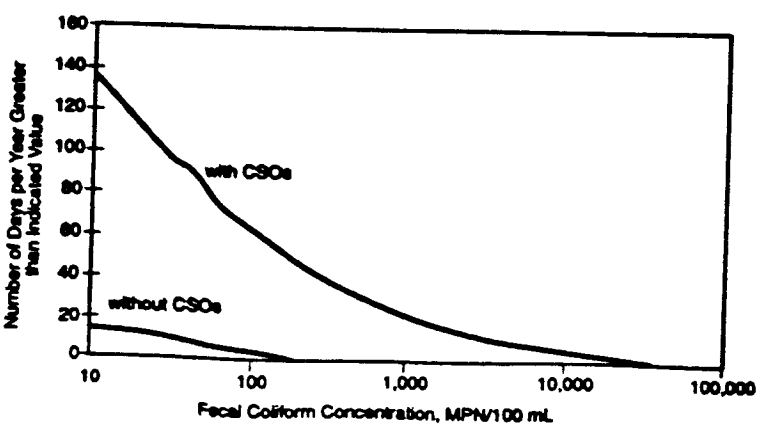

Figure 8-4. Example continuous simulation results (Freedman and Marr, 1992).

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of structures included in the alternative. Operability is generally a measure of a system's complexity. Complicated systems and plans might be difficult or expensive to implement and operate; these factors are, therefore, taken into consideration in the BMP selection. Typically, this decision factor favors source control and regulatory practices that do not have the level of complexity and possible operational problems of structural controls.

Buildability

This decision factor is directed primarily at the selection of structural BMPs. Taking into consideration the various aspects of construction, the criteria investigated under this category include the site requirements, extent of disruption, and degree of construction difficulty. When relying on complex structural controls, difficulties inherent in construction and future maintenance might need to be overcome. While not a consideration in source control and regulatory control practice, this factor can be very important for structural controls.

Environmental Effects

Implementing urban runoff pollution control plans can affect the environment both positively and negatively. The positive effects on resources result from the removal of pollution sources. Resources that can be positively affected include water resources, aquatic animal and plant life, wildlife, wetlands, and many others. The negative environmental effects, which can include aesthetic problems, cross-media contamination, the loss of useable land, wetlands impacts, and many others, must also be considered in the assessment.

The importance of this decision factor is becoming more widely recognized. There seems to be a shift away from viewing urban runoff control structures only on their pollution control ability. Incorporating structures into new developments or retrofitting them in existing areas can gain wider acceptance if additional aesthetic qualities are considered. For example, unvegetated aboveground infiltration basins or dry ponds are generally not attractive elements of the environment and could serve as insect breeding grounds. Natural-looking wet ponds or vegetated wetlands, however, can be incorporated into the environment and even serve to improve aesthetics. These issues can greatly affect public acceptance.

Institutional Factors

This decision factor relates to existing governmental structures, legal authority, and implementation responsibilities. To implement alternatives, the logistical resources must be in place, and the proper authority to pass and enforce regulatory practices must exist. If the proper authority does not exist, an analysis of attaining it must be undertaken. In addition to these considerations, the team should investigate existing urban runoff programs in the community, region, or state. Often, cost savings can be realized and total program efforts can be reduced by taking advantage of material and data compiled during these existing programs.

Public Acceptance

In many instances, the public will be responsible for at least a portion of the funding required to implement the recommended plan. Public reaction to the urban runoff control plan should, therefore, be assessed through the use of public meetings. Measuring public acceptance can be difficult, but can be important to the overall success of a program.

Other Decision Factors

Additional decision factors—such as maintainability, level of pollution control, or size requirements—can be included in the assessment of alternative plans if they are more important than those discussed above.

Once the final decision factors have been chosen and applied to the alternative plans, the plans can be assessed through applying a decision analysis tool. Methods for conducting this decision analysis are presented below.

Decision Analysis Methods

Assessing alternatives takes into account a variety of factors, both quantitative and qualitative. The type of assessment conducted in these programs, which involves an integration and comparison of these factors, is an example of multiattribute decision-making and can be performed with various decision analysis methods. The following decision analysis methods, which are listed in order from the most qualitative to the most quantitative, can be utilized:

- Holistic
- Cost-benefit ratios
- Matrix comparisons
- Decision factor analysis
- Optimization

Two additional BMP selection processes, which combine aspects of a number of the above approaches, are discussed in the case studies at the end of the chapter.

Holistic

This approach is qualitative and relies on certain basic facts, intuition, and professional judgment. One key deciding factor (e.g., cost) can guide the process. Given

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the inherent complexity of assessing alternative urban runoff control plans and the large number of available inputs to the decision, this approach is usually over-simplified. Selecting an appropriate plan from the developed alternatives will generally require an assessment of multiple factors and should be done in as quantitative a manner as is reasonably possible.

Cost-Benefit Ratios

The relative value of different alternatives can be measured using cost-benefit ratios, such as cost per pound of pollutant removed or cost per day of effect on resources. This approach can be used as a tool to determine which BMP should be used first. For example, if it is determined that reducing solids using source control measures costs less per pound than using a structural BMP, then source control measures should be utilized first. Since the unit cost of source control measures increases with the amount of solids eliminated, the cost per pound of solids removed increases with the number of pounds removed. The extent to which source control measures should be used for pollutant removal is then given by the point at which the marginal cost-benefit ratio (i.e., change in cost/change in benefit) becomes larger than that of another alternative.

Another advantage of the cost-benefit ratio approach is that it allows use of the knee-of-the curve methodology, which seeks to determine the point in the cost-benefit curve where the marginal cost to achieve a marginal benefit becomes significantly higher. This factor is measured by the marginal cost-benefit ratio defined above. Figure 8-5 shows an example of this methodology where the cost-effectiveness drops dramatically as practices are implemented to reduce lake standards exceedance to below 10 days per year.

The cost-benefit ratio approach, however, is limited by the number of cost-benefit ratios that can be conveniently considered simultaneously. To represent the different elements of a complex issue better, where some benefits might be counterbalanced by some detriments, multiple costs and benefits must be considered.

Matrix Comparison

Matrix comparison, a common decision-making method used in facilities planning and siting, is suggested in EPA's Construction Grants guidelines (see Table 8-2). Environmental impacts in Table 8-2 can be divided into short-term construction-related impacts and long-term operational impacts. The matrix comparison approach is also applicable to the assessment of urban runoff control alternatives. This approach involves preparing a matrix that compares alternatives against selected decision factors, both quantitative and qualitative. Where possible, numerical values are given to compare the alternatives, and, for qualitative factors, subjective comparisons are used (such as poor, fair, good, and excellent).

An example of the matrix comparison approach for CSO abatement is shown in Table 8-3. In this example, three alternative control programs are compared for cost, conformance with objectives, operability, and buildability. While Alternative 1 provides the greatest pollutant removal and reliability, it also has the highest cost. If cost is an important factor, Alternative 3 would be the selected alternative, since it has the lowest present worth cost. Alternative 2, however, provides better reliability than Alternative 3 and has equivalent

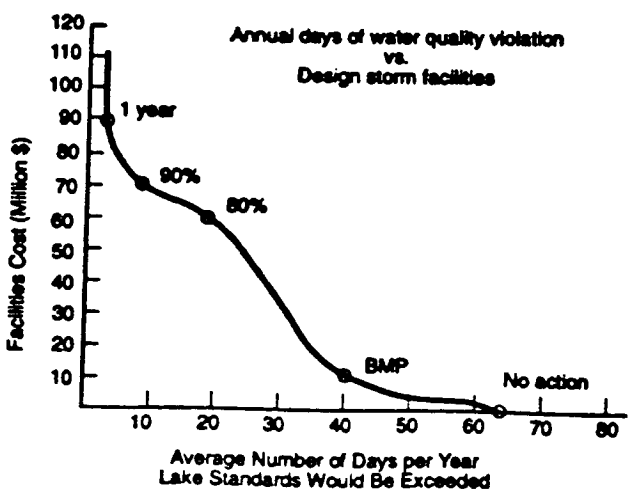

Figure 8-5. Example cost-benefit ratio curve (Moffa, 1990).

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Table 8-2. Example Matrix Comparison (adapted from U.S. EPA, 1986)

Type of Impact	Alternatives #1	#2	#3	#4
Monetary Cost, $				
Capital cost	↔	–	–	+
Annual O&M cost	–	+	+	+
Cost per household unit	+	+	+	–
Environmental Impact				
Cultural resources	●	+	—	–
Floodplains and wetlands	+	–	–	–
Agricultural lands	–	↔	+	–
Coastal zones	+	–	+	+
Wild and scenic rivers	●	+	–	+
Fish and wildlife	↔	–	↔	+
Endangered species	+	–	+	+
Air quality	●	●	–	+
Water quality and uses	+	↔	+	+
Noise, odor, aesthetics	–	+	–	—
Land use	●	+	–	+
Energy requirements	●	–	●	–
Recreational opportunity	+	↔	–	–
Reliability	–	–	+	–
Implementability	+	+	—	+

Legend:
↔ Significant beneficial impact
+ Minimal beneficial impact
● No impact
– Minimal adverse impact
— Significant adverse impact

cost-effectiveness in terms of present worth dollars per gallon controlled. While this approach is useful, it can be quite subjective and care and professional judgment must be taken in defining the appropriate decision factors and applying the method.

Decision Factor Analysis

This is a matrix approach, which further quantifies the decision factors by using weighting methods. In this approach, quantitative factors are used to eliminate the subjective comparisons required in other matrix approaches. These criteria should be:

1. Nondominant—no criterion should be dominant.
2. Complete—no pertinent information should be left out.
3. Scorable—criteria cannot be vague, since it must be weighted clearly.
4. Independent—criteria should not overlap each other.

Weights are then generated for each decision factor. These weights must have a common scale, and the relative importance of each factor to the decision should be reflected in the weights. One example of this approach for site priority setting was described in Chapter 6. A further example is the BMP selection approach in the ME DEP case study at the end of this chapter. The major difference between this approach and the matrix approach outlined above is that, in this approach, the decision factors must be quantitative. Therefore, subjective comparison terms, such as good or fair, cannot be utilized. The decision factors must be able to be described by values that can be summed. Variations on this type of approach and various decision support software can facilitate the conduct of these analyses.

Optimization

Optimization, a widely used method of quantitative decision making, involves formulating a problem as the

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Table 8-3. Example CSO Abatement Alternative Matrix Comparison (Metcalf & Eddy, Inc., 1988)

Selection Criteria	Alternatives		
	#1	#2	#3
Monetary Factors			
Capital cost	$176,000,000	$106,000,000	$92,600,000
Annual O&M cost	—	$4,070,000	$4,080,000
Present worth (PW), 20 yr	$162,000,000	$139,000,000	$126,000,000
PW, $/gal	$9.08	$7.77	$7.77
Conformance with Objectives			
Control of major discharges	Good	Good	Good
Elimination of problem areas	Good	Fair	Fair
Impact of priority areas	Good	Good	Good
Operability			
Number of facilities	0	3	3
Reliability	High	Medium	Low
Level of O&M	Low	High	High
Reliance on existing facilities	Low	High	High
Impacts on downstream facilities	Low	High	High
Buildability			
Site requirements	Low	High	High
Extent of disruption	High	Low	Low
Degree of difficulty	High	High	High
Adaptability to phased implementation	Good	Fair	Fair
Conformance with current plans	Fair	Poor	Poor

maximization (or minimization) of an objective function, subject to a series of constraints. In linear optimization, both the objective function and the constraints must be linear functions of the decision variables. Various methods are available for finding the optimum set of decision variables and several software packages can perform the analysis. These methods are summarized in basic textbooks on optimization (Monks, 1987).

For plan selection, the objective function can be cost or a more complicated function of cost, benefits, and detriments. Examples of benefits that could be included are gallons of discharge removed, pounds of pollutants removed, and days of beach closure avoided. A multifactor objective function can account for tradeoffs among costs, benefits, and detriments by incorporating relative weight for each factor:

$$F = \Sigma a_i y_i$$

where:

F = objective function
a_i = weight and conversion factor
y_i = cost-benefit factor

All terms in the above equations must have the same dimension (e.g., dollars) so that weights also incorporate a conversion factor. The optimization process then consists of maximizing the objective function, by optimally selecting the values of the decision variables on which the different factors depend. Then, each cost-benefit factor, y_i, must be expressed linearly in terms of each of the decision variables, x_j:

$$y_i = \Sigma b_{ij} x_j$$

where:

b_{ij} = a different weight or conversion factor

This relationship is relatively easily established for cost (such as life-cycle cost), but more difficult for other factors, such as pounds of pollutant removed or days of beach closure. For these types of factors, models need to be applied with different values of the decision variable and straight-line fitted to the result. Constraints must also be established as linear functions of the decision variables. Possible constraints are the maximum number of excursions of standards per year or the maximum amount of pollutant reduction

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achievable given background conditions. Once the objective function and constraints are defined, various algorithms and software packages are available to determine the combination of decision variables maximizing the objective function.

A major problem with this approach is that many relationships pertaining to BMP selections are nonlinear. Qualitative factors are also difficult to incorporate in the process, especially in the form of linear functions of the decision variables. Nonlinear optimization, while accounting for the nonlinear dependence of various factors, is mathematically complex. It also tends to suffer from the same types of drawbacks as linear programming because it is not effective for problems that include qualitative factors.

Determination of Appropriate Decision Analysis Approaches

Matrix comparison and decision factor analysis approaches are typically best suited to BMP selection. Such approaches rely on the analytical tools available to analyze the system and on the best professional judgment of those assessing the alternatives. Given specific problems that can be quantified, optimization could be tried. Most BMP selection projects involving urban runoff, however, would be too complex. If the problems being addressed are simple, then the holistic or cost-benefit ratio techniques can be utilized. These simple, qualitative approaches can also be implemented as first approximations for plan assessments whose final results must be made using more complex approaches. In summary, an appropriate decision analysis method or methods must be selected that reflect:

- The complexity of the problems and the plans to address them.
- The data needs of each method and the ability to obtain the required data.
- The financial and personnel resources available to conduct the assessment.

A matrix comparison or decision factor analysis most likely would be involved.

Conclusions

The selection of BMPs to control urban runoff pollution is difficult and can best be performed by undertaking a systematic assessment process, aided by the use of analytical tools and the selection of appropriate design conditions and decision factors. Because of the qualitative nature of some inputs to the decision, subjective comparisons among the alternative plans typically are necessary. The process outlined in this chapter is a guide for decision making, but cannot account for all possible circumstances. Professional judgment and care are needed in determining the methods for developing alternatives, the decision factors to be employed, and the decision analysis method to utilize. Once these choices have been made and the BMP plan has been selected, the urban runoff pollution prevention and control plan can be developed in more detail so that it can be implemented.

The following case studies provide examples of BMP selection approaches used by the State of Maine for runoff control in new developments and by the Santa Clara Valley Water Quality Control Board in the development and implementation of a major runoff pollution prevention and control plan.

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Case Study:
Maine Department of Environmental Protection
BMP Selection Matrix

To address storm water and NPS pollution control in areas of new development, the Maine Department of Environmental Protection (ME DEP) has developed a method to select BMPs. The method which is presented in a state guidance document is based on the following information:

- Development land use type and size
- Receiving-water type (e.g., estuary, wetland, river, or stream)
- Watershed priority (either priority or non-priority)
- Erosion and sediment control target or level to achieve
- Storm water quality control target or level to achieve
- Erosion and sediment control options and treatment level codes
- Storm water quality control options and treatment level codes

To implement the BMP selection method, ME DEP developed a series of eight matrices, two matrices for each receiving water type (i.e., estuary, wetland, river, and stream). One matrix is applied to development in designated priority watersheds and the other is applied to development in nonpriority watersheds. A priority watershed list has been developed by ME DEP based on environmental sensitivity, local support for water quality, and importance of the watershed to the state. Example matrices for priority and non-priority estuary watersheds are shown in Tables 8-4 and 8-5.

Each matrix has two major components, which are broken down by land use type: an erosion and sediment control level to achieve and a storm water quality level to achieve. The level to achieve for a given combination of land use and receiving-water category is a relative, qualitative measure of the impact of storm runoff pollution. It ranges from 1 to 5, with 1 being the lowest impact and 5 being the greatest impact. For example, a multihousing development proposed for a priority estuary watershed is given an erosion and sediment level to achieve of 2 and a water quality level to achieve of 3. By comparison, a small residential development in the same priority watershed is given an erosion control level to achieve of 1 and a water quality level to achieve of 1. In all cases, the levels to achieve for priority watersheds are greater than or equal to those for nonpriority watersheds.

Each matrix also addresses the types of BMPs that can be implemented for pollution control. ME DEP selected a number of BMPs and assigned each a treatment level code based on the expected level of pollutant removal. The treatment level code is a relative, qualitative measure designed to indicate the relative pollutant removal expected from various BMPs. Treatment level codes range from 1 to 3, with 1 providing the lowest level of control and 3 providing the greatest level of control. The BMPs and their treatment level codes are shown in Table 8-6. As indicated, various designs for each BMP are given different treatment level codes. For example, a 50-foot buffer is given a treatment level code of 1; a 125-foot buffer is given a treatment level code of 2; and a 200-foot buffer is given a treatment level code of 3.

For a proposed development to be approved, the sum of treatment level codes for the proposed BMPs must be greater than or equal to the level to achieve. For example, if a multihousing unit development is proposed for a priority estuary (erosion level to achieve of 2 and water quality level to achieve of 3), the developer could implement erosion and sediment controls (treatment level 2) and a combination of a swale (treatment level 1) and an infiltration system (treatment level 2). Additional combinations also could be implemented as long as the total treatment level provided is greater than or equal to the total level to achieve. ME DEP has also recommended that at least one vegetative BMP be implemented unless the site is already 100-percent impervious. The specified vegetative BMPs are buffers, grassed swales with level spreaders, and swales.

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Table 8-4. Priority Estuary Storm Water Control Matrix

Land Use Category	Erosion and Sediment Level to Achieve	Erosion and Sediment Controls	Water Quality Level to Achieve	Storm Water Controls
Low-density residential, >2 ac/lot	1	Erosion and sediment 1	1	Buffer 1
High-density residential, <2 ac/lot	2	Erosion and sediment 2	3	Buffer 1 or 2 Wet pond 2 Infiltration 1 or 2 Created wetland 2
Commercial, <1 ac disturbed	1	Erosion and sediment 1	1	Buffer 1
Commercial, 1-3 ac disturbed	1	Erosion and sediment 1	2	Buffer 1 or 2 Infiltration 1 Swale 1
Commercial, >3 ac disturbed	2	Erosion and sediment 2	4	Buffer 1 or 2 Infiltration 1 or 2 Created wetland 2 Wet pond 2 or 3 Fertilizer control 1 Shallow impoundment 1
Intensive-use open space (e.g., golf courses, nurseries)	2	Erosion and sediment 2	5	Buffer 1 or 2 Fertilizer control 1 Pesticide control 1 Created wetland 2 or 3 Wet pond 2 or 3
Multihousing users	2	Erosion and sediment 2	3	Buffer 1 or 2 Fertilizer control 1 Pesticide control 1 Created wetland 2 Wet pond 2 Infiltration 1 or 2
Industrial, <1 ac disturbed	1	Erosion and sediment 1	1	Buffer 1 Swale 1
Industrial, 1-3 ac disturbed	1	Erosion and sediment 1	2	Buffer 1 or 2 Swale 1
Industrial, >3 ac disturbed	2	Erosion and sediment 2	5	Buffer 1 or 2 Swale 1 Created wetland 2 or 3 Wet pond 2 or 3

This BMP selection system is in its early stages of implementation. Its success will depend on the ability to establish levels to achieve that adequately protect water bodies in new developments. It will also depend on the ability of treatment level codes to quantify the effectiveness of the identified control measures. Thus, the system is a technology-based approach for erosion and sediment control, as well as for storm water pollution control.

Currently this method is outlined in a statewide guidance document and is not a regulatory requirement. Municipal officials can incorporate this process at their discretion in subdivision regulations. This method of BMP selection requires extensive upfront work to develop the matrices and BMP levels of treatment. Once these are developed, however, this method provides a simple and direct technology-based approach to BMP selection. It has flexibility in terms of the range of BMPs that can be selected for given types of proposed development and given site constraints.

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Table 8-5. Nonpriority Estuary Storm Water Control Matrix

Land Use Category	Erosion and Sediment Level to Achieve	Erosion and Sediment Controls	Water Quality Level to Achieve	Storm Water Controls
Low-density residential, >2 ac/lot	1	Erosion and sediment 1	1	Buffer 1
High-density residential, <2 ac/lot	2	Erosion and sediment 2	2	Buffer 1 or 2 Infiltration 1
Commercial <1 ac disturbed	1	Erosion and sediment 1	1	Buffer 1
Commercial, 1-3 ac disturbed	1	Erosion and sediment 1	1	Buffer 1
Commercial, >3 ac disturbed	2	Erosion and sediment 2	2	Buffer 1 or 2 Infiltration 1 Swale 1 Shallow impoundment 1
Intensive-use open space (e.g., golf courses, nurseries)	2	Erosion and sediment 2	3	Buffer 1 or 2 Infiltration 1 or 2 Fertilizer control 1 Created wetland 2 Wet pond 2
Multihousing units	2	Erosion and sediment 2	2	Buffer 1 or 2 Infiltration 1
Industrial, <1 ac disturbed	1	Erosion and sediment 1	1	Buffer 1 Swale 1
Industrial, 1-3 ac disturbed	1	Erosion and sediment 1	2	Buffer 1 or 2 Swale 1
Industrial, >3 ac disturbed	2	Erosion and sediment 2	4	Buffer 1 or 2 Swale 1 or 2 Created wetland 2 or 3 Wet pond 2 or 3

Table 8-6. Summary of BMP Treatment Level Codes

BMPs	Level of Treatment
Erosion and Sediment Control	
One line of erosion control	1
Two lines of erosion control	2
Nongrassed Buffers	
50 ft	1
125 ft	2
200 ft	3
Infiltration Systems	
Single system	1
Multiple systems	2
Wet Ponds	
Single-pond system holding 2.5 in of runoff	2
Double-pond system each pond holding 2.5 in of runoff	3
Created Wetlands	
Single created wetland	2
Two created wetlands	3
Other BMPs	
Swales	1
Shallow impoundments	1
Street cleaning	1
Fertilizer application control	1
Pesticide use control	1
Grassed swales with level spreaders	1
Reverting land (i.e., allowing currently impervious land to be a vegetative buffer)	1

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Case Study:
Santa Clara Valley, California,
Nonpoint Source Control Program BMP Screening Procedure

Background

In 1986, the San Francisco Regional Water Quality Control Board developed a basin plan for San Francisco Bay which involved regulatory activities to control point and nonpoint source discharges. The basin plan was the driving force behind initiating the Santa Clara Valley Nonpoint Source Control Program. This program involves a number of local governments and county agencies and is designed to address water quality problems in Lower South San Francisco Bay. In developing the Santa Clara Valley Nonpoint Source Plan, a 12-step process that closely follows the process outlined in this handbook was used. The steps in this process are:

- Initiate program
- Determine existing conditions
- Conduct field monitoring
- Define program objectives
- Develop evaluation and planning criteria
- Compile inventory of candidate controls
- Apply criteria to screen candidates
- Apply professional judgment to select a practical set of controls
- Estimate overall program cost and effectiveness
- Revise the previously defined control programs to balance cost, effectiveness, and other factors
- Describe the roles of various agencies
- Develop an implementation schedule

Development of the Santa Clara Valley Nonpoint Source Control Plan began in 1986 and has continued through various stages to initial implementation and preliminary assessment of effectiveness.

Watershed Description

Santa Clara County, which incorporates the entire study area, is located at the southern end of San Francisco Bay (see Figure 8-6). The 690-square-mile watershed consists primarily of the relatively flat Santa Clara Valley. Land use in the watershed is approximately 30 percent residential, 5 percent industrial (predominantly light industry associated with high technology manufacturing), and 62 percent open space. Three large cities—San Jose, Sunnyvale, and Santa Clara—account for the majority of urban areas in the watershed.

Overview of Water Quality

To characterize existing water quality in Lower South San Francisco Bay, a comprehensive monitoring program was undertaken. This program included hydrologic monitoring, wet- and dry-weather water quality monitoring, sediment monitoring, and biological monitoring. The monitoring was conducted primarily to determine the levels of toxic pollutants, such as heavy metals and pesticides, as well as nutrients and fecal coliform bacteria. Data obtained through this monitoring program were input to data bases and used for developing computer models. Watershed loads were estimated using the Storm Water Management Model (SWMM), calibrated to the observed data gathered in the monitoring program.

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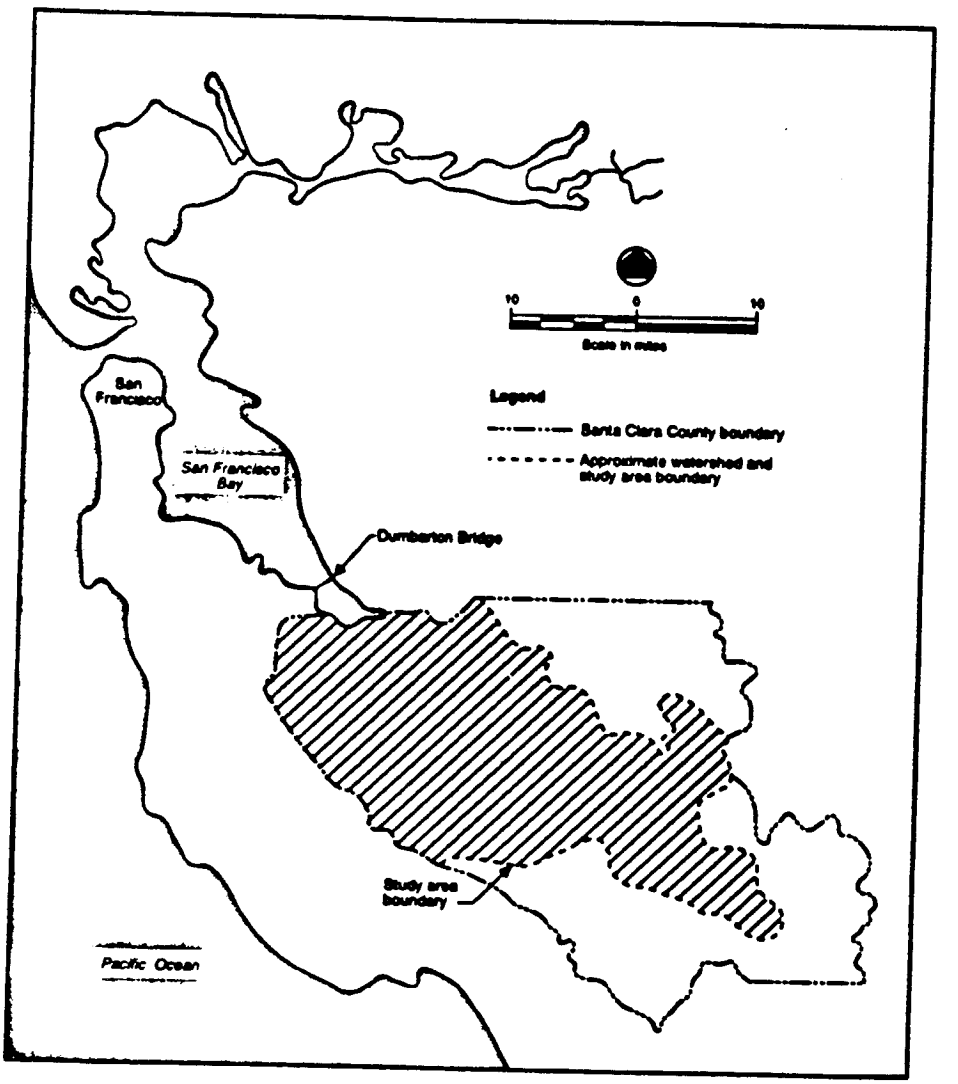

Figure 8-6. Santa Clara Valley watershed.

The data were also used to compare the relative contributions of point (e.g., waste water treatment plants) and nonpoint source pollution to the bay.

Water quality monitoring results indicated that heavy metal concentrations in receiving waters increase during wet weather, because of contaminated runoff as well as resuspension of contaminated sediments. The metals primarily detected were cadmium, chromium, copper, lead, nickel, and zinc. Copper was the primary metal regularly detected at levels greater than the EPA aquatic life criteria; these criteria were exceeded only occasionally for cadmium, lead, and zinc. Also, during wet weather, hydrocarbons and pesticides were detected in approximately 25 percent of the ambient water samples collected, while none were detected during dry weather. The limited bacteria data gathered indicated increased levels

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(by a factor of about 10) of fecal coliform bacteria during wet weather as compared to dry-weather conditions.

In comparing point and nonpoint source contributions to water quality problems in Lower South San Francisco Bay, the monitoring results showed that point sources account for approximately 98 percent of the nutrient load. Nonpoint sources, however, accounted for 60 to 80 percent of the load for metals and about 98 percent of the total suspended solids yearly load.

Management Practice Screening

Because of the large size of the watershed and the variety of pollutants entering the Lower South San Francisco Bay, the emphasis of the nonpoint source pollution control program was on pollution prevention measures and nonstructural controls that could be implemented across municipal boundaries. Selection of appropriate pollution prevention measures and controls was accomplished through a process consisting of preliminary screening followed by final control measure selection (see Figure 8-7).

In order to screen the extensive list of potential pollution prevention and control practices, the program team first listed important criteria for the selected measures. The criteria developed for this project were:

- *Pollutants controlled:* Controls for metals, pesticides, oil and grease, bacteria, and sediments are emphasized.
- *Effectiveness:* Each control measure should provide sufficient pollution control toward the overall program to warrant its inclusion.
- *Reliability/sustainability:* Control measures should be effective over an extended time period and be able to be properly implemented over time.
- *Implementation cost:* Control measures with low planning, design, land acquisition, construction, and equipment acquisition costs were emphasized.
- *Continuing costs:* Emphasis was placed on control measures with low operation, maintenance, repair, support service, and equipment replacement costs.
- *Equitability:* Controls were evaluated regarding the degree to which costs and benefits would be equitably distributed among the participating agencies.
- *Universality:* Controls were evaluated in terms of how universally they would have to be applied to be effective.
- *Public acceptability:* Control measures were assessed on the expected public response to implementation.
- *Agency acceptability:* Control measures were evaluated on the expected response of agencies responsible for implementation.
- *Relationship to regulatory requirements:* Control measures were evaluated on their consistency with existing and anticipated regulatory requirements.
- *Risk/liability:* Control measures were evaluated in terms of the risks or liabilities which could occur in implementation.
- *Environmental implications:* Control measures were evaluated regarding the positive and negative environmental impacts resulting from their use.

Once the control measure criteria were developed and agreed upon, the program team developed a comprehensive list of potential measures for implementation. The inventory of potential measures was developed through a review of technical literature and other nonpoint source control programs. In addition, technical and managerial personnel from other state agencies, county agencies, and city public works and planning agencies were interviewed.

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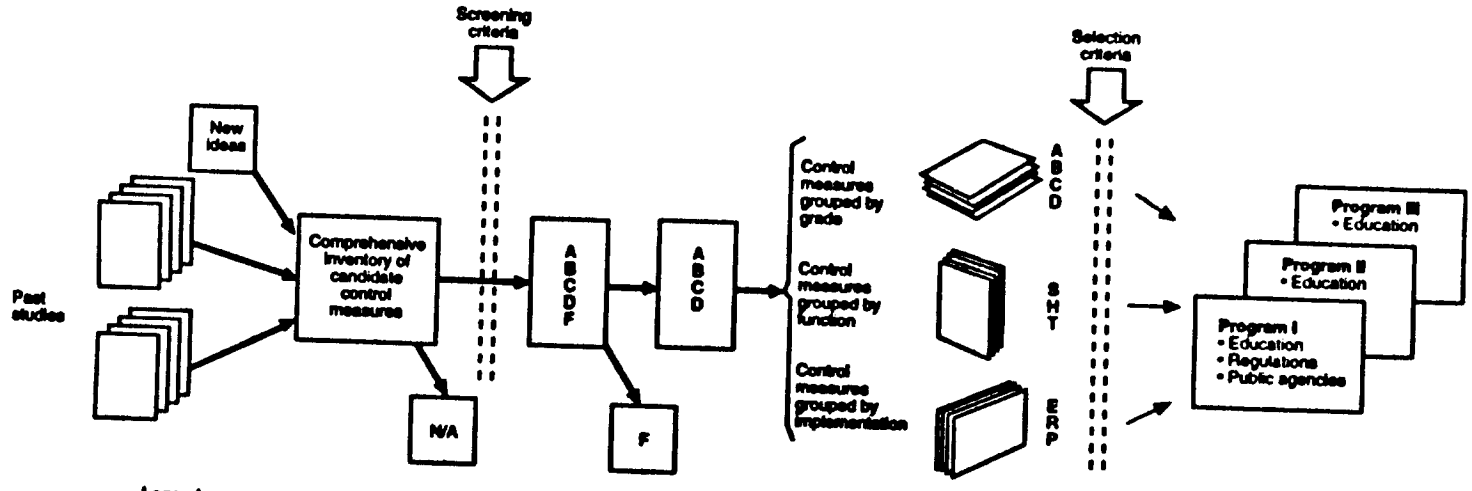

Legend

A, B, C, and D are letter grades.

S, H, and T are functions (i.e., source controls, hydraulic controls, treatment-based controls).

E, R, and P are modes of implementation (i.e., education, regulation, public agency actions).

Figure 9-7. BMP selection process.

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This review resulted in a list of more than 120 separate measures to be screened. This initial list was to be comprehensive; no consideration was given to the applicability of the measures. Once the list had been developed, however, obviously inappropriate measures were eliminated—primarily those designed to address specific situations that did not exist in the watershed. This initial screening reduced the list of potential pollution prevention and control measures to 92.

This list of 92 measures was then assessed qualitatively using the criteria developed earlier in the program. Each potential control measure was assigned a letter grade (A through F) for its ability to meet the criteria. Measures receiving an A were viewed to meet all or a large number of the assessment criteria, while those receiving an F were viewed to meet none or very few of the assessment criteria. The control measures that fell into the category of F were immediately eliminated from further consideration in the Santa Clara Valley watershed.

The final list of potential pollution prevention and control measures was then arranged into three groups by grade, function, and implementation method as shown in Figure 8-7. The control measures arranged by function included source controls, hydraulic controls, and treatment-based controls. The control measures arranged by implementation method included educational controls, regulatory controls, and public agency actions. By arranging the controls in these various ways, the program team could select control measures that gave a good mix of type and implementation method.

Management Practice Selection

At this point, the assessment criteria used in the initial screening were applied to each potential control measure to develop three alternative programs: Program I, the smallest scale program, was designed to be low cost and provided a minimal level of pollution control. Program III, the largest scale program, was designed to provide a high level of pollution control but had a high cost. Program II, designed to represent a middle road between Programs I and III, was the program recommended in the report because it was felt to provide the best cost-benefit of the three alternatives.

The recommended alternative included educational, regulatory, and public works (structural) control measures. Most of these measures are to be implemented across the watershed, but some recommendations specific to known problems areas are also included.

Implementation

In order to efficiently implement the NPS control plan, the task force determined high-priority actions for immediate implementation. The following actions are considered to be high priority because they can be implemented across the watershed.

- Conduct wet-weather monitoring.
- Develop and implement a public information program.
- Develop and begin implementation of illicit connection identification and removal.
- Conduct illegal dumping monitoring program and provide training.
- Evaluate treatment based controls.
- Develop and begin implementation of areawide and community-specific storm water management program.

Still in the early stages of implementation, the program cannot yet be evaluated. Implementation of many of the above high-priority measures, however, is progressing. This case study shows a qualitative selection process that utilizes a set of screening and selection criteria to develop low, medium, and high pollution prevention and control alternatives.

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Chapter 9
Implement Plan

The final step in the planning process is to develop an implementation plan for prevention and control of urban runoff pollution. This plan sets forth the recommended control program in a form readily usable by the team charged with program implementation. The information obtained through the earlier tasks of assessing existing conditions, collecting and analyzing additional data, identifying and assessing problems, and screening and selecting BMPs must be clearly summarized as a "roadmap" or work plan for future activities.

Contents of an Urban Runoff Pollution Prevention and Control Plan

The urban runoff pollution prevention and control plan should contain the following information:

- Conceptual information on recommended BMPs
- Schedule of activities
- Responsibilities for BMP implementation
- Description of monitoring plan
- Summary of regulatory requirements
- Public involvement program
- Identification of funding sources/mechanisms

Each item is important to implementation of the plan and is described in the following pages. At the end of this chapter, a case study using the Pipers Creek watershed implementation plan shows how each of these plan components was developed.

Description of Recommended Best Management Practices

The first part of the urban runoff pollution prevention and control plan is a description of the BMPs selected for implementation. This includes regulatory BMPs, municipal practices, structural BMPs, and any other BMP activities selected for implementation.

Regulatory BMPs

Regulatory BMPs, which play an important role in urban runoff pollution prevention and control, should be included and summarized in the control plan. The summary requires a clear description of the proposed regulatory changes and the approach to implement the changes. Regulatory BMPs can address requirements for an entire community or can be focused on a specific area targeted for protection. The level of effort necessary to implement the control program varies depending on these regulatory requirements. This information is included in the BMP description along with a discussion of the method required to comply with the regulation, and any required enforcement and maintenance activities. Some regulations require passage through the vote of a specific board or committee, while others require a full vote of residents in the community. The process needs to be outlined in the urban runoff pollution prevention and control plan. Finally, costs need to be developed. These include one-time costs associated with implementing the regulation as well as recurring costs associated with education, information, oversight, and enforcement. Case studies of regulatory control approaches are presented at the end of Chapter 4 (Lewiston, Maine) and Chapter 7 (Austin, Texas).

Municipal BMPs

Municipal BMPs include the nonstructural and source control practices carried out by each responsible public entity—street-sweeping, catch basin cleaning, and cross-connection identification and removal. For each of these BMPs, a plan needs to be prepared that details the frequency of conducting each practice, the locations at which the practice takes place (preferably on a map), a schedule of activities, the required staffing, and the cost. Initial program startup costs could include training staff and purchasing equipment. In addition, municipal BMPs typically include ongoing operational costs—labor for public works and maintenance staff efforts. A record system should also be designed to track activities and pertinent data (e.g., pounds of debris removed and areas swept). Municipal source control and nonstructural practices are discussed in Chapters 4 and 7 and in the Lewiston, Maine, case study, which is presented at the end of Chapter 4.

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Structural BMPs

Structural BMPs eventually require engineering design and construction. At this stage of planning, information needed to support each BMP includes a description, pictures, diagrams or concept sketches (see Figures 9-1 and 9-2), design information and assumptions, as well as pertinent conceptual details of the structural BMPs. The details should indicate known site conditions such as existing structures; topography; and other site-specific information such as soil conditions, utility locations, and wetlands, as available. Also included should be a general plan of the watershed showing

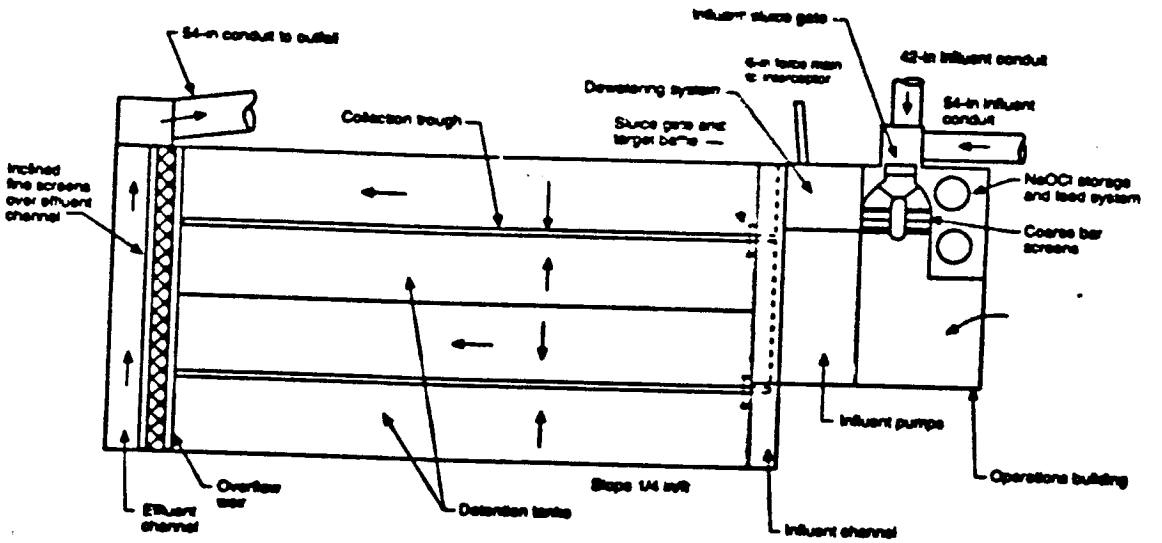

Figure 9-1. Example CSO control conceptual design of a sedimentation/disinfection facility (Metcalf & Eddy, Inc., 1988).

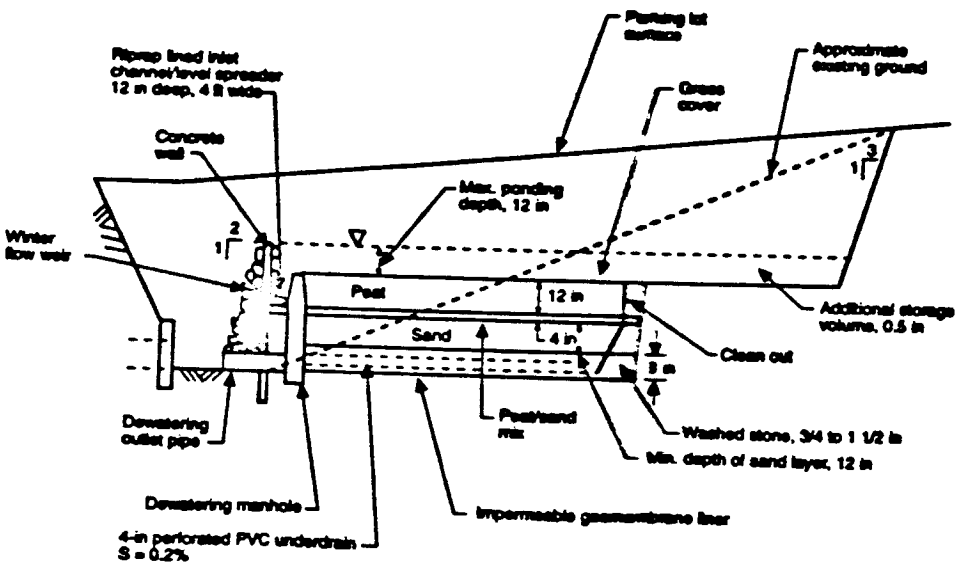

Figure 9-2. Example runoff control conceptual design for a filter system (U.S. EPA, 1992).

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locations of the recommended BMPs and the pollution sources they are designed to address. Final detailed design plans and specifications for each structural BMP are developed later, once the plan is approved.

For each BMP, a cost estimate is also developed. After the initial cost estimate during the alternatives development step, this estimate is refined to a more detailed estimate for purposes of the implementation plan. Improved accuracy is important since it could provide a basis for allocation of funds. Given the uncertainty at this stage (site survey and engineering work normally is still to be done), contingencies should be included in the estimate; and the cost perhaps should be presented as a range. For structural BMPs, ranges of costs can be obtained by consulting the Chapter 7 references. These costs, however, provide only guidelines and often vary widely depending on site-specific characteristics, such as soil conditions, depth to bedrock, and level of surrounding development. Costs include those for design, capital, and operations and maintenance. Costs for engineering, field surveys, borings, construction labor and materials, and contingency are also usually included. These costs can be presented in terms of present worth and tied to an applicable price index, such as the *Engineering News Record* (ENR) cost index, so the costs can be adjusted by others in the future.

Proper operation and maintenance is particularly important to the long-term functioning of structural BMPs. A method must be developed for ensuring that maintenance requirements are included in the management plan along with inspection and/or enforcement mechanisms. For example, if a community requires an industry or developer to construct a detention facility to remove suspended solids from runoff, the community must also develop a method for ensuring that the practice is properly maintained. Some municipalities have addressed this issue by establishing special funds designed to ensure maintenance of BMPs. In these circumstances, a municipality might require the industry or developer to contribute a fee to a fund that pays for inspection and maintenance of the BMP by municipal employees. Another option is for the municipality to require the private party to perform the maintenance. This option, however, gives the municipality less control over the BMP and still requires that the municipality conduct periodic inspections of the BMPs.

Other Related Activities

Several related activities, which might not fall strictly into the earlier categories identified, include public participation and education, monitoring, and maintenance and enforcement. Both public participation and education, and monitoring are addressed as separate plan components later in this chapter. Maintenance and enforcement is discussed under the section on responsibilities for BMP implementation. In general, however, all BMPs and activities which are to be included in the program should be described and discussed as part of the implementation plan.

Schedule of Activities

Because of the complex nature of urban runoff planning, implementing all the recommended BMPs in a short time generally is not possible. In some cases, the implementation schedule must allow time for pilot testing of BMPs in selected areas, monitoring the results of these pilot tests, and final design of full-scale BMPs. In fact, implementation of complex and expensive urban runoff BMPs is often conducted in a series of steps. These steps can include the following (U.S EPA, 1991):

- *Planning phase:* Analyzing, evaluating, and planning initial tasks.
- *Preparation phase:* Preparing budgets, resources, and necessary permits.
- *Pilot-scale implementation phase (only if necessary):* Testing selected BMPs for effectiveness and cost prior to full-scale implementation.
- *Full-scale implementation:* Designing and constructing the selected BMPs.
- *Evaluation/documentation phase:* Evaluating the effectiveness of the implemented BMPs to guide future action; preparing periodic reports documenting the results.

These considerations are incorporated into a schedule with start and finish dates for major tasks and milestones. The schedule should also include interim dates of reporting BMP results and monitoring program results.

Depending on the program's size, the schedule could be shown by means of a simple bar chart or a more complex critical path method (CPM) system using project scheduling/management computer software. The type of schedule selected depends on the level of program complexity—the number of tasks and subtasks (activities) required, the number of involved entities, the length of time over which the program will extend, and the available program management resources.

Implicit in developing an implementation schedule is the need to set priorities. The program team should review the recommended BMPs and determine an order of implementation (or phasing), taking into account extenuating circumstances in any particular case. If funding is a major issue, for example, the least expensive recommendations can be implemented early

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in the process. Individual projects need to be phased in accordance with available funding.

One set of priorities that might be considered is to first implement regulatory and nonstructural controls, then evaluate them over time, and later implement structural controls. This approach might be effective in developing areas where BMPs can be required as development occurs. In addition, nonstructural and regulatory BMPs are less costly to implement than structural BMPs. This approach would not be as effective in areas where retrofit of BMPs is necessary. In general, priorities and thus the schedule of program implementation, must be tailored to each situation.

If the development of public support for the program is critical, the team might choose to address BMPs with potential for significant pollution reduction. In this case, BMPs that could improve the water quality of widely used water bodies should be implemented, if possible, before other steps are taken. These decisions should be reflected by the implementation schedule. A cost-benefit analysis (see Chapter 8) can be used to assist in setting priorities. For example, an analysis could be performed to determine total cost per pound of pollutant removed and projects implemented accordingly.

Responsibilities for BMP Implementation

The individuals and entities responsible for implementing each aspect of the program must be identified in the urban runoff pollution prevention and control plan. Since a well-defined institutional framework for urban runoff pollution prevention and control might be lacking, much of the effort for implementing plans must come from local and regional governments. Officials at the state and federal levels will likely be responsible for enforcement and oversight, and technical and financial assistance might also be available.

To develop a plan, municipal officials must coordinate, initiate activities, and motivate others in the community or other agencies to get involved. Figure 9-3 is an example format showing recommended actions and the agencies charged with implementation. Obtaining firm commitments from these agencies prior to program implementation is important to the final success of the program. Table 9-1 identifies groups, agencies, and individuals that can provide support for aspects of the management plan, including monitoring, design, permitting, regulations, public education, maintenance, and enforcement.

Description of Monitoring Plan

A monitoring program should be conducted during and after urban runoff pollution prevention and control program implementation to assist the municipality in determining the effectiveness of its overall program in achieving water resource goals. Monitoring during program implementation includes data collection to measure the overall program effects on water resources and determine the effectiveness of BMPs. Existing water resource conditions determined during the planning process provide a good understanding of water resource quality before program implementation. A monitoring plan to assess water resource conditions during and after program implementation allows the level of resulting improvements to be assessed by comparison to existing conditions.

Trend analyses are important in understanding the effects of watershed activities on water resources, and can provide important feedback to assessments of the success of urban runoff pollution prevention and control measures. Long-term data can be used to demonstrate the influence of program activities on water resource quality. Sampling data can also be used to educate the public on the effects of urban runoff pollution on water resources and the need for control. To increase public awareness, information that identifies the effects of urban runoff pollution can be disseminated in newsletters, at public meetings, or by other means.

Overall program effectiveness can usually be determined more easily than the effectiveness of individual BMPs. As part of the urban runoff control program, a long-term monitoring plan should be designed to measure program effectiveness and provide program accountability. The plan should use existing monitoring stations (both those used in previous studies and those used for collecting additional data as outlined in Chapter 5) to collect long-term data with which comparisons can be made. In this way, the progress of the program in addressing pollution problems and preventing further water resource degradation can be determined. Monitoring plan components (e.g., a map of monitoring stations, a record of the frequency of sampling at each station, a parameter list, and a QA/QC project work plan) should be identified in a work plan similar to that outlined for sampling in Chapter 5.

Collecting sufficient data to clearly demonstrate BMP effectiveness is difficult for many reasons, including the variability of runoff flow and quality, and the difficulty in separating the effect of a particular BMP on a receiving water. Caution should be exercised in developing these types of monitoring programs because they can be very expensive; sufficient data to reach a conclusion might not be obtained. More detailed discussions of BMP effectiveness sampling is available elsewhere (U.S. EPA, 1976).

The effectiveness of nonstructural and regulatory BMPs is difficult to assess. These BMPs are usually implemented slowly over time and affect a geographically wide area (typically within a political boundary). Patience

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Recommended Areawide NPS Control Measures (Program II)	Cities				County				State		
	Manager/attorney	Planning	Public works	NPS coordinator	Manager/attorney	Planning	Public works	NPS coordinator	General manager	Water quality	Environmental
Public Agency Actions											
P1 Label storm drain inlets and provide signs along the banks of drainage channels and creeks	ab	cd	cd e	cd ek	ab	cd	cd c	cd	a	cd k	
P2 Develop and implement programs to properly dispose of oil, antifreeze, pesticides, herbicides, paints, solvents, and other potentially harmful chemicals (recycle if possible)	ab h	cd	cd e	cd eg k	ab h	cd	cd e	ed ek	a	k	
P3 Develop and implement an aggressive field program to search for, detect, and prevent dumping or routine discharging of pollutants into storm sewers and drainage channels	ab cj		ce f	ef gi k	ab cj		ce f	ef gi k	a	ce fg jk	ef
P4 Develop and implement an aggressive field program to search for, detect, and control illicit connections of sewers	ab cj		ce f	ef gi k	ab cj		ce f	ef gi k	a	ce fg jk	ef
P5 Determine the effectiveness of increasing the frequency of cleaning out storm sewer inlets, catch basins, storm sewers, and drainage channels in areas where sediment and/or debris tend to accumulate	ab		ce f	cf jk	ab		ce f	ef jk	a	ce fg jk	c
P6 Search for, test, remove, and properly dispose of sediment deposits (in drainage channels and streams) that contain relatively high concentrations of pollutants	ab		ce f	cf jk	ab		ce f	ef jk	a	ce fg jk	c
P7 Develop and implement a program to record the observations of field inspection and maintenance personnel, to help locate the source(s) of pollutants	ab		ce	ce k	a		ce	ce k	a	ck	ce

Legend

a Initiate/authorize program.
b Appoint or hire staff person to coordinate program.
c Work with inhouse personnel and consultant.
d Work with inhouse personnel and volunteers.
e Provide technical information and guidance.
f Conduct technical studies and/or inspections.
g Develop focused educational materials and/or work with media.
h Research existing regulations, authority, and precedent.
i Develop new regulations and/or policy statements.
j Coordinate enforcement actions.
k Coordinate with NPS Task Force.

Figure 9-3. Sample agency responsibility matrix (Woodward-Clyde Consultants, 1988).

is needed in assessing the effects of these types of BMPs because improvements in water quality will usually occur over a span of years. A long-term monitoring program should be used to determine BMP effectiveness. Other nonconventional types of monitoring might provide a more rapid and quantifiable means of BMP effectiveness. These monitoring methods include (CDM, 1993):

- *Record keeping/program tracking:* Keeping careful records of the quantities of pollutants removed by source control activities (e.g., length of streets swept and quantity of street sweepings removed, number of catch basins cleaned and amount of material removed, and the number, flow, and quality of illicit connections removed).
- *Level of participation:* Maintaining information on the number of participants and results of programs involving participation of the public and businesses (e.g., volumes and types of waste collected during a special collection program).
- *New programs implemented:* Measuring what has been accomplished, such as the number of new ordinances enacted or the number of public education meetings held.

Another nonconventional method to assess program effectiveness is an overall rating index. An example of this type of index has been developed and tested in two test case projects within the Rural Clean Water Program (Dressing et al., 1992). The index comprises four subindices: beneficial use support status, water quality data, extent of critical area treatment, and pollution control expected from treatment applied. Each subindex has its own scoring system, and the overall score is a weighted average of the subindex score. This type of

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Table 9-1. Potential Implementation Responsibilities

Program Component	Potentially Responsible Parties	Other Potentially Involved Parties
Monitoring	Local boards of health State water pollution control agency State marine fisheries department	Local environmental groups University students Volunteer organizations Environmental consulting companies
Engineering design	Local engineering department State department of public works SCS	University engineering departments Engineering consulting companies
Permitting and regulatory controls	Local boards of health Local conservation office Local planning board EPA State water resources agency Federal coastal zone management U.S. Army Corps of Engineers	Local environmental groups Environmental consulting companies
Public education	Regional environmental agency Local environmental groups Watershed associations State environmental agency Soil and water conservation districts EPA	Local environmental groups Local civic groups Private organizations Cable TV/newspapers
Maintenance	Local department of public works SCS Private owners of BMPs	Contract maintenance providers
Enforcement	Local conservation agency Local board of health Planning board Local code enforcement officer Federal coastal zone management U.S. Army Corps of Engineers EPA	

rating system can be useful to assess program effectiveness semiquantitatively over time, or at critical periods before and after BMP implementation.

These types of nonconventional monitoring methods are not as direct as demonstrable water resource quality improvements, but they are valuable in documenting program success.

Summary of Regulatory Requirements

Regulatory issues that need to be addressed include both the implementation of regulatory BMPs and the application for regulatory approvals and permits needed to implement nonstructural and structural BMPs. Regulatory BMPs are discussed in Chapter 7. The urban runoff pollution prevention and control program could involve the modification or strengthening of existing regulations, including zoning, site plan review, subdivision, or wetlands protection or the development of new regulations.

In addition, a municipality must obtain appropriate regulatory approvals and permits before implementation and construction of BMPs that could alter wetlands, waterways, or water quality, even if the BMP results in environmental benefit. These requirements should be summarized as part of the urban runoff pollution prevention and control program. Coordination with appropriate agencies is advisable before applying necessary approvals and permits. Agencies from which permits will be required should be contacted early in the planning process to determine requirements for securing all necessary approvals and permits.

Major permits required in implementing urban runoff control BMPs originate at all levels of government—federal, state, and local. The permits of concern usually address the following issues:

- Alterations to wetlands.
- Dredging and filling operations.
- Disturbances within a specified distance of a waterway.
- Soil and erosion control at construction sites.
- Alterations to the water quality of a water body.
- Alterations to existing or construction of new discharges to a water body.
- Impacts on endangered species.
- Impacts on historic/archaeological sites.
- Impacts on natural resources and ecologically sensitive areas.

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Major permitting programs at the federal level include: the National Environmental Policy Act (NEPA); the U.S. Army Corps of Engineers—Section 10 of the Rivers and Harbors Act and CWA Section 404; EPA's NPDES Permit Program; and the CZMA Federal Consistency Concurrence Certificate. Additional requirements can be in place for many of the regulatory programs outlined in Chapter 2. Information is available through regional EPA offices and the state agencies dealing with these issues. Requirements for state and local permits are site specific vary widely, and are available from the responsible local or state agency.

Public Involvement

Support and involvement of the general public, both homeowners and businesses, is considered crucial to plan implementation and its ultimate success. While public involvement should be an integral part of the planning process, a public involvement program should be developed as part of overall program implementation.

Components of public involvement programs can be wide ranging, involving one or more of the following components:

- Program meetings and presentations to provide information and updates.
- Program materials such as newsletters, fact sheets, brochures, and posters.
- School education programs such as special classes and tours.
- Homeowner education programs on individual control of urban runoff related pollution.
- Consumer education programs on appropriate product purchasing and handling.
- Business education programs.
- Media campaigns including radio, newspaper, or television.
- Coordinating and coalition building with local watershed or activist groups to support the program.

The numerous other possibilities include setting up a program hotline, sponsoring special events, and conducting surveys. A task force can be set up to coordinate and help focus these activities.

Public involvement can be approached in numerous ways. The case study on the Pipers Creek watershed at the end of this chapter identifies the elements used for that program. The Santa Clara Valley case study at the end of Chapter 8 shows how public involvement activities can be identified and evaluated as BMP options.

Funding Sources and Mechanisms

Since a large percentage of funding for urban runoff pollution prevention and control programs comes from local sources, this section focuses on local funding mechanisms. Sources of funding at the federal and state levels are uncertain and likely only to provide a small percentage of the total needed funding. It is important to keep in touch with the regional EPA offices and the state agencies dealing with urban runoff pollution prevention and control to determine the current status of funding for program implementation. Funding sources usually available to local jurisdictions fall into the following categories:

- Local funding mechanisms
- Matching fund programs
- Grant programs

An urban runoff pollution prevention and control program budget typically includes funds from a combination of sources. The actual funding sources utilized depend on many factors, including the following (PSWQA, 1989):

- The sustainability of the funds.
- The ease with which the funds can be obtained.
- The administrative requirements of the funding option.
- The correlation between the funding option and the problem.
- The typical use made of the funding.

The construction of a structural BMP, for example, typically requires one-time, short-term funding that can be obtained through a grant or cost share program. The development of a monitoring or maintenance program, however, typically requires continuing funding.

Local Funding Mechanisms

Regional, state, and federal storm water and NPS funding programs are usually intended for small-scale projects to collect data and demonstrate control methods. Larger scale programs, therefore, have to be financed primarily through local mechanisms, including (U.S. EPA, 1990):

- General funds
- Long-term borrowing
- Pro-rata share fees
- Storm water utilities
- Special assessment districts

General Funds. General funds are raised locally, usually through property taxes, fees, and fines and can

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be directed to urban runoff pollution prevention and control. The use of general funds might require reallocating existing revenues or creating additional revenue sources. These funds can be used either for one-time costs or annual operation and maintenance costs.

Long-Term Borrowing. Local entities can also fund pollution prevention and control projects through bonds and other long-term borrowing. Funding through bond issues is usually used only for one-time expenses, such as the design and construction of large structural BMPs.

Pro-Rata Share Fees. Pro-rata share fees can be used to finance the construction and maintenance of urban runoff projects. This mechanism requires land developers to contribute funds to a local entity in charge of local BMPs. Fees are typically based on a technical assessment of the development's potential to contribute to the urban runoff pollution problem. For example, a municipality can require developers to pay a fee based on the amount of impervious surface in the development. The fees could vary depending on the development's location (e.g., watershed or proximity to protected resources). These pro-rata share fees are often used in currently undeveloped areas where future development could threaten water resources.

Storm Water Utilities. Many municipalities in urban areas have begun to set up storm water utilities. Storm water utilities usually assess all existing residential and commercial buildings a fee based on their percentage of impervious area. A survey of 25 storm water utilities conducted by the Maryland Department of the Environment in 1987 outlined many of the similarities and differences among these utility programs (Lindsey, 1988). According to the survey, storm water utilities had been established in small communities as well as large urban centers. Most utilities are administered by local departments of public works, which also have the responsibility for operation and maintenance of BMPs. These programs have proved to be good, stable funding sources.

Special Assessment Districts. Some states have enacted legislation that allows for the development of special assessment districts for flood control, lake management, aquifer protection, drainage, or shellfish protection. Once a special district is formed, funds for projects in a district can be raised by levying fees on landowners in the district. Such programs are viewed as more equitable forms of financing. Because these programs require approval of residents in the special district these funding programs can be difficult to establish (PSWQA, 1989).

Matching Fund Programs

Matching fund programs (also called cost share programs) can exist at the regional, state, and federal level and are typically restricted to financing specific activities or control measures. In these programs, entities implementing control programs can obtain funding for a certain percentage of the cost. Matching fund programs have been available from the federal government through the Construction Grants Program, State Revolving Loan Fund, NPS program (CWA Section 319), the Clean Lakes Program (CWA Section 314), and the National Estuary Program (CWA Section 320). Each of these programs is described in Chapter 2. Matching funds are also available from the Department of Agriculture through the Soil Conservation Service and the Agricultural Stabilization and Conservation Service.

Grant Programs

Regional, state, and federal agencies might also offer special grants which typically are limited and can change from year to year. Because of the uncertain nature of these grants, they are not reliable sources of funding for long-term programs; however, they can provide funding for short-term needs. Grants are available through many of the same federal sources as for matching funds.

Summary

The final recommended urban runoff pollution prevention and control plan should be summarized in a document which can be used by responsible officials and agencies in plan implementation. An example of such a plan is provided in the case study on the Pipers Creek watershed at the end of this chapter. By developing a thorough and accessible final implementation document and periodic reports, the plan will have a greater chance of success. In addition, valuable information can be compiled for other communities.

While completion of the urban runoff pollution prevention and control plan signifies the end of the planning process described in this handbook, it is only the first step in the overall program. Plan implementation will likely be a long-term effort and the planning is by no means over at this stage. As implementation and further monitoring occurs, the plan might need to be updated, refined, and modified. When this occurs, the planning process described in this handbook (Figure 3-1) may be re-entered at any point. For example, a new problem assessment might be needed, a change in priorities (or problem ranking) could be necessary, or new BMP options (or deletion of BMPs previously thought appropriate) might need to be

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considered. The program needs to be reevaluated and updated constantly throughout implementation.

As a final note, achieving the critical balance between resources expended on program planning and those used for program implementation is a challenging task. The program team must develop a pollution prevention and control plan using its valuable resources cost-effectively. Every dollar and manhour not used in the planning process can be applied to program implementation. Difficult choices must be made throughout the planning process to ensure that technically defensible decisions are made while still maintaining adequate resources for future implementation.

Case Study: Pipers Creek Watershed Action Plan for the Control of Nonpoint Source Pollution

The Pipers Creek watershed, an urban drainage basin of approximately 3.5 square miles, is located in northern Seattle, Washington, bordering Puget Sound. To improve the water quality in Puget Sound and its tributaries, a comprehensive study of the Pipers Creek watershed was conducted during 1989 and 1990 by the city of Seattle and the Washington State Department of Ecology (WA DOE, 1990). This study led to the development of the Pipers Creek Watershed Action Plan for the Control of Nonpoint Source Pollution. The plan presents recommended actions, an implementation schedule, regulatory issues, and remaining needs for the watershed.

The Pipers Creek Action Plan was developed through a 12-step process that closely follows the 7-step process used in this handbook (see Chapter 3). The steps include:

- Initiate public participation
- Define existing conditions
- Review regulatory requirements
- Define goals and objectives
- Define and describe the problem
- Identify candidate measures to control NPS pollution
- Employ a practical approach to evaluate candidate pollution control measures
- Develop criteria for evaluating candidate controls
- Examine, evaluate, and screen candidates
- Select most promising source control measures
- Continue assessment of selected source control measures
- Recommend source control measures and an implementation program

In this program, the existing conditions were defined prior to developing and stating program goals. Goals were reevaluated and redefined at numerous points during the program.

NPS pollution and erosion problems were of highest concern in the Pipers Creek watershed. A watershed management committee (WMC) was created to develop the action plan, made up of local residents and representatives of community and environmental organizations, businesses, and local government agencies. The committee determined that, since NPS pollution is difficult to link precisely to sources, a

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broad range of control measures should be recommended. The following five programs for controlling NPS pollution were developed:

- *Public education:* Since some pollution problems were caused by public actions, public education programs were recommended to inform the general public of actions that result in pollution of surface waters.
- *Regulation:* Since some existing regulations could be used to address NPS pollution, regulatory programs were recommended to increase coordination and enforcement of the existing laws and regulations designed to prevent water pollution.
- *Operation and maintenance:* Since existing drainage structure operation and maintenance activities could be used to reduce NPS pollution, the action plan recommended ways to protect water resources through improving and coordinating these efforts.
- *Public works:* Even with full implementation of municipal and regulatory control practices throughout the watershed, pollution problems would still exist. The action plan therefore, included recommendations for structural control practices where appropriate, to reduce water quality degradation.
- *Monitoring:* The action plan includes recommendations for monitoring management practice implementation to determine the effectiveness of individual practices as well as a recommendation for monitoring overall water resources to further characterize the NPS problems.

The recommendations given within these programs are broad in scope and focus primarily on municipal and regulatory controls (Table 9-2). Controls for specifically identified pollution sources are included in the public works recommendations and consist of demonstration projects designed to determine the effectiveness of specific structural controls.

For each of the five programs, WMC has developed detailed recommendations and summarized them in an action plan that includes conceptual information on recommended BMPs, a schedule of activities, responsibilities involved in implementation, a description of the monitoring plan, a summary of regulatory requirements, and identification of funding requirements and sources. The plan also includes a discussion of pollution prevention and reduction activities that have been implemented already and additional water resource data that should be obtained.

To increase the effectiveness of the public education program, the WMC and the WA DOE recommended that some public education activities begin before the action plan is completed. As a result, a number of actions to inform and educate the watershed community have been initiated with the approval of the city, including:

- Posting informational signs at key areas in the watershed.
- Stenciling storm drains with a warning against dumping wastes.
- Providing staff assistance to community efforts related to water quality protection.
- Staging a media event and dedicating a billboard promoting the protection of water quality.
- Starting a public education pilot project that provides a half-time watershed educational specialist to undertake a variety of activities in the watershed.

A detailed plan to implement the recommendations has been developed, including:

- Obtaining written commitments from local and state agencies and citizen's groups responsible for implementation; these commitments are important given the wide array of agencies and organizations involved in the program.
- Creating an implementation committee staffed by community representatives and members of agencies responsible for implementation; this committee is responsible for evaluating program progress.

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Table 9-2. Pipers Creek Action Plan Recommendations

Public Education

Provide public information during action plan development

Develop a household educational brochure

Hire a watershed specialist to provide education

Develop a park educational display

Develop a watershed educational video

Continue volunteer activities in the watershed

Institute an annual watershed awareness week

Paint signs on storm drains—"Dump No Waste, Drains to Stream"

Regulatory Controls

Develop a septic system inspection program

Develop a water quality training program for all city inspectors

Monitor permanent detention systems

Require BMPs at many new construction sites

Install additional pet waste signs

Conduct a study to determine the effectiveness of current regulations

Install additional dumping enforcement signs

Operation and Maintenance

Develop a program to trace pollution in storm drainage systems

Locate septic systems serving basements

Expand sanitary sewer system inspections

Inspect the major sanitary system trunk line in the Pipers Creek watershed

Operation and Maintenance (cont.)

Develop a program to determine the correct cleaning schedule for catch basins

Improve maintenance of open drainage ditches

Provide additional trash receptacles in parks

Expand the existing spill-response program

Public Works

Construct a test grassed swale in the watershed

Conduct a program to test erosion controls

Conduct a test program to increase in-system detention

Reduce erosion from an identified pipe discharge

Reduce erosion from waterside park trails

Install current deflectors to reduce in-stream erosion

Improve the fisheries habitat in park areas

Reduce odor from two sewer systems

Monitoring Program

Create an implementation committee to oversee the action plan

Conduct routine water quality monitoring

Conduct storm event monitoring in Pipers Creek

Conduct periodic video surveys and a refuse dumping survey in Pipers Creek

Periodically review watershed land use

Require annual agency status reports

Require annual summary reports of progress in Pipers Creek

- Developing assessment criteria for the implementation committee to evaluate the program's success; assessment criteria should include:
  - source control recommendations implemented,
  - water quality monitoring results,
  - opinion surveys,
  - recycling participation,
  - yard waste collection,
  - results of the annual neighborhood cleanup program,
  - Earth Day participation,
  - return of salmon to Pipers Creek,
  - participation in educational events, and
  - attention from the local media.
- Developing and implementing a long-term monitoring program, including:
  - routine water resource monitoring,
  - specific storm event monitoring,

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- visual monitoring, and
- land use monitoring.

* Requiring biannual status reports from each agency responsible for implementation; these reports should address:
  - progress and accomplishments in general,
  - problems with implementation,
  - actual versus estimated costs,
  - suggested modifications to the program, and
  - actions for the following year.

Since the recommendations made in this program rely heavily on the data available to the program team, the initial focus of implementation is on pollution prevention activities, public education, demonstration projects, and additional data gathering. In this way implementation is not delayed while further water resource sampling is conducted. Additional sampling and assessment of control measures could lead to further implementation.

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When an NTIS number is cited in a reference, that document is available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

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Appendix A
Additional References

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National Technical Information Service
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Appendix B
Table of Annotated References

Document Title	Author, Date*	BMPs Included	Information Available
Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs	Schueler, 1987	Detention Infiltration Vegetative Filtration Quality inlets	General descriptions Effectiveness Design Use limitations Maintenance Cost Examples
Protecting Water Quality in Urban Areas	MPCA, 1989	Housekeeping Detention Infiltration Vegetative Quality inlets	General descriptions Effectiveness Use limitations Maintenance Cost Examples
Guide to Nonpoint Source Control	U.S. EPA, 1987	Housekeeping Detention Infiltration	General descriptions Effectiveness Cost
Water Resource Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development	ULI, 1981	Housekeeping Detention Infiltration Vegetative Quality inlets	General descriptions Effectiveness Design Use limitations Maintenance Cost
Urban Targeting and BMP Selection: An Information and Guidance Manual for State NPS Program Staff Engineers and Managers	Woodward-Clyde Consultants, 1990	Housekeeping Detention Infiltration Vegetative	General descriptions Effectiveness Design Use limitations
Combined Sewer Overflow Pollution Abatement	WPCF, 1989	Housekeeping Collection system Storage Treatment	General Descriptions Design Effectiveness Maintenance Cost
Urban Storm Water Management and Technology: An Assessment	U.S. EPA, 1974c	Housekeeping Collection system Storage Treatment	General descriptions Design Maintenance Use limitations
Decision Maker's Storm Water Handbook: A Primer	U.S. EPA, 1992c	Housekeeping Detention Infiltration Vegetative Filtration Quality inlets	General descriptions Effectiveness Design Use limitations Maintenance Examples
Urban Storm Water Management and Technology: Update and User Guide	U.S. EPA, 1977	Source control Collection system Storage Treatment	General descriptions Design Maintenance Use limitations
Control and Treatment of Combined Sewer Overflows	Moffa, 1990	Source control Collection system Storage Treatment	General descriptions Design Maintenance Use limitations

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Document Title	Author, Date*	BMPs Included	Information Available
Guidance Specifying Management Measures for Source of Nonpoint Pollution in Coastal Waters	U.S. EPA, 1993b	Housekeeping Infiltration Vegetative Filtration Quality Inlets	General descriptions Effectiveness Design Use limitations Maintenance Cost Examples
The Florida Development Manual: A Guide to Sound Land and Water Management	Livingston et al., 1988	Housekeeping Infiltration Vegetative Detention Filtration Site planning	General descriptions Effectiveness Design Use limitations Maintenance Cost Examples
Storm Water Management Manual for the Puget Sound Basin	WA DOE, 1991	Housekeeping Infiltration Vegetative Quality Inlets	General descriptions Effectiveness Design Use limitations Maintenance Cost Examples

* For complete citations, see Chapter 7 reference list.

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Appendix C
Acronyms and Abbreviations

ARM	agricultural runoff model
ASCS	Agriculture Stabilization and Conservation Service
ATV	all-terrain vehicle
BAT	best available technology economically achievable
BCT	best conventional technology
BMP	best management practice
BNA	base/neutral and acid extractable compound
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
BPJ	best professional judgment
CBOD	carbonaceous biochemical oxygen demand
CCMP	Comprehensive Conservation and Management Plan
CFR	Code of Federal Regulations
CMA	calcium magnesium acetate
CMP	Central Maine Power
CPM	critical path method
COD	chemical oxygen demand
CSO	combined sewer overflow
CWA	Clean Water Act
CWO	Comprehensive Watersheds Ordinance
CZMA	Coastal Zone Management Act
DAF	dissolved air floatation
DEM	digital elevation model
DLG	digital line graph
DO	dissolved oxygen
ED	extended detention
EMC	event mean concentration
ENR	Engineering News Record
EPA	U.S. Environmental Protection Agency
EPT	*Ephemeropter, Plecoptera, Trichoptera*

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EXAMS II	Exposure Analysis Modeling Systems II
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GC	ground-water conservation
GIS	geographic information system
GNIS	geographic names information system
GWA	ground water A (classification)
HEC	Hydrologic Engineering Center (U.S. Army Corps of Engineers)
HSPF	Hydrological Simulation Program—Fortran
IBI	index of biotic integrity
ICI	invertebrate community index
I/I	infiltration and inflow
LC	lake conservation
LULC	land use and land cover
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
ME DEP	Maine Department of Environmental Protection
MIwb	modified index of well being
MPN	most probable number
N/A	not applicable
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NH_3	ammonia
NO_3	nitrate
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NURP	Nationwide Urban Runoff Program
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PCS	Permit Compliance System
PS	point source
PSI	pounds per square inch
PVC	polyvinyl chloride
PW	present worth
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control

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QUAL2E	Enhanced Stream Water Quality Model
RC	resource conservation
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SLAMM	Source Loading and Management Model
SOD	sediment oxygen demand
SS	suspended solids
SSES	sanitary sewer evaluation survey
STORM	Storage, Treatment, Overflow, Runoff Model
SWMM	Storm Water Management Model
SWTR	Surface Water Treatment Rule
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TOC	total organic carbon
TSS	total suspended solids
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UV	ultraviolet
VOC	volatile organic compound
WA DOE	Washington Department of Ecology
WASP4	Water Quality Analysis Simulation Program
WMC	watershed management committee
WQ	water quality
WSE	water surface elevation

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