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B.0 PROGRAM MONITORING AND DATA ANALYSIS METHODS

The core monitoring program is conducted in accordance with the monitoring requirements set forth in Order No. R9-2007-0001. Collection and analysis of ambient water quality and storm water runoff at mass loading stations (MLS) was conducted. Ambient water samples were collected at MLS during one event. Storm water samples were collected during one storm event at each MLS and were analyzed for chemical constituents, indicator bacteria, and toxicity to bioassay test organisms. Trash assessments were conducted at each MLS during all monitoring events. After the first major rainfall of the season, post-storm sediment sampling occurred at each MLS to assess the relative concentrations of synthetic pyrethroids in sediment in receiving waters. Rapid stream bioassessment surveys were conducted during Spring of 2009 at each MLS and coincided with the spring ambient water quality sampling. Periphyton sampling and physical habitat assessments were also conducted. Watershed assessment methods, GIS and modeling methods, and statistical analysis methods are also described in this section.

In addition to the core monitoring described above, the following monitoring activities were conducted by the Copermittees during the 2008–2009 Monitoring Season. Mass loading station (MLS) monitoring occurred during one wet weather event.

- Trash assessment and evaluation.
- Sediment pyrethroids monitoring.
- Stormwater Monitoring Colalition (SMC) Regional Bioassessment and Water Quality Monitoring Survey.
- Bight '08 Coastal Ecology Monitoring
- Coastal storm drain monitoring (CSDM).
- Municipal separate storm sewer system (MS4) outfall monitoring.
- Source identification monitoring.

These programs are summarized in the attachments that follow the body of the methods section.

B.1 Water Quality Monitoring Methods

B.1.1 Mass Loading Station (MLS) Site Selection

The 2008–2009 monitoring program included storm water monitoring at 11 MLS. The data collected at each station is representative of large drainage areas with mixed land use characteristics. The MLS sites were selected to directly measure pollutant loads being discharged into San Diego's receiving waters by the major watersheds within the San Diego region. Monitoring sites were installed where flow from the catchment area passes a single hydrologically ratable point, and is suitable for water quality sampling. In some instances, sites were located upstream of the drainage area discharge point for accessibility and/or to avoid tidal influences.

B.1.2 Monitoring Equipment

Flow was monitored at all stations using American Sigma flow meters. A variety of flow measurement technologies were utilized to accurately measure flow rates including ultrasonic sensors, bubblers, and submerged pressure transducers. The sensors provided a continuous measurement of river or stream stage (height) and relayed that information to the flow meter. The flow meter continually calculated flow rates by inserting the stage information into the preprogrammed discharge equation. Two stations are co-located with U.S. Geological Survey (USGS) stream gauging stations. At these sites the USGS rating curves were used.

Field crews measured the flow rate of streams using USGS stream profiling guidelines prior to the beginning of, and periodically throughout, the storm season. This was accomplished by manual rating techniques using a hand held flow meter. The resulting discharge rates were used to calculate a discharge equation, which was utilized by the flow monitoring equipment at some stations. At other stations where a discharge equation could not be developed, velocity/stage measurements were utilized to calculate discharge rates using the area velocity method.

B.1.3 Sampling Procedures

B.1.3.1 Grab Samples

Grab samples were collected for those constituents that are not amenable to composite sampling. The grab samples were analyzed for the following parameters:

- Temperature.
- pH.
- Specific conductance.
- Biochemical oxygen demand.
- Oil and grease.
- Total coliform.
- Fecal coliform.
- Enterococci.

Samples were collected from the horizontal and vertical center of the channel if possible and kept clear from uncharacteristic floating debris. Because oil and grease and other petroleum hydrocarbons tend to float, oil and grease grab samples were collected at the air/water interface. Bacteria samples were collected in a sterile sample bottle and then placed in a clean Ziploc bag and put on ice for transport to the laboratory for analysis within six hours.

B.1.3.2 Composite Samples

Ambient samples and storm water samples were collected as flow-weighted composites during each monitoring event. Ambient event flows typically do not fluctuate over a wide range of flow rates and were monitored over a 24-hour period to represent the conditions during both day and night. Storm event flows were monitored during the initial rise and peak of the hydrograph. When practical, the entire event was sampled. At some monitoring stations this was not practical due to the runoff characteristics of the watershed or due to the amount and duration of rainfall received. For example, San Luis Rey and San Diego Rivers are large water bodies that continue to rise following the initial flow of runoff during storm events and it is not uncommon to see a double peak in the hydrographs. The first peak (usually smaller than the second) is the immediate response from runoff. The second peak is typically the result of groundwater flowing from the unsaturated zone that appears as a much larger peak, usually hours or days after rainfall has stopped. Sampling this additional flow would dilute the analytes measured in the composite sample and would result in slightly lower concentrations. For large watersheds, the sampling strategy was determined by using best professional judgment to monitor rainfall and runoff and determine the appropriate time to terminate sampling. In some cases, safety was a factor for determining when to terminate sampling.

In general, a larger concentration of constituents from urban runoff enters the storm drainage system during the initial stages of flow and during peak flow and/or peak rainfall intensity for small rainfall events, which are typical in our region (Tiefenthaler et al., 2001; City of Austin, 1990). Therefore, a successful event was determined by capturing flow weighted aliquots during the initial rise and peak of runoff (at a minimum) from the storm event.

Storm teams evaluated telemetry data from the monitoring sites during storms to ensure all of these conditions were met before terminating sampling. Storm hydrographs for each of the monitored events are presented in Appendix G.

B.1.4 Stream Rating Methods

The stream flow rate at each of the monitoring sites was determined by stream stage (water level) sensors that are typically secured to the bottom of the channel. To quantify flow rates based on stream stage, a relationship between flow and stage was derived using standardized stream rating protocols developed by the USGS (Rantz, 1982; Oberg et al., 2005). Instantaneous flow measurements were measured at various stages at each of the sites. The measurements were combined to produce a rating curve for each site.

Methodology has been improved for the measurement and accuracy of flow estimates at MLS sites. Due to safety issues, past estimates for high flows based on stage were made based on extrapolation of the rating curve at low flow. This extrapolation was derived using a best-fit curve approach. To accurately measure flow in streams there are three critical elements needed to develop rating curves:

- An accurate survey of the stream channel cross section and longitudinal slope.
- Accurate level measurements based on a fixed point.
- Measurements of velocity and flows at several points throughout the rating curve including low flow, mid flow, and peak flow conditions.

To measure instantaneous flows during low flow and base flow conditions, two velocity measurement instruments were used: (1) a Marsh-McBirney Model 2000 Portable Flow Meter connected via a cable to an electromagnetic open channel velocity sensor, and (2) the SonTek (YSI) FlowTracker Acoustic Doppler Velocimeter. The FlowTracker is a high-precision, shallow-water velocity/flow meter that measures velocity in 3 dimensions and features an automatic discharge computation.

The velocity sensors were attached to a stainless steel top-setting wading rod. To make an instantaneous flow measurement, a tape measure was stretched across the stream, perpendicular to flow and secured on both banks of the stream. The tape was positioned so that it was suspended approximately one foot above the surface of the water. The distance on the tape directly above the waterline (where the water met the bank) was then recorded as the initial point. The first measurement was then made at the first point where there was adequate water depth (at least 0.2 feet) and measurable velocity. At this point, three measurements were made: water depth, velocity, and distance from the bank (the initial point). Subsequent depth, velocity, and distance measurements were then made incrementally across the entire width of the channel so that a minimum of ten points were measured per site. Water depth was determined from calibrations on the wading rod in tenths of feet. Velocity measurements were made at each point along the transect by positioning the velocity sensor perpendicular to flow at 60% of the water depth (from the surface) to attain an average velocity. The top setting wading rod is designed so that the sensor can be conveniently positioned at the appropriate depth. Water velocity was measured in feet per second.

Data from the field measurements were entered into a computer model that calculates the stream's cross-sectional profile from the depth and distance from bank measurements. Total flow across the channel was determined by integrating the velocity measurements over the cross-sectional surface area of the stream channel. The result is an instantaneous flow measurement in cubic feet per second.

A StreamPro Acoustic Doppler Current Profiler (ADCP) was used to measures high stage and flow conditions. The StreamPro ADCP is the USGS instrument of choice for measuring flows nation-wide (Oberg et al., 2005). The instrument is pulled across the stream either by walking across a bridge or attaching the unit to a tagline. Data are collected in real-time and transmitted via a wireless data link to a palm PC. Data can be viewed in real time and is typically post-processed following the field event in the office.

Rating curves were extended to high stream stages not measured using site-specific survey information and the Chézy-Manning formula (Linsley et al., 1982). The Chézy-Manning formula is an empirical formula for open channel flow, or flow driven by gravity:

$$Q= (1.486/n)AR^{2/3}S^{1/2}$$

where,

Q = Flow
n = Manning Roughness coefficient
A= Cross sectional area
R= Hydraulic radius
S= Hydraulic slope

The hydraulic radius is derived as:

$$R = A/P$$

Where;

A = Cross sectional area of flow (ft^2)
P = Wetted perimeter (ft)

The Chézy-Manning formula was developed for conditions of uniform flow in which the water surface profile and energy gradient are parallel to the streambed and the area, hydraulic radius, and depth remain constant throughout the reach. Field surveys of the channel geometry of each MLS were conducted in order to compute the channel characteristics for each site.

Channel cross section surveys were conducted at each site in order to derive stream discharge using the Manning equation. The cross section surveys involved placing endpoints and a benchmark on the nearest overhead bridge structure or stretched line such that the endpoints were placed at the highest point of the channel on each bank. A tape was then stretched between the endpoints such that the zero end of the tape was attached to the endpoint on the left bank of the channel (looking downstream). Using a weighted tape measure, at least twenty vertical distance measurements from a standard level on the bridge or stretched line to the channel bottom were then recorded at equal horizontal distances across the creek. A DeWalt transit level was used to survey the channel thalweg. A minimum of three elevations at increasing horizontal distances from the transit level were recorded in the channel bed. A minimum of five elevations were measured at sites with irregularly sloped or curved channel surfaces. The average channel slope was calculated from the survey data.

Channel survey data were used with the Chézy-Manning formula to produce a rating curve for each sampling site. Each rating curve was calibrated using instantaneous flow measurements by adjusting the formula roughness coefficient.

For long-term flow monitoring, instream flow measurement devices (such as the Sigma 950 flow meter) with pressure/level sensors, area velocity sensors, or ultrasonic level sensors are used. These data are downloaded bi-weekly from each site and are verified by a Senior Hydrologist to ensure accuracy and identify maintenance and calibration needs. Flow data are then entered into the data management system. All flow data are backed up and archived on a weekly basis.

B.1.5 Sample Handling and Processing

In accordance with USEPA sampling protocols and the Weston Quality Assurance Program, all samples collected were stored in the appropriate container type for the analytical method to be performed. Additionally, all samples were stored chilled in ice-chests for transfer to the laboratory and between laboratories. The sample containers used were certified as clean and sterile by the laboratory performing the analyses. Chain-of-custody forms were completed for each sample and accompanied the samples to the laboratories and between laboratories at all times.

Sample preservatives and holding time requirements for each analytical measurement (Table B-1 and Table B-2) were based on the recommendations by the Standard Methods for the Examination of Water and Wastewater and the USEPA methods. All storm water samples were transported from the field to the laboratory under Weston chain-of-custody procedures. Samples moved between laboratories were transported under the laboratories' chain-of-custody procedures. Samples not processed at Weston's laboratories were submitted by Weston to CRG Marine Laboratories, Inc. in Torrance, CA.

Table B-1. Analytical Requirements for Mass Loading Stations 2007–2008

Constituent	Volume Required	Method	Target Reporting Limit	Units	Max Holding Time
General Physical and Inorganic Non-Metals					
Total Dissolved Solids (TDS)	100 mL	SM 2540C	20	mg/L	7D
Total Suspended Solids (TSS)	100 mL	SM2540D	20	mg/L	7D
Turbidity	100 mL	SM 2130A-B	0.1	NTU	48H
Total hardness	150 mL	SM 2340B	10	mg/L	6M
pH (field)	In field	EPA 150.1	0.1	S.U.	-
Specific conductance (field)	In field	SM 2510B	1	umhos/cm	-
Temperature (field)	In field	Meter	-	-	-
Dissolved phosphorus	250 mL	SM 4500PE	0.05	mg/L	48H
Total phosphorus	250 mL	SM 4500PE	0.05	mg/L	28D
Nitrate	200 mL	SM4500NO3E	0.1	mg/L	48H
Nitrite	200 mL	SM4500NO2B	0.05	mg/L	48H
Total Kjeldahl Nitrogen (TKN)	500 mL	SM4500C	0.1	mg/L	28D
Ammonia	250 mL	SM 4500NH3D	0.1	mg/L	28D
Biological Oxygen Demand (BOD) 5-day (grab only)	1000 mL	SM5210B	2	mg/L	48H
Chemical Oxygen Demand (COD)	25 mL	EPA 410.4	25	mg/L	28D
Total organic carbon (TOC)	125 mL	SM 5310 B	1	mg/L	28D
Dissolved organic carbon (DOC)	125 mL	SM 5310 B	1	mg/L	28D
Organics					
Oil and Grease (O&G) (grab only)	500 mL	EPA 1664	5	mg/L	14D
Diazinon	1 liter	EPA 625	0.05	µg/L	14D
Chlorpyrifos	1 liter	EPA 625	0.05	µg/L	14D
Malathion	1 liter	EPA 625	0.05	µg/L	14D
Synthetic pyrethroids (storm events only)	1 liter	GC/MS NCI Mode	0.005	µg/L	7 D
MBAS	250 mL	SM 5540C	1	mg/L	48H
Chollas Creek Only (additional methods)					
Polychlorinated Biphenyls (PCBs)	1 liter	EPA 625	0.020	µg/L	14D
Chlordane	1 liter	EPA 625	0.005	µg/L	14D
Polycyclic Aromatic Hydrocarbons (PAHs)	1 liter	EPA 625	0.10	µg/L	14D
Metals – Total and Dissolved					
Antimony (Sb)	75 mL	EPA 200.8	0.002	mg/L	6M
Arsenic (As)	75 mL	EPA 200.8	0.001	mg/L	6M
Cadmium (Cd)	75 mL	EPA 200.8	0.001	mg/L	6M
Chromium (Cr)	75 mL	EPA 200.8	0.005	mg/L	6M
Copper (Cu)	75 mL	EPA 200.8	0.001	mg/L	6M
Lead (Pb)	75 mL	EPA 200.8	0.001	mg/L	6M
Nickel (Ni)	75 mL	EPA 200.8	0.002	mg/L	6M
Selenium (Se)	75 mL	EPA 200.8	0.002	mg/L	6M
Zinc (Zn)	75 mL	EPA 200.8	0.02	mg/L	6M
Bacteriological					
Total coliform	200 mL	SM 9221B	20-1.6 mil.	MPN/100mL	6H
Fecal coliform	200 mL	SM9221E	20-1.6 mil.	MPN/100mL	6H
Enterococcus	200 mL	SM 9230	20-1.6 mil.	MPN/100mL	6H
Toxicity	10 liters	-	-	-	36H
96-hr acute and seven-day chronic and reproductive test with the cladoceran *Ceriodaphnia dubia*					
Chronic test with the freshwater algae *Selenastrum capricornutum*					
96-hr acute survival test with the amphipod *Hyalella azteca*.					

B.1.6 Laboratory Analysis

B.1.6.1 Chemical Constituents

General physical and chemical constituents were analyzed by CRG Marine Laboratories, Inc. with the exception of field measured constituents (pH, conductivity, and temperature). Field measurements were conducted by Weston's field scientists during field sampling activities. The chemical constituents measured in this monitoring program are presented in Table B-1 and Table B-2. Additional chemical analyses were conducted in the San Dieguito River Watershed Management Area to characterize fire impacts within the watershed (Table B-3).

Table B-2. Synthetic Pyrethroid Analytes

Constituent	Volume Required	Method	MDL	Units	Holding Time
Synthetic Pyrethroids	2 L	EPA 625-NCI Mode			Extraction-7 Days Analysis-40 Days
Allethrin			0.005	µg/L	
Bifenthrin			0.005	µg/L	
Cyfluthrin			0.005	µg/L	
Cypermethrin			0.005	µg/L	
Danitol			0.005	µg/L	
Deltamethrin			0.005	µg/L	
Esfenvalerate			0.005	µg/L	
Permethrin			0.005	µg/L	
Prallethrin			0.005	µg/L	

Table B-3. San Dieguito River Fire Impact Assessment Analytes

Constituent	Volume Required	Method	Target Reporting Limit	Units	Max Holding Time
General Physical and Inorganic Non-Metals					
Sulfate	200 mL	EPA 300.0	0.05	mg/L	28D
Organics					
PAHs	1 liter	EPA 625	0.005	µg/L	14D
Metals – Total and Dissolved					
Mercury (Hg)	75 mL	EPA 245.7	0.02	µg/L	28D

B.1.6.2 Toxicity Testing

Toxicity testing was performed on flow-weighted composite samples collected from the MLS at the same time as the chemistry constituents. Toxicity testing is an effective tool for assessing the potential impact of complex mixtures of unknown pollutants on aquatic life in receiving waters. Rather than performing chemical analysis on a sample for a host of compounds potentially toxic to aquatic life, this approach utilizes a laboratory test species to provide a direct measure of the toxicity of the sample. Interactions among the complex mixture of chemicals and physical constituents can lead to additive or antagonistic effects, potentially causing an individual compound to become either more or less toxic than it would be were it isolated. While the potential effects of these interactions cannot be derived from simple chemical measurements, they are directly accounted for in toxicity tests. Toxicity identification evaluations (TIE) can help to characterize and identify constituent(s) causing toxicity. Toxicity testing can provide information on both potential short-term or "acute" effects as well as longer-term "chronic" effects. Historically, toxicity tests, including TIEs, have been used to assess both short and long-term impacts of point source discharges (e.g., Publicly Owned Treatment Works (POTW), power plant and industrial effluents) on aquatic life in a receiving water body. However, these tools can be applied to non-point source discharges, such as urban runoff. TIEs were not performed during the 2008-2009 season, as persistent toxicity was not observed at the identified TIE-candidate site, Agua Hedionda (Regional Monitoring Program (Receiving Waters Monitoring and Urban Runoff Reporting Program).

Toxicity testing provides the only direct means to assess the potential toxicity waters within the receiving waters. Living organisms are able to integrate effects of multiple contaminants and account for the inherent properties of the sample matrix (e.g., hardness and alkalinity of a storm water sample) that influence bioavailability and hence toxicity. However, the same elements that make these tools so effective can contribute to variability in the response. Living organisms respond to a host of factors other than contaminants. If test organisms are stressed in any way prior to testing, variability of the test organism response may increase and produce equivocal results. The use of controls and reference toxicant testing are quality assurance and quality control measures that have been put in place to identify changes in test organism sensitivity due to stress or other factors. Naturally occurring characteristics of the sample matrix can also affect organism response. For example, mortality of test organisms can result from extreme variations in water hardness. Consequently, understanding the importance of such features on test organism response is critical for the accurate interpretation of test results. The test procedures employed to date represent the culmination of some 40 years of research. While this does not guarantee that they are employed properly in every circumstance, there is a wealth of information to document the utility of such procedures.

Freshwater species were used to evaluate the potential impacts of urban runoff in the receiving waters at each MLS. It is important to note that, ultimately, all of the receiving water bodies for these drainage basins are estuarine/marine habitats (e.g., San Diego Bay, Mission Bay, various coastal lagoons and estuaries). The extrapolation of these freshwater species tests to evaluate the potential impact in the downstream marine/estuarine environments can be problematic. For example, the organic ligands present in an estuarine environment may make contaminants unavailable for uptake and reduce toxicity. In addition, marine organisms often have different sensitivities to contaminants than freshwater organisms.

Three species were used in this monitoring program. The cladoceran, *Ceriodaphnia dubia*, represents the invertebrates that live in the water column and serve as a source of food for larger invertebrates and small fish. This species is known to be sensitive to metals and pesticides in water, as well as other contaminants. The freshwater amphipod, *Hyalella azteca,* is an invertebrate that is associated with the sediment at the bottom of streams and lakes. It again serves as a food source for larger invertebrates as well as fish. This species is generally sensitive to metals and pesticides, as well as nitrogen compounds such as ammonia. *Hyalella azteca* is also known to be sensitive to synthetic pyrethroids in low concentrations that tend to bind to sediments (Amweg et al., 2005; Anderson et al., In Press; and Maund et al., 2002). The freshwater plant, *Selenastrum capricornutum,* is a unicellular algae that is present in the water column of lakes and streams. It is at the base of the food chain in freshwater systems. It is sensitive to herbicides and metals, but its growth is also greatly affected by nutrient loads (e.g., nitrates and phosphorus) in a water body. Nutrients tend to stimulate the growth of *S. capricornutum* (causing an algal bloom) and, if the nutrient loads are high enough in a water body, they can offset the toxic effect that contaminants might otherwise produce. All toxicity tests were conducted by Weston's laboratory in Carlsbad, California.

Ceriodaphnia dubia

Samples from mass loading stations were tested for toxicity according to the USEPA protocol (EPA-821-R-02-013). This protocol was developed for testing the chronic toxicity of point-source discharges where the effluent is diluted considerably in the receiving waters. Laboratory test organisms are placed in small containers of effluent sample and monitored over time to compare the response of organisms placed in non-toxic control water to the sample water. The sample is diluted (with control water) to several known concentrations before the test and test organisms are added to each concentration. The standard USEPA recommended dilution series (100%, 50%, 25%, 12.5%, 6.25%, and a control) are used for all toxicity tests. The test solutions are renewed and test organisms are fed daily. In the *Ceriodaphnia* chronic test, single females are placed in individual test chambers (ten test chambers per concentration) and the number of dead organisms along with the number of offspring produced per organism is recorded each day. When the controls reach an average of at least fifteen young per surviving adult, and 60% of the controls have had three broods, the test is terminated (day six to eight). Additionally, the acute, 96-hour (4-day) endpoint data (survival) is also collected from the seven-day chronic test. Only the original test organisms with which the test was begun were used for the calculation of both the acute and chronic survival endpoints.

Test Acceptability

Acceptability of the test is determined by evaluating the response of the control organisms. The test is considered acceptable if control survival is greater than 80%, control reproduction is greater than or equal to an average of fifteen young per adult, and more than 60% of the adults produce three broods by day eight of the test. If any one of these test acceptability standards is not met then the test is considered invalid and no further analysis is performed.

A reference toxicant test is also run to establish whether the test organisms used fall within the normal range of sensitivity. The reference toxicant test is conducted with known concentrations of a given toxicant (e.g., copper sulfate is used for *Ceriodaphnia*). The effect on the survival and reproduction of the test organisms is compared to historical laboratory data for the test species and reference toxicant. If the values are within two standard deviations of the historical average, the test organisms are considered to fall within the normal range of sensitivity.

The concentration that causes 50% mortality of the organisms (the median lethal concentration, or LC_{50}) is calculated from the data for 96 hours (96-hour acute LC_{50}) and for day seven (seven-day chronic LC_{50}) using USEPA methods. The LC_{50} values are point-estimates expressed as "percent sample;" the lower the LC_{50} percentage the more toxic the sample. For acute and chronic regulatory standards, the No Observed Effect Concentration (NOEC), for both survival and reproduction is calculated. This is the highest concentration tested in which there was no effect on the survival or reproduction compared to the control response. The lower the NOEC, the more toxic the sample.

Hyalella azteca

Storm water samples from each of the mass loading stations were also evaluated for acute toxicity using the freshwater amphipod, *Hyalella azteca,* according to a modified version of the USEPA protocol for testing sediment-associated contaminants with freshwater invertebrates (EPA-821-R-02-012). This protocol provides test methods for measuring acute toxicity in *Hyalella* exposed to freshwater sediments, as well as a test method for conducting a water-only acute reference toxicant test. The reference toxicant test protocol was modified to conduct the toxicity testing on samples collected from the mass loading stations. The test solution is prepared using the dilution series described above, and placed in 250-mL aliquots into 4 replicate test chambers. Clean sand is placed as a thin "monolayer" in the bottom of the test chamber and 10 organisms per replicate are added. The test organisms are exposed for four days and fed on day 2. At the end of the test, the survivors are removed from the sand and counted. A 96-hour LC_{50} is calculated from this data.

Prior to analysis of the data, test acceptability is determined by evaluating the response of the control organisms. The test is considered invalid if survival of control test organisms is less than 90%. As with *Ceriodaphnia*, a reference toxicant test using copper sulfate is also conducted with *Hyalella* to establish whether the test organisms used fall within the normal range of sensitivity. If the test data meet acceptability criteria, the LC_{50} is calculated from the 96-hour test data. Values are reported as the NOEC for the purposes of this report.

Selenastrum capricornutum*

In years prior to 2001, toxicity testing for the storm water monitoring program was conducted using a freshwater vertebrate species: the fathead minnow (*Pimephales promelas*). Results of tests conducted with this species failed to show any toxicity relative to the other species tested. Consequently, the San Diego Regional Water Quality Control Board (RWQCB) approved the replacement of this test with a chronic *Hyalella* toxicity test measuring a sublethal endpoint (e.g., growth). Attempts to develop a short-term sublethal toxicity test with *Hyalella* during the 1999-2000 and 2000-2001 storm seasons proved unsuccessful, due to the variability of the growth

* The name of this species has been changed to *Pseudokirchneriella subcapitata*, however, *Selenastrum capricornutum* will continue to be utilized for the purposes of continuity with previous testing.

endpoint. Consequently, it was recommended and the RWQCB subsequently approved replacing the proposed *Hyalella* chronic test with the *Selenastrum capricornutum* chronic test. This algal species has the potential to be sensitive to metals (in waters low in nutrients) and herbicides.

Samples from the mass loading stations were tested for toxicity according to the USEPA protocol (EPA-821-R-02-013) using the unicellular algae *Selenastrum*. This protocol was developed for testing the 96-hour chronic toxicity of point-source discharges. The sample and the control water are spiked with equal amounts of nutrients and subsequently filtered to remove any unicellular algae that might be present prior to test initiation. The concentration series is prepared and 50-mL aliquots are placed into four replicate test chambers. Approximately 10,000 cells per mL are added to the test chamber and placed in random order under high-intensity 24-hour light for four days. The test chambers are shaken twice and randomized daily. At the end of the test period, chambers are analyzed for chlorophyll *a* concentrations (fluorescence).

Test acceptability is determined by evaluating the response of the control organisms. The test is considered invalid if the criterion of a mean cell density of 1,000,000 cells per mL in the control is not met. Variability between the control replicates should not exceed 20%. A reference toxicant test using copper sulfate is also run parallel with the test to establish the sensitivity of the organisms.

Alterations to the *S. capricornutum* testing protocol were put into effect with the promulgation of the updated EPA guidelines in October 2002. The most significant changes to the protocol involve the addition of ethylenediaminetetraacetic acid (EDTA) as a component of the nutrient stock for conducting the test. The addition of EDTA has been determined to greatly reduce the incidences of false positives and increase the precision of the test method. This chemical has the ability of reducing the toxicity of certain metals by making them unavailable to the test organism. The guidance document warns that this method may underestimate the toxicity of metals and should be used in conjunction with multiple species tests, such as in this program, to monitor toxicity. Another alteration to test protocol was increasing the acceptability criterion of a mean cell density 200,000 algal cells per mL in the control to 1,000,000 cells per mL.

If the test data meet acceptability criteria, inhibition concentrations, an IC_{25} and an IC_{50}, are calculated from the data: the concentrations that cause a 25% or 50% inhibition in the growth, or cell density, of the algae. A NOEC is also calculated from this data and is used for reporting purposes.

B.1.6.3 Microbiology Testing

Measures of bacteria from grab samples were made by the Weston microbiology laboratory located in Carlsbad, California. Samples were collected during the each monitoring event using grab poles and aseptic techniques by Weston's field technicians and scientists and delivered to the microbiology laboratory within the six hour holding time requirement. Sample analyses were initiated immediately upon receipt for all three indicators by multiple tube fermentation; total coliform using SM 9221B, fecal coliform using SM 9221E, and enterococcus using SM 9230B. All results were reported to a most probable number value (MPN/100 mL). "Greater than" values were utilized for MPN values that exceeded 16,000,000.

B.2 Rapid Stream Bioassessment Methods

Weston conducted stream bioassessment pursuant to RWQCB Order No. 2001-01 to assess the ecological health of the watershed units in San Diego County. The assessment was undertaken utilizing a protocol that samples and analyzes populations of benthic macroinvertebrates (BMIs). For the 2008–2009 program, Weston followed the sampling protocols of the Surface Water Ambient Monitoring Program Standard (SWAMP) *Operating Procedures for Collecting Benthic Macroinvertebrates and Associated Physical and Chemical Data* (Ode, 2007) for field collections and also incorporated the Stormwater Monitoring Coalition (SMC) Regional Monitoring of Southern California's Coastal Watersheds work plan (SCCWRP 2007).. Taxonomic identifications were to standard taxonomic level II (Genus level for most insects, Class or Order for most non-insects) as defined by the most recent version of the *Southwestern Association of Freshwater Invertebrate Taxonomists List of Macroinvertebrate Taxa from California and Adjacent States and Ecoregions; and Standard Taxonomic Effort* (SAFIT, 2006).

The SWAMP sampling protocol includes the collection of stream benthic macroinvertebrates and also assesses the quality and condition of the physical habitat in detail (note: a physical habitat index based on the SWAMP procedure has not been developed at the time of this report). Benthic macroinvertebrates reside in streams for periods ranging from a month to several years, and have varying sensitivities to the multiple stressors associated with urban runoff. Utilizing species specific tolerance values and community species composition, numerical biometric indices are calculated, allowing for comparison of relative habitat health among streams in a region. By assessing the invertebrate community structure of a stream, a cumulative measure of stream habitat health and ecological response is obtained.

This report presents the results from stream bioassessment surveys conducted in May 2009 as well as summary data since the beginning of the program in 2001. The data include a taxonomic listing of all benthic macroinvertebrates identified in the surveys, and calculation of the biological metrics listed in the CSBP. Additionally, calculation of two indices that rate the overall BMI community quality was performed. These included the Index of Biotic Integrity (IBI) (Ode et al., 2005) and the O/E ratio of Observed to Expected taxa.

Benthic macroinvertebrate sampling

B.2.1 Monitoring Reaches

From 2001 to 2007, a minimum of 23 monitoring reaches were sampled in each survey, including three reference sites per survey. In 2009, the program was re-structured and a total of 16 monitoring reaches were sampled. The sites were selected in a stratified random approach and in coordination with the SMC regional monitoring program. The three strata were designated Urban, Agricultural, and Open. Descriptions of the locations are presented in Table B-1.

In 2009, there were no designated reference sites sampled. Historically, reference sites have been designated by CDFG and the RWQCB based on upstream land use characteristics as determined by GIS datasets. When selecting reference monitoring sites for comparison with urban affected sites, elevation was considered, and most of the reference sites were at similar elevation to the urban sites. One exception was the Doane Creek reference site (REF-DC), located on Palomar Mountain at an elevation of nearly 5,000 feet. It may be noted that the locations of the reference sites was in the upper erosional portion of the hydrologic units while the test monitoring sites were generally in lower depositional areas and this may affect benthic community composition independent of water quality.

Comparison of urban monitoring sites to reference sites is not limited to the three reference sites sampled in this program. The benthic community summary indices (described below in Section B2.8) that provide community quality ratings already incorporate a broad range of historical reference sites throughout the region. For example, Ode et al. used 275 different reference sites to develop the Index of Biotic Integrity, and the scoring criteria are based on mean metric values for all of these sites. Reference sites monitored concurrently with the urban sites provide a direct temporal correlation that includes seasonal environmental variables (e.g., rainfall).

Table B-4. San Diego County: Stream Bioassessment Monitoring Sites (June 2001–May 2009)

Watershed Name	Receiving Water	Station Identification	Site Description	Station Coordinates	Jun-01	Oct-01	May-02	Oct-02	May-03	Oct-03	May-04	Oct-04	May-05	Oct-05	May-06	Oct-06	May-07	May 08	May 09
Reference Sites																			
Santa Margarita River	Sandia Creek	REF-SC	Reach consisted of 5 riffles along Sandia Creek Drive	33 25.482' 117 14.942'	x	x	x	x	x	x									
Santa Margarita River	Sandia Creek	REF-SC2	Reach consisted of 5 riffles along De Luz Road	33 29.529' 117 16.020'							x	x	x	x	x	x	x	x	
Santa Margarita River	Sandia Creek	REF-SCCR	Reach consisted of 5 riffles downstream of Carancho Road	33 29.529' 117 16.020'		x													
Santa Margarita River	San Mateo Creek	REF-SMC	Reach consisted of 3 riffles upstream of San Mateo Road	33 25.248' 117 32.000'	x														
Santa Margarita River	De Luz Creek	REF-DLC	Reach consisted of 5 riffles downstream of De Luz Road	33 26.483' 117 19.434'	x		x		x	x	x								
Santa Margarita River	De Luz Creek	REF-DLC3	Reach consisted of 5 riffles along De Luz-Murietta Road	33 27.574' 117 17.456'				x		x		x							
San Luis Rey River	Doane Creek	REF-DC	Reach consisted of 5 riffles upstream of Doane Pond in Palomar Mt. State Park	33 20.124' 116 53.496'							x	x	x	x	x	x	x	x	
San Luis Rey River	Keys Creek	REF-KC	Reach consisted of 5 riffles at Old Lilac Road	33 17.744' 117 05.149'		x	x	x											
San Diego River	Boulder Creek	REF-BCR	Reach consisted of 5 riffles upstream of Boulder Creek Road	32 57.827' 116 39.731'										x	x	x	x	x	
San Diego River	Cedar Creek	REF-CC	Reach consisted of 5 riffles upstream of Cedar Creek Road	33 01.154' 116 38.029'					x										
Tijuana River	Wilson Creek	REF-WC	Reach consisted of 5 riffles upstream of Lyons Valley Road	32 42.449' 116 44.231'									x						
Urban Influenced Sites																			
Santa Margarita River	Santa Margarita River	SMR-WGR	Reach consisted of 5 riffles upstream of Willow Glen Road	33 25.614' 117 11.861'				x	x	x	x	x	x	x	x	x	x	x	
Santa Margarita River	Rainbow Creek	RC-WGR	Reach consisted of 150 meters upstream of Willow Glen Road	33 24.468' 117 12.109'														x	
Santa Margarita River	Santa Margarita River	SMR-MIS-2 (SMR-DLR)	Reach consisted of 5 riffles downstream of De Luz Road	33 23.844' 117 15.734'				x										x	
Santa Margarita River	Santa Margarita River	SMR-CP	Reach consisted of 5 riffles downstream of Santa Margarita Road, Camp Pendleton	33 20.457' 117 19.897'					x	x	x	x	x	x	x	x	x		
San Luis Rey River	San Luis Rey River	SMC 01717	Reach consisted of 150m of stream length	33.340147' 117.132327'															x
San Luis Rey River	Key's Creek	SMC 01909	Reach consisted of 150m of stream length	33.311289' 117.138853'															x
San Luis Rey River	Moosa Canyon Creek	SMC 00457	Reach consisted of 150m of stream length	33.233704' 117.093917'															x
San Luis Rey River	San Luis Rey River	SMC 00153	Reach consisted of 150m of stream length	33.221932' 117.346118'															x
San Luis Rey River	San Luis Rey River	SLR-MLS (SLRR-BR)	Reach consisted of 2 riffles near the USGS gauging station at Benet Road	33 13.095' 117 21.569'			x	x	x	x	x	x	x	x	x	x	x	x	
San Luis Rey River	San Luis Rey River	SLR-TWAS-1 (SLRR-MR)	Reach consisted of 3 riffles upstream of Mission Road	33 15.587' 117 14.176'	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Carlsbad	Loma Alta Creek	LAC-ECR	Reach consisted of 3 riffles up and downstream of El Camino Real	33 11.995' 117 19.878'	x	x	x	x											
Carlsbad	Loma Alta Creek	LAC-CB	Reach consisted of 5 riffles of College Blvd.	33 12.363' 117 17.087'	x	x	x												
Carlsbad	Loma Alta Creek	LAC-TWAS-1	Reach consisted of 150 meters downstream of I-5	33 11.301' 117 21.697														x	
Carlsbad	Buena Vista Creek	BVC-TWAS-1 (BVR-ED)	Reach consisted of 5 riffles downstream of Santa Fe Av.	33 10.840' 117 19.717'	x	x	x											x	
Carlsbad	Buena Vista Creek	BVR-CB	Reach consisted of 5 riffles downstream of College Blvd.	33 10.809' 117 17.918'		x	x	x		x						x			
Carlsbad	Buena Vista Creek	BVR-SVW	Reach consisted of 5 riffles downstream of South Vista Way.	33 10.840' 117 19.713'	x														
Carlsbad	Agua Hedionda Creek	AHC-TWAS-1 (AHC-MR)	Reach consisted of 5 riffles upstream of Melrose Road	33 09.132' 117 14.454'	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Carlsbad	Agua Hedionda Creek	AHC-MLS (AHC-ECR)	Reach consisted of 5 riffles downstream of El Camino Real	33 08.940' 117 17.830'	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Carlsbad	San Marcos Creek	SMC-M	Reach consisted of 5 riffles upstream of McMahr Road	33 07.831' 117 11.575'	x	x	x												
Carlsbad	San Marcos Creek	SMC-SP	Reach consisted of 5 riffles downstream of Santar Place	33 08.501' 117 08.740'	x	x	x												
Carlsbad	San Marcos Creek	SMC-RSFR	Reach consisted of 4 riffles downstream of Rancho Santa Fe Road	33 06.191' 117 13.609'	x	x	x												
Carlsbad	San Marcos Creek	SMC-LCCC	Reach consisted of 5 riffles upstream of La Costa Country Club	33 05.466' 117 14.664'	x	x	x	x				x							
Carlsbad	San Marcos Creek	SMC 00729	Reach consisted of 150m of stream length	33.135252' 117.174887'															x
Carlsbad	Encinitas Creek	ENC-GVR	Reach consisted of 3 riffles southwest of El Camino Real and La Costa Blvd	33 04.697' 117 16.000'	x	x	x												
Carlsbad	Cottonwood Creek	CC-E	Reach consisted of 4 riffles downstream of Hwy 101 along Encinitas Blvd.	33 02.905' 117 17.629'	x	x	x												
Escondido Creek	Escondido Creek	ESC-HRB	Reach consisted of 5 riffles downstream of Harmony Grove Bridge	33 06.550' 117 06.688'	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Escondido Creek	Escondido Creek	ESC-TWAS-1 (ESC-CC)	Reach consisted of 5 riffles downstream of Country Club Road	33 05.925' 117 07.836'			x											x	
Escondido Creek	Escondido Creek	ESC-EF	Reach consisted of 5 riffles downstream of the old Elfin Forest Resort	33 04.417' 117 09.853'	x	x	x	x	x	x	x	x	x	x	x	x	x		
Escondido Creek	Escondido Creek	ESC-VC	Reach consisted of 5 riffles in Vista Canyon	33 03.617' 117 10.802'			x												
Escondido Creek	Escondido Creek	ESC-MLS	Reach consisted of 150 meter reach upstream of El Camino del Norte	33 02.912' 117 13.543															
Escondido Creek	Escondido Creek	ESC-RSFR	Reach consisted of 3 riffles upstream of Rancho Santa Fe Road	33 02.365' 117 13.837'	x	x	x												
San Dieguito River	San Dieguito River	SDC-TWAS-2	Reach consisted of 150 meters upstream of Lake Hodges	33 03.637 117 01.869														x	
San Dieguito River	San Dieguito River	SMC 00473	Reach consisted of 150m of stream length	33.039165' 117.158029'															x
San Dieguito River	Green Valley Creek	SDC-TWAS-1 (GVC-WB)	Reach consisted of 5 riffles downstream of West Bernardo Drive	33 02.625' 117 04.567'				x	x	x	x	x	x	x	x	x	x	x	
San Dieguito River	San Dieguito River	SDC-MLS	Reach consisted of 150 meters at Morgan Run Golf Course	32. 59.743' 117 12.378'														x	

Table B-4. San Diego County: Stream Bioassessment Monitoring Sites (June 2001–May 2009)

Watershed Name	Receiving Water	Station Identification	Site Description	Station Coordinates	Jun-01	Oct-01	May-02	Oct-02	May-03	Oct-03	May-04	Oct-04	May-05	Oct-05	May-06	Oct-06	May-07	May 08	May 09
San Dieguito River	San Dieguito River	SD-DDH	Reach consisted of 5 riffles along Del Dios Highway downstream of Lake Hodges	33 02.459' 117 08.595'				x	x	x	x	x	x	x	x	x	x		
Los Peñasquitos Creek	Los Peñasquitos Creek	LPC-CCR	Reach consisted of 5 riffles upstream of Cobblestone Creek Road	32 56.949' 117 04.214'	x	x	x		x	x	x	x	x	x	x	x	x		
Los Peñasquitos Creek	Los Peñasquitos Creek	LPC-TWAS-2	Reach consisted of 150 meters upstream of Springbrook Dr.	33 56.553' 117 05.018'														x	
Los Peñasquitos Creek	Los Peñasquitos Creek	LPC-BMR	Reach consisted of 5 riffles downstream of Black Mountain Road	32 56.349' 117 07.864'	x	x	x	x											
Los Peñasquitos Creek	Los Peñasquitos Creek	LPC-MLS (LPC-805)	Reach consisted of 5 riffles upstream of I-805 at Mass Load Station	32 54.288' 117 13.379'												x	x	x	
Los Peñasquitos Creek	Carroll Canyon Creek	LPC-TWAS-1 (CCC-805)	Reach consisted of 5 riffles downstream of I-805 at Sorrento Valley Road	32 53.403' 117 12.717'	x	x	x	x	x	x	x	x	x	x	x			x	
Los Peñasquitos Creek	McGonigle Canyon Creek	SMC 01158	Reach consisted of 150m of stream length	33.962813' 117.166763'															x
Los Peñasquitos Creek	Los Peñasquitos Creek	SMC 00198	Reach consisted of 150m of stream length	33.937095' 117.138512'															x
Los Peñasquitos Creek	Soeldad Canyon Creek	SMC 00710	Reach consisted of 150m of stream length	33.889342' 117.200282'															x
Mission Bay	Rose Creek	MB-RC	Reach consisted of 5 riffles downstream of Highway 52	32 50.056' 117 13.887'				x	x	x	x	x	x	x	x	x	x		
Mission Bay	Rose Creek	SMC 01606	Reach consisted of 150m of stream length	32.841989' 117.234811'															x
Mission Bay	Tecolote Creek	TC-TCNP	Reach consisted of 4 riffles downstream of Mt. Acadia Blvd	32 47.874' 117 11.339'	x	x	x	x	x	x	x	x	x	x	x	x	x		
Mission Bay	Tecolote Creek	SMC 01046	Reach consisted of 150m of stream length	32.795095' 117.184945'															x
San Diego River	Forester Creek	SMC 02006	Reach consisted of 150m of stream length	32.830830' 116..984864'															x
San Diego River	San Diego River	SMC 04054	Reach consisted of 150m of stream length	32.836979' 117.018746'															x
San Diego River	San Diego River	SDR-MT	Reach consisted of 5 riffles in Mission Trails Park	32 49.249' 117 03.866'			x	x	x	x	x	x	x	x	x	x	x		
San Diego River	Murphy Canyon Creek	SMC 01990	Reach consisted of 150m of stream length	32.796538' 117.113274'															x
San Diego River	San Diego River	SDR-1	Reach consisted of 5 riffles downstream of Mission Valley Golf Course	32 45.736' 117 11.557'			x	x	x	x	x	x	x	x	x	x	x		
San Diego Bay	Chollas Creek	CC-FB	Reach consisted of 5 riffles downstream of Federal Boulevard	32 43.606' 117 04.219'					x	x	x	x	x	x	x	x	x	x	
Sweetwater River	Sweetwater River	SMC 00282	Reach consisted of 150m of stream length	32.871805' 116.613578'															x
Sweetwater River	Long Canyon Creek	SR-AD	Reach consisted of 5 riffles along Acacia Drive	32 39.394' 117 00.800'				x											
Sweetwater River	Sweetwater River	SR-WS	Reach consisted of 5 riffles along Bonita Road	32 39.436' 117 02.717'			x		x	x	x	x	x	x	x	x	x		
Sweetwater River	Sweetwater River	SR-94	Reach consisted of 5 riffles at Highway 94	32 44.005' 116 56.348'			x			x	x		x	x	x	x	x		
Sweetwater River	Sweetwater River	SMC 01258	Reach consisted of 150m of stream length	32.649495' 116.058868'															x
Tijuana River	Campo Creek	CC-C	Reach consisted of 4 riffles up/downstream of H94 bridge in Campo	32 36.552' 116 26.448'							x	x	x	x	x	x	x		
Tijuana River	Campo Creek	CC-H94	Reach consisted of 4 riffles at the Highway 94 USGS gauging station	32 35.456' 116 31.551'					x										
Tijuana River	Tijuana River	TJ-BF	Reach consisted of 2 riffles near the International Boundary border fence	32 32.539' 117 02.619'													x		
Tijuana River	Tijuana River	TJ-DM	Reach consisted of 5 riffles upstream of Dairy Mart Road	32 32.816' 117 03.741'					x				x		x				

B.2.2 Monitoring Reach Delineation

Using SWAMP methodology, every monitoring reach was 150 m in length and was sampled from downstream to upstream. Site coordinates were randomly selected and delineated the downstream margin of the sampling reach. If sampling could not begin within 300 meters of the nominal coordinates (i.e., the site was deeply ponded, obstructed, or dry) the site was rejected.

B.2.3 Macroinvertebrate Sample Collection

BMI samples were collected at evenly spaced 15-m transects for a total of 11 transects in the 150-m reach. The samples were collected in an alternating margin-center-margin pattern. Collections were made using a 1-ft-wide, 0.5-mm-mesh, D-frame kick-net. A 1-ft^2 area upstream of the net was sampled by disrupting the substrate and scrubbing the cobble and boulders, so that the organisms were dislodged and swept into the net by the current. The duration of the sampling generally ranged from 1 to 3 minutes, depending on substrate complexity. Every monitoring site was sampled from downstream to upstream. The samples were combined into a single composite sample for the reach, transferred to one-quart jars, preserved with 95% ethanol, and returned to Weston's laboratory for processing. Photographs were taken of every monitoring site.

B.2.4 Multihabitat Periphyton Sample Collection

Periphyton was collected using the reach-wide procedure and within the same transects used for benthic macroinvertebrate collection, but offset 1-m upstream to avoid disturbed substrate. Depending on the substrate type and stream habitat, one of three sampling devices was used to collect the substrate sample. If the sampling location was in an erosional habitat (e.g. rocks, wood, etc.), the substrate was collected and placed in a plastic washtub. A rubber delimiter was used to define a 12.6 cm^2 area on the upper surface of the substrate. A toothbrush was used to dislodge the attached algae from the substrate surface in the defined area and the detached algae were rinsed into the washtub using a wash bottle. If the sampling location was in a depositional habitat (e.g. sand, sediment gravel, etc.), a clean PVC delimiter with a diameter of 4 cm was pressed into the top 1 cm of the substrate. A clean spatula was placed beneath the delimiter to assisting in containing the substrate and the contents were transferred to the washtub. If the sampling point was on substrate that could not be removed from the water (e.g. bedrock, boulder, concrete, etc.), a "syringe scrubber" (Davies and Gee, 1993) was used to collect algae from the surface. If the sampling point was on a mat of macroalgae, the PVC delimiter and spatula were used to cut a circle out of the mat. Once all transects were sampled, the collected substrate was massaged to dislodge any algae. The algae and remaining liquid were then collected into a clean sample bottle and the volume was recorded. The liquid portion of the composite was filtered in the field and the filters were placed on ice and/or frozen until delivery to the analytical laboratory.

B.2.5 Physical Habitat Quality Assessment

Physical habitat assessment

For each monitoring reach sampled, the physical habitat of the stream and its adjacent banks were assessed to provide a record of the overall physical condition of the reach. Parameters such as substrate complexity, channel alteration and human influence, frequency of riffles, and width and quality of riparian zones help to provide a more comprehensive understanding of the condition of the stream. Additionally, specific characteristics of the sampled riffles were measured, including substrate size classes, stream depth, gradient, sinuosity, and flow volume.

Water quality measurements were taken at each of the monitoring sites using a YSI Model 6600 environmental monitoring system. Measurements included water temperature, specific conductance, pH, and dissolved oxygen. Samples were collected for laboratory analysis of alkalinity. Stream flow velocity was measured with a Marsh-McBirney Model 2000 portable flow meter, or was visually estimated when the water was too shallow for the flow meter.

B.2.6 Laboratory Processing and Analysis

At the laboratory, samples were poured over a No. 35 standard testing sieve (0.5-mm stainless steel mesh), and the ethanol was retained for re-use. The sample was gently rinsed with fresh water, and large debris, such as wood, leaves, or rocks was removed. The sample was transferred to a tray marked with grids approximately 50 cm^2 in size. One grid was randomly selected, and the sample material contained within that grid was removed and processed. In cases where the test organisms appeared extremely abundant, a fraction of the grid may have been removed. The material from the grid was examined under a stereomicroscope, and all the invertebrates were removed, sorted into major taxonomic groups, and placed in vials containing 70% ethanol. If there were less than 600 test organisms in the grid, another grid was selected and processed. This process was repeated until 600 organisms were removed from the sample, or until the entire sample was sorted. Organisms from a grid in excess of the 600 were counted and placed in a separate vial labeled “remaining test organisms,” so that estimated total organism abundance and density for the sample could be calculated. Terrestrial organisms, vertebrates, water-column associated organisms (e.g., copepods), and nematodes were not removed from the samples. Processed material from the sample was placed in a separate jar and labeled “sorted,” and the unprocessed material was returned to the original sample container and archived. Sorted material was retained for quality assurance purposes.

All organisms were identified to SAFIT standard taxonomic level II. Quality assurance of sample sorting was performed on all of the samples to ensure at least a 95% removal rate of organisms. Taxonomic quality assurance was performed on 10% of the samples by taxonomists at the CDFG Aquatic Bioassay Laboratory in Rancho Cordova, CA.

B.2.7 Data and Statistical Analysis

A taxonomic list of BMIs identified from the samples was created using Microsoft Excel. Metric values based on the BMI community were calculated from the database. A list of these metric values is presented in Table B-5, including a brief description of what they signify and how they respond to ecological stressors.

For every monitoring reach, an Index of Biotic Integrity (IBI) was calculated utilizing the most recent method developed by CDFG (Ode et al., 2005). The IBI is derived from seven individual metrics and gives a numeric value to the benthic community based on the range of reference conditions in the region. The IBI scores are then classified into quality rating categories that range from Very Poor to Very Good. The IBI can also be used to evaluate community conditions over time to monitor the effects of habitat degradation or the success of restoration efforts.

Additional analysis of the data included an analysis of the trends of the monitoring results since the beginning of the program in May 2001 and calculation of the O/E ratio. Like the IBI, the O/E approach produces an easily understood and ecologically meaningful summary of the biological condition at a site. The O/E ratio is the number of taxa observed ("O") at a test site compared to the number of taxa expected to occur ("E") based on local reference conditions. O/E ratio values can theoretically vary from over 1 (better than mean reference conditions) to zero (completely degraded - all expected taxa are missing). O/E is not based on raw taxa richness. Instead, O/E is constrained to include only those taxa predicted to naturally occur at a site (e.g., non-native taxa are generally excluded from the analysis). The relative value of each taxon observed is not equal and each has a predetermined percent probability of capture and a sensitivity index that factor into the results. The predictive model for most San Diego County sites is associated with warm, dry, flashy stream types. This model uses the classification variables of longitude, percent sedimentary bedrock, and long-term mean annual precipitation. This model works well for low gradient depositional coastal streams that are dominated by fine particulate sediment.

Table B-5. Bioassessment Metrics Used to Characterize BMI Communities

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	Decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	Decrease
Dipteran Taxa	Number of taxa in the insect order (Diptera, "true flies")	Increase
Non-Insect Taxa	Number of non-insect taxa	Increase
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae	Decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae with tolerance values between 0 and 3	Decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver, 1962)	Decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	Increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	Increase
Percent Chironomidae	Percent composition of the tolerant dipteran family Chironomidae	Increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	Decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	Increase
Functional Feeding Groups (FFG)		
Percent Collector-gatherers	Percent of macrobenthos that collect or gather fine particulate matter	Increase
Percent Collector-filterers	Percent of macrobenthos that filter fine particulate matter	Increase
Percent Scrapers	Percent of macrobenthos that graze upon periphyton	Variable
Percent Predators	Percent of macrobenthos that prey on other organisms	Variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	Decrease
Percent Others	Percent of macrobenthos that are parasites, macrophyte herbivores, piercer herbivores, omnivores, and xylophages	Variable
Abundance		
Estimated Abundance	Estimated number of BMIs in sample calculated by extrapolating from the proportion of organisms counted in the subsample	Variable
Source: SDRWQCB, 1999		

B.3 Ambient Bay and Lagoon Monitoring

The Ambient Bay, Lagoon, and Coastal Receiving Water Monitoring Program (ABLM) completed three years of monitoring during the summer of 2005. The data collected under this program were evaluated to determine if any linkage was observed between sediment conditions in the bays, estuaries, and lagoons and the freshwater conditions at upstream mass loading stations. A final report was prepared and was included as Appendix J in the San Diego County Municipal Copermittees 2005–2006 Urban Runoff Monitoring Report (Weston, 2007).

The ABLM program was not conducted during the 2007–2008 monitoring seasons. Per the June 12, 2008 letter from John Robertus of the SDRWQCB, the Copermittees were allowed to redirect the 2007-2008 resources from the ABLM program towards Bight 08 on the eutrophication study in the San Diego Lagoons.

B.4 Watershed Management Area Assessment and Long-Term Effectiveness Assessment Rating Methods

B.4.1 Watershed Management Area Assessment Methods

With the implementation of the new monitoring program design, the Copermittees are faced with assessing new data sets with the goal of complying with the permit and that will provide information that leads to reasonable management actions. The Copermittee Monitoring Workgroup recognizes that the data assessment process needs to transition to assess new data under the new permit. The monitoring workgroup will be reviewing the data assessment process during 2009. For the purposes of this report, interim watershed data assessments were prepared using the interim guidance document "Watershed Data Assessment Framework" (June 2004) which closely resembles the "Model Storm Water Monitoring Program for Municipal Separate Storm Sewer Systems in Southern California" developed by the Storm Water Monitoring Coalition's (SMC) Model Monitoring Technical Committee. A complete description of methods and tools used to perform the watershed assessment can be found in the guidance document. The monitoring workgroup will be reviewing the data assessment process during 2009 to develop an assessment process for future monitoring reports.

The watershed assessments are intended to provide a management tool for Copermittees to utilize in the development of short and long-term actions to address potential or actual water quality problems in the watershed. During the annual water quality assessment, the high, medium or low frequency of occurrence for constituents of concern (COC(s)) is evaluated for each watershed using the latest data collected and potential water quality issues are determined. In some cases confirmation of water quality problems will require that additional data be collected or assessed to understand the extent of the problem. Additional information to assess if a water quality problem exists may be available from third party data or a special study that can be used to answer questions relating to sources of the COC(s). In some instances, data from third parties or special studies may be used to further define the problem both spatially and temporally. The watershed assessment process leads to a prioritization of water quality issues by individual Watershed Copermittees and should assist them in short and long-term planning efforts, and developing activities directed at maintaining or improving water quality.

The watershed assessment methodology was designed around the previous monitoring program under Order 2001-01 and primarily assessed storm event concentrations, toxicity, and bioassessment data. The Copermittees monitoring program under Order R9-2007-0001 presented significant changes to the monitoring program and includes the addition of temporary watersheds assessment stations (TWAS), ambient monitoring events, and a rotational schedule between the north and south portions of the County. The previous watershed assessment framework did not include ambient condition assessments. However, the framework was modified to include an ambient assessment and likely provides a more complete assessment of the general ecological conditions in receiving waters and the relation to urban runoff impacts.

The watershed assessment process can be broken into seven steps:

1) Compare chemistry results to water quality benchmarks and action levels
2) Examine exceedance percentages, bioassessment rankings and toxicity results
3) Apply the Interim Criteria Ranking System to results
4) Evaluate third party data and 303(d) listing information
5) Examine any available trend information
6) Apply triad decision matrix to data
7) Identify priorities and recommend actions

Watershed area assessments occur in a three fold process:

1) Wet weather data assessments are conducted
2) Dry weather data assessments are conducted
3) An integrated data assessment of items 1 and 2 are presented

Receiving Water Monitoring Data

Wet weather and ambient chemistry data (physical, chemical, and bacteriological measurements) from the MLS and TWAS were compared to the water quality benchmarks shown in Table B-6 to determine constituent exceedances. The benchmark source information with associated links to documents (where available) is provided in Table B-7. Wet weather sample data are compared to the wet weather benchmarks and ambient sample data are compared to the ambient benchmarks. The tables are not inclusive of all analytical measurements that can be conducted, but represent the constituents that are most common to water quality monitoring and those that are required by the permit. If other chemistry data are available, the appropriate standards or water quality benchmarks are identified. In general, water quality objectives are defined in the San Diego County Copermittee program as benchmarks for comparison to monitoring results and do not necessarily reflect regulatory compliance for municipal storm water discharges.

In order to allow for comparison of wet weather data with exceedances at jurisdictional dry weather monitoring program stations (DWS), for which different Action Levels are used, modifications were made to the wet weather benchmarks for bacterial indicators. Wet weather results were compared against the dry weather action levels to determine exceedances for total coliforms and enterococci.

The benchmarks utilized are the same across all watersheds in San Diego County except for total dissolved solids and fecal coliform. Total dissolved solids benchmarks are applied by hydrologic area or hydrologic sub-area as noted in the 1994 Basin Plan. Fecal coliform REC-2 standards are applied at Tecolote Creek, Chollas Creek, and Tijuana River, while REC-1 standards are used for all other watersheds.

The California Toxics Rule (CTR) metals criteria are used for the water quality benchmarks for metals results. Previous annual monitoring reports compared total metals to a dissolved metals criteria after applying a conversion factor. The dissolved metals criteria are used because they are biologically available. Because this program analyzes for dissolved metals, only the dissolved metals criteria are applied. This may result in some previously identified total metals identified as priority constituents to be removed from the diamond rating tables for establishing frequency of occurrence.

Table B-6. Water Quality Benchmarks for use in the San Diego County Regional Copermittee Monitoring Program

Constituent	Units	Wet Weather Water Quality Benchmark	Ambient Water Quality Benchmark	Source
General / Physical / Organic				
Electrical conductivity	µmhos/cm	NA	900-1,600-2,200 Varies by Watershed	2. CCR, 5. Goldbook
Oil and grease	mg/L	10	10	1 Basin Plan, 3. Anacostia River TMDL, 4. MSGP 2000
pH	pH Units	6.5-9.0	6.5-9.0	1. Basin Plan
Bacteriological				
Enterococci	MPN/100 mL	NA	151	1. Basin Plan
Fecal coliform	MPN/100 mL	400/4,000	400/4,000	1.Basin Plan REC-1/REC-2
Total coliform	MPN/100 mL	NA	NA	1. Basin Plan (Bays and Estuaries and Shell Criteria)
Wet Chemistry				
Ammonia As N	mg/L	CMC (Salmonids Absent) Calculation based on pH, Temp	CCC (early life stages present) Calculation based on pH, Temp	6. U.S. EPA Water Quality Criteria (Freshwater)
Biochemical oxygen demand	mg/L	30	10	4. MSGP 2000, 8. McNeeley (1979)
Chemical oxygen demand	mg/L	120	120	4. MSGP 2000
Dissolved phosphorus	mg/L	2	0.1	4. MSGP 2000, 1. Basin Plan
Nitrate As N	mg/L	10	10	1. Basin Plan
Nitrite As N	mg/L	1	1	1. Basin Plan
Surfactants (MBAS)	mg/L	0.5	0.5	1. Basin Plan
Total dissolved solids	mg/L	500-2,100 (Varies by watershed)	500-2,100 (Varies by watershed)	1. Basin Plan
Total Kjeldahl nitrogen	mg/L	NA	NA	NA
Total nitrogen	mg/L	NA	1.0	1. Basin Plan
Total phosphorus	mg/L	2	0.1	4. MSGP 2000, 1. Basin Plan
Total suspended solids	mg/L	100	58	4. MSGP 2000, 14. NSQD, Basin Plan
Turbidity	NTU	20	20	1. Basin Plan
Pesticides				
Chlorpyrifos	µg/L	0.02 (acute) / 0.014 (chronic)	0.02 (acute) / 0.014 (chronic)	12. CA Dept. of Fish & Game, 2000
Diazinon	µg/L	0.08 acute / 0.05 chronic [Chollas 0.072 (acute) / 0.045 (chronic)]	0.08 acute / 0.05 chronic [Chollas 0.072 (acute) / 0.045 (chronic)]	12. CA Dept. of Fish & Game, 2000, 11. Chollas Creek TMDL for Diazinon, 10. U.S. EPA, Aquatic Life Ambient Water Quality Criteria Diazinon
Malathion	µg/L	0.43	0.43 acute / 0.1 chronic	13. CA Dept. of Fish & Game, 1998, 5. Goldbook
Synthetic Pyrethroids				
Allethrin	µg/L	NA	NA	NA
Bifenthrin	µg/L	0.0093	NA	15. Anderson et al. in press
Cyfluthrin	µg/L	0.344 µg/L; 0.20 µg/L with PBO	NA	17. Wheelock et al. 2004
Cypermethrin	µg/L	0.683 µg/L; 0.005 µg/L with PBO	NA	17. Wheelock et al. 2004
Danitol	µg/L	NA	NA	NA
Deltamethrin	µg/L	NA	NA	NA
Esfenvalerate	µg/L	0.25 µg/L; 0.21 µg/L with PBO	NA	17. Wheelock et al. 2004
L-Cyhalothrin	µg/L	0.20 µg/L; 0.005 µg/L with PBO	NA	17. Wheelock et al. 2004
Permethrin	µg/L	0.021	NA	15. Anderson et al. in press
Prallethrin	µg/L	NA	NA	NA
Piperonyl Butoxide	µg/L	650 µg/L	NA	18. El-Merhibi et al. 2004

Table B-6. Water Quality Benchmarks for use in the San Diego County Regional Copermittee Monitoring Program

Constituent	Units	Wet Weather Water Quality Benchmark	Ambient Water Quality Benchmark	Source
Hardness				
Total Hardness	mg $CaCO_3$/L	NA	NA	NA
Total Metals				
Antimony	mg/L	NA	0.006 for MUN water	1. Basin Plan
Arsenic	mg/L	NA	0.05 for MUN water	1. Basin Plan
Cadmium	mg/L	NA	0.005 for MUN water	1. Basin Plan
Chromium	mg/L	NA	0.05 for MUN water	1. Basin Plan
Copper	mg/L	NA	1.0 for MUN water	1. Basin Plan
Lead	mg/L	NA	NA	NA
Nickel	mg/L	NA	0.1 for MUN water	1. Basin Plan
Selenium	mg/L	NA	0.005	16. 40 CFR 131.38
Zinc	mg/L	NA	5.0 for MUN water	1. Basin Plan
Dissolved Metals				
Antimony	mg/L	0.006	0.006	1. Basin Plan
Arsenic	mg/L	0.34 (acute)	0.34 (acute) and 0.15 (chronic) / 0.05 for drinking water	16. 40 CFR 131.38
Cadmium	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38
Chromium	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38
Copper	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38
Lead	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38
Nickel	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38
Selenium	mg/L	NA	NA	16. 40 CFR 131.38
Zinc	mg/L	CTR (acute)	CTR (acute and chronic)	16. 40 CFR 131.38

* NA indicate no criteria or published value was available or applicable to the matrix or program.

*[(1)] Nutrient analytes for ambient conditions are assessed based on a weight of evidence approach using the EPA's Nutrient Numeric Endpoint Tool to determine if beneficial uses have potential for impairment.

Table B-7. San Diego County Copermittee Benchmark Sources

Reference ID #	Source	Document Link
1	San Diego Regional Water Quality Control Plan for the San Diego Region (Basin Plan), 1994 (with amendments effective prior to April 25, 2007)	http://www.waterboards.ca.gov/sandiego/programs/basin_plan/Update%2010-22-07/Chapter%203%20-%20April%2025,%202007.pdf
2	California Code of Regulations 64449.	http://www.co.kern.ca.us/eh/pdfs/WaterWells/CaliforniaCodeOfRegulationsTitle22.pdf
3	District of Columbia Final Total Maximum Daily Load for Oil and Grease in Anacostia River, October, 2003	http://ddoe.dc.gov/ddoe/frames.asp?doc=/ddoe/lib/ddoe/tmdl/fin_ana_oil_grease.pdf
4	Multisector General Permit for Industrial Activities, Section2,	http://www.epa.gov/npdes/pubs/msgp_permit_section2.pdf
5	U.S. EPA, Quality Criteria for Water, May 1, 1986, EPA 440/5-86-001. (Goldbook)	http://www.epa.gov/waterscience/criteria/goldbook.pdf
6	U.S. EPA, 1999 Update of Ambient Water Quality Criteria for Ammonia, EPA-822-R-99-014, December 1999	http://www.epa.gov/waterscience/standards/ammonia/99update.pdf
7	U.S. EPA, Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, EPA-440/5-88-004, April 1989	http://www.epa.gov/waterscience/criteria/library/ambientwqc/ammoniasalt1989.pdf
8	Mcneely, R.N., Neimasis, V.P., Dwyer, L. (1979), Oxygen-chemical oxygen demand. In: *Water Quality Sourcebook. A guide to water quality parameters*. Water Quality Branch Inland Waters Directorate, Environment Canadá, Ottawa, p.32-33.	
9	U.S. EPA, Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams in Nutrient Ecoregion III (EPA 822-B-00-016, December, 2000)	http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/rivers_3.pdf
10	U.S. EPA, Aquatic Life Ambient Water Quality Criteria Diazinon FINAL, EPA-822-R-05-006, December 2005.	http://www.epa.gov/waterscience/criteria/diazinon/final-doc.pdf
11	California Regional Water Quality Control Board San Diego Region, Technical Report for Total Maximum Daily Load for Diazinon in Chollas Creek Watershed San Diego County, Final, August 14, 2002.	http://www.waterboards.ca.gov/sandiego/tmdls/tmdl_files/chollas%20creek%20diazinon/FinalTechTMDL(29Apr03).pdf
12	Water quality criteria for diazinon and chlorpyrifos: California Department of Fish and Game, 2000.	http://www.krisweb.com/biblio/cal_cdfg_siepmannetal_2000.pdf
13	Hazard Assessment of the Insecticide Malathion to Aquatic Life in the Sacramento-San Joaquin River System: California Department of Fish and Game, Office of Spill Prevention and Response Administrative Report 98-2, 1998.	http://www.cdpr.ca.gov/docs/emon/surfwtr/hazasm/hazasm98_2.pdf
14	Research Progress Report, Findings from the National Stormwater Quality Database, January, 2004.	http://www.cwp.org/NPDES_research_report.pdf
15	Anderson B.S., B.M. Phillips, J.W. Hunt, S.A. Huntley, K. Worcester, N. Richard, and R.S. Tjeerdema. In Press. Evidence of pesticide impacts in the Santa Maria River watershed (California, USA). Environmental Toxicology and Chemistry.	
16	40 CFR 131.38	http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=401d1fa5a85e820674e669b8a3edf23b&rgn=div5&view=text&node=40:21.0.1.1.18&idno=40#40:21.0.1.1.18.4.16.8
17	Wheelock, C.E., Miller, J.L., Miller, M.J., Gee, S.J., Shan, G., Hammock, B.D. 2004.Development of toxicity identification evaluation procedures for pyrethroid detection using esterase activity. Environmental Toxicology and Chemistry, 23:2699–2708.	
18	El-Merhibi, A et al. (2004) Role of piperonyl butoxide in the toxicity of chlorpyrifos to *Ceriodaphnia dubia* and *Xenopus laevis* Ecotoxicol Environ Saf 57:202-12	
19	Technical Approach to Develop Nutrient Numeric Endpoints for California, Prepared for U.S. EPA Region 9 and California State Water Resources Control Board Planning and Standards Implementation Unit. Prepared by Tetra Tech, Inc., July 2006.	http://rd.tetratech.com/epa/Documents/CA_NNE_July_Final.pdf

Wet Weather Metals Benchmarks

Wet weather dissolved metals are compared to the hardness based criteria maximum concentration (CMC) termed the acute benchmark. Because storm events are relatively short term events, the wet weather benchmarks are not compared to the criteria continuous concentration (CCC) termed the chronic benchmark. The benchmark for each metal is based on the hardness measured in the specific sample collected. Samples with relatively lower hardness concentrations will have lower benchmarks for those metals based on the CTR calculation.

Ambient Metals Benchmarks

Ambient water quality samples for total metals are compared to Basin Plan standards which are based on municipal water supply standards with the exception of selenium which is based on CTR. Ambient dissolved metals results are compared to both the acute (CMC) and chronic (CCC) benchmarks. Because ambient events are representative of conditions normally found in the receiving waters, these comparisons provide the ability to assess whether conditions are protective of municipal water beneficial uses, and to relate chemistry results to any observed toxicity measured at the time of sampling in order to assess impacts to stream ecological health.

Toxicity

Toxicity testing at the MLS does not measure a constituent. Toxicity testing determines if an analyte (chemical or other) or group of analytes is present in concentrations capable of causing toxicity in the selected species. Toxicity testing results for the acute and chronic endpoints are reported as the no observed effect concentration (NOEC) of 100% in the test sample. The seven-day chronic effects are estimated using the NOEC for both survival and reproduction. This is the highest concentration tested in which there was no statistically significant effect on the survival or reproduction compared to the control response. Lower NOEC values equate to higher toxicity in the sample. Therefore, a concentration of less than 100% is considered to have some degree of toxic effect. The toxicity benchmarks used in the regional monitoring program are shown in Table B-8.

Table B-8. Toxicity Benchmark Water Quality Objectives for wet weather monitoring at Mass Loading Stations

Species/Test	Units	WQO	Source[1]
Toxicity			
Ceriodaphnia 96-hr	NOEC (%)	100	NPDES Order 2007-0001
Ceriodaphnia 7-day survival	NOEC (%)	100	NPDES Order 2007-0001
Ceriodaphnia 7-day reproduction	NOEC (%)	100	NPDES Order 2007-0001
Hyalella 96-hr	NOEC (%)	100	NPDES Order 2007-0001
Selenastrum 96-hr	NOEC (%)	100	NPDES Order 2007-0001

Persistent toxicity is evident when more than 50% of the toxicity tests conducted to date for any given species at a specific site have a NOEC of less than 100%. The results of this determination are then combined with the high frequency constituents of concern (chemistry data) and benthic data in the Triad Decision Matrix to determine the actions to be taken. If persistent toxicity is identified at a site (e.g., more than 50% frequency of occurrence) the source (compound or compound class) of the toxicity can be identified using toxicity identification evaluations (TIE).

Comparison of Water Quality Benchmark Ratios

Sample results are normalized to the appropriate benchmark and are presented graphically for those constituents that have most frequently been above its respective water quality benchmark across all watersheds for the monitoring season. The ratio to the water quality benchmark for each constituent was determined by dividing the constituent result by its respective benchmark for each sample event monitored. Mean ratios to the water quality benchmark were determined for each constituent to compare results to the mean of the historical results. Santa Margarita River was not sampled during 2004-2005 and 2006-2007, therefore only the mean ratios to the benchmark WQO are presented for this MLS. Toxicity ratios were determined by dividing the no observed effect concentration (NOEC %) by 100 and then subtracting one. For example, a NOEC of 50% indicates toxicity was only observed in the undiluted sample based on the dilutions presented in the toxicity methods section. The ratio to the benchmark of an organism with a NOEC of 50% is 1 [(100/50)-1=1] which is indicative of a toxic effect.

Jurisdictional Dry Weather Monitoring Data

In addition to the wet weather monitoring discussed above, a separate dry weather monitoring program is carried out by each jurisdiction. Dry weather monitoring reports are provided separately by each jurisdiction in its Jurisdictional Urban Runoff Management Program (JURMP) Annual Report. Dry weather data are also provided in a regional data sharing format which is used for the watershed management area assessments and regional comparisons in this report. Dry weather monitoring sites with field parameter and chemistry results are summarized in each section of the individual WMA sections. Dry weather sample data are compared to dry weather action levels. The data are tabulated indicating the number of results above the action level, the total number of samples collected in each WMA, the average ratio of exceedance, and the standard deviation of the ratio of exceedance.

Dry weather action levels are established by the Copermittees to trigger investigations upstream of the sampling location and to eliminate illicit connections and illegal discharges (ICID). Dry weather action levels were initially established in 2002 and are updated on a yearly basis, as necessary. The WMA assessments compare wet and dry weather exceedances. In some cases, the wet weather water quality objectives are not comparable with dry weather action levels. For example, turbidity action levels in dry weather samples are evaluated using Best Professional Judgment; while in wet weather and ambient sample events (at the MLS and TWAS) the Basin Plan water quality objective of 20 NTU is used. In order to allow for direct comparison with exceedances at the MLS and TWAS, when assessing dry and wet weather samples for turbidity at a watershed level the Basin Plan objective was used. See Table B-9 for a summary of the dry weather action levels used to perform the data evaluation.

Table B-9. Dry Weather Action Levels

Constituent	Action Level	Note
pH	<6.5 or >9.0	
Orthophosphate-P	2.0 mg/L	
Nitrate-N	10.0 mg/L	
Ammonia-N	1.0 mg/L	
Turbidity	20 NTU	Used Basin Plan benchmark WQO instead of BPJ when comparing with MLS data
Conductivity	5000 us/cm	Based on best professional judgment (BPJ)
MBAS	1.0 mg/L	
Oil and grease	15 mg/L	
Diazinon	0.5 µg/L	
Chlorpyrifos	0.5 µg/L	
Dissolved cadmium	CTR	Used CTR table, 1-hour criteria. Action level is based on hardness. Where hardness data were not available, the average value for the watershed was substituted.
Dissolved copper	CTR	
Dissolved lead	CTR	
Dissolved zinc	CTR	
Total coliform	50,000 MPN/100 mL	2005 Action Levels defined by 95th percentile were applied at the MLS for comparison with DWS data. Basin Plan objectives are only available for fecal coliform (REC-1 and REC-2).
Fecal coliform	20,000 MPN/100 mL	
Enterococci	10,000 MPN/100 mL	

Establishing Frequency of Occurrence to Determine Constituents of Concern

Previous Urban Runoff Monitoring Program reports under Order 2001-01 assessed three storm water events in the receiving water at one MLS. With the addition of the TWAS and ambient monitoring, the Copermittees are now able to assess the general health of the receiving waters both spatially and with respect to storms vs. ambient conditions. The monitoring results (including all monitoring years' data) are examined to establish if percentages of the data collected exceed water quality benchmarks or action levels, toxicity results are prioritized, and bioassessment results are ranked. The matrix of findings is developed for each watershed by wet weather and ambient events separately (Table B-10 and Table B-11 respectively). The matrix includes the number of observations that were measured above water quality benchmarks at the MLS and TWAS for each monitoring season. A cumulative exceedance rate is then calculated.

Table B-10. Interim Wet Weather Condition Matrix of Findingss

San Luis Rey River																				
Constituents With Any Wet Weather Benchmark or Dry Weather Action Level Exceedance	Wet Weather Receiving Water Results at the MLS																		Frequency of Occurrence	Criterion No.
	2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		2006/2007		2007/2008		2008/2009		CUMULATIVE			
	#/3	%	#/3	%	#/3	%	#/3	%	#/3	%	#/3	%	#/4	%	#/1	%	**#/23**	**%**		
Conventional Parameters																				
pH	0	0	1	33	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**4**	-	-
BOD	0	0	0	0	1	33	0	0	0	0	1	33	0	0	0	0	**2**	**9**	-	-
Total dissolved solids	3	100	3	100	3	100	3	100	3	100	3	100	4	100	1	100	**23**	**100**	♦♦♦	1
Total suspended solids	0	0	1	33	0	0	1	33	0	0	0	0	3	75	0	0	**5**	**22**	-	-
Turbidity	0	0	1	33	0	0	2	67	0	0	1	33	4	100	0	0	**8**	**35**	♦	9
Bacteriological																				
Total coliform**	0	0	0	0	0	0	1	33	0	0	1	33	3	75	1	100	**6**	**26**	♦	9
Fecal coliform	0	0	1	33	1	33	3	100	3	100	3	100	4	100	1	100	**16**	**70**	♦♦♦	2
Enterococci**	0	0	1	33	0	0	2	67	0	0	1	33	2	50	1	100	**7**	**30**	♦	9
Pesticides																				
Diazinon	1	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**4**	-	-
Chlorpyrifos	0	0	0	0	0	0	0	0	0	0	0	0	1	25	0	0	**1**	**4**	-	-
Pyrethroids																				
Bifenthrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	50	1	100	**3**	**60**	♦♦	5
Toxicity																			**EVIDENCE OF PERSISTENT TOXICITY?**	
Ceriodaphnia 7-day reproduction	1	33	0	0	1	33	0	0	0	0	0	0	1	25	0	0	**3**	**13**	No	
Hyalella 96-hour acute	0	0	0	0	0	0	0	0	0	0	1	33	0	0	0	0	**1**	**4**	No	
Selenastrum 96-hour	0	0	0	0	1	33	0	0	0	0	0	0	0	0	1	100	**2**	**9**	No	
Bioassessment	**IBI Rating**																		**EVIDENCE OF BENTHIC ALTERATION?**	
San Luis Rey River, at Benet Rd., (Downstream of MLS)	Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		**Very Poor[3]**		Yes	
San Luis Rey River, TWAS[1]	Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		Very Poor		*(Very Poor)* [2]		**Very Poor[3]**			
Doane Creek, Ref. Site	-		-		-		Very Good		Good		Very Good		Very Good		*(Very Good)* [2]		**Very Good[3]**			

- = Constituent results are below the defined requirements for a Low Frequency of Occurrence rating.

** = Total coliform and Enterococci were compared to DWS action levels.

NA = Not assessed, Not Applicable, or Not Analyzed.

[1] Data from Fall 2001-Spring 2007 were collected approximately two miles downstream at the Mission Rd. Bridge under the Order R9-2001-01.

[2] Bioassessment monitoring was not conducted during this year. The result is based on 2007/2008 data.

[3] Cumulative result based on average of last 3 years of historic data.

♦ = Low Frequency of Occurrence rating.

♦♦ = Medium Frequency of Occurrence rating.

♦♦♦ = High Frequency of Occurrence rating.

Table B-11. Interim Ambient Condition Matrix of Findings

San Luis Rey River								
Constituents With Any Ambient Receiving Water Benchmark	Ambient Receiving Water Results						Frequency of Occurrence	Criterion No.
	2007/2008		2008/2009		CUMULATIVE			
	#/4	%	#/4	%	#*	%		
Conventional Parameters								
Chemical oxygen demand	1	25	NA	NA	**1**	**25**	♦	9
Total dissolved solids	4	100	NA	NA	**4**	**100**	♦♦♦	1
Turbidity	1	25	NA	NA	**1**	**25**	♦	9
Chloride	NA	NA	3	75	**3**	**75**	♦♦	5
Sulfate	NA	NA	3	75	**3**	**75**	♦♦	5
Nutrients								
Total Nitrogen	2	50	4	100	**6**	**75**	♦♦	5
Total Phosphorus	3	75	3	75	**6**	**75**	♦♦	5
Bacteriological								
Fecal coliform	1	25	NA	NA	**1**	**25**	♦	9
Enterococci	3	75	NA	NA	**3**	**75**	♦♦♦	3
Toxicity							**EVIDENCE OF PERSISTENT TOXICITY?**	
Ceriodaphnia 7-day reproduction	0	0	NA**	NA**	**0**	**0**	No	
Bioassessment	**IBI Rating**						**EVIDENCE OF BENTHIC ALTERATION?**	
San Luis Rey River, at Benet Rd., (Downstream of MLS)	Very Poor		Very Poor		**Very Poor**[2]		Yes	
San Luis Rey River, TWAS	Very Poor		*(Very Poor)* [1]		**Very Poor**[2]			
Doane Creek, Ref. Site	Very Good		*(Very Good)* [1]		**Very Good**[2]			

* = Total number of observations varied among constituents.
** = Toxicity in 2008-2009 screen values were used therefore data are not comparable.
[1] Bioassessment monitoring was not conducted during this year. The result is based on 2007/2008 data.
[2] Cumulative result based on average of last 3 years of historic data (refer to wet weather long-term WMA assessment table).
NA = Not assessed, Not Applicable, or Not Analyzed.
NB = No benchmarks
\- = Constituent results are below the defined requirements for a Low Frequency of Occurrence rating.
♦ = Low Frequency of Occurrence rating.
♦♦ = Medium Frequency of Occurrence rating.
♦♦♦ = High Frequency of Occurrence rating.

Jurisdictional dry weather monitoring exceedances, Coastal Storm Drain Monitoring (CSDM) data (bacteria only during ambient conditions), and relevant third party data results exceeding action levels or relevant water quality benchmarks are included to provide an urban runoff exceedance rate (also in Table B-10). Jurisdictional dry weather data collected prior to the receiving water monitoring events are used. Such as, for the 2007–2008 monitoring season, the 2007 dry weather data is used for assessment. Jurisdictional dry weather data is used in the same manner for both ambient event assessments and wet weather assessments. Coastal Storm Drain Monitoring data is used differently. For ambient assessments, CSDM data from May 1, 2007 – September 30, 2007 is used. For wet weather assessments, CSDM bacteria data from October 1, 2007 – April 30, 2008 was used. Any third party data provided is assessed in a similar fashion.

The constituent of concern (COC) frequency of occurrence ranking of “high”, “medium”, or “low” is established using the 2002–03 interim criteria (Table B-12). This was the same criteria used during each successive annual report and was modified in this 2007–2008 monitoring season in order to incorporate ambient condition assessments and TWAS. The interim criteria take into account the exceedances at the MLS and TWAS, DWS and coastal outfalls; and classify each COC as high, medium or low frequency of occurrence in the watershed. The classification of COC can change from year to year in response to the changes in the levels of the pollutants and with respect to observed trends.

Jurisdictional Dry Weather Station (DWS) data were given less weight in the determination of watershed COC due to factors that include:

1) The dry weather monitoring program’s main focus is to identify illicit connections and illegal discharges (ICID) in the MS4. Sample stations may not be representative of overall urban runoff quality since they include samples of ponded water.
2) Dry weather monitoring parameters are a subset of receiving water monitoring parameters at the MLS and TWAS.
3) DWS may be located in the MS4 upstream of BMPs (detention basins, etc.) and samples may not be representative of urban runoff entering the receiving water.

Only DWS located upstream of the MLS are taken into account when applying the interim COC criteria. In addition, only DWS samples collected during routine monitoring and not as part of the ICID investigation phase of the program are used in the assessment. The majority of the 2007 dry weather data used for the assessment represented routine site visits.

If the number of DWS sampled was small, best professional judgment was used when applying the interim COC criteria. For example, if only three samples were collected and one exceedance was observed, then the 33% exceedance frequency may not be representative of watershed conditions.

Table B-12. Interim Criteria for Evaluating Constituents of Concern Frequency of Occurrence

COC Frequency of Occurrence	Criterion No.	Definition
High ♦♦♦	1	Mass loading station MLS or temporary watershed assessment station (TWAS) tests results exceed benchmark WQO in greater or equal to 80% of samples.
	2	The last six consecutive sample events at the MLS or TWAS exceed water quality benchmark.
	3	Less than 80% and greater than or equal to 50% of the MLS or TWAS samples exceed the water quality benchmark <u>and</u> at least one DWS exceedance in the past year.
	4	Less than 80% and greater than or equal to 50% of the MLS or TWAS samples exceed the water quality benchmark <u>and</u> a significant increasing trend is found.
Medium ♦♦	5	Less than 80% and greater than or equal to 50% of the MLS or TWAS samples exceed the water quality benchmark <u>and</u> no exceedances or data available for DWS in the past year.
	6	Less than 80% and greater than or equal to 50% of the MLS samples exceed the water quality benchmark <u>and</u> one or more exceedances found in last 2 years of monitoring at the MLS or TWAS (generally applies to historical datasets).
	7	Greater than 50% of the DWS samples have exceedances in the past year.
Low ♦	8	DWS exceedances in 10 to 50% of the samples in the past year.
	9	MLS or TWAS exceedances found in 25% to less than or equal to 50% of the samples <u>and</u> at least one exceedance found in last 2 years at the MLS or TWAS (with or without DWS exceedances in the past year).
	10	Greater than 50% of the MLS or TWAS samples have exceedances <u>and</u> no exceedances in the last 2 years at the MLS or TWAS.
Coastal Storm Drain Program	11	Persistent exceedances (greater or equal to 80% of samples). Add one ♦ to bacteria determination (up to three ♦ maximum for ambient conditions only).

Note: Best professional judgment applies when unique situations arise (fewer samples at a site; sewage spills) and for toxicity once it is linked to a specific COC.

1. Definitions were updated to incorporate ambient data and TWAS data and associated new programs detailed in RWQCB Order No. R9-2007-0001.

Benchmarks for bacterial levels are assessed differently in the receiving water and DWS. The receiving water benchmarks for fecal coliform are derived from the Basin Plan (REC-1 and REC-2) standards while DWS levels are compared to Copermittee defined action levels for all three bacterial indicators (total coliform, fecal coliform, and enterococcus). In order to compare the two datasets, the DWS action levels are applied to the receiving water wet weather total coliform and enterococcus data. Otherwise, identification of bacterial indicators as potential COCs in the watershed between these two different data sets would not have been feasible. During ambient event assessments, the receiving water enterococcus results are applied to the Basin Standard of 151 MPN/100mL.

Trash assessments were conducted separately from this analysis due to few data points collected during the 2007–2008 monitoring period and with the foresight that an extensive amount of data will be available for future assessments. Trash assessments were evaluated in a separate section prior to the integrated assessment.

Integrated Watershed Data Assessment

Assessment of the watershed during both wet weather and ambient monitoring conditions is presented in an integrated manner to present managers with an overall assessment of the watershed to provide answers to the core management questions. The integrated assessment provides the results of the receiving water assessments and urban runoff assessments during both storm events and ambient events and provides a summary of the overall watershed findings. It is anticipated that MS4 Outfall Program data and Source Identification Program monitoring data will bolster the assessment process as the data becomes available. Integrated watershed assessments are presented in table format as presented in Table B-13.

Table B-13. Interim Integrated Watershed Area Management Assessment

San Luis Rey WMA Integrated Watershed Management Area Assessment						
Assessment Category		Program	Frequency of Occurrence Assessment Findings	Persistent Toxicity Observed	Evidence of Benthic Impairment	Integrated WMA Assessment Summary
Ambient	Ambient Receiving Water	SMC and Bioassessment Monitoring	♦♦♦-TDS, Enterococci ♦♦-Chloride, Sulfate, Total nitrogen, Total phosphorus ♦-COD, Turbidity, Fecal coliform	No	Yes	TDS and enterococcus were identified as a high frequency of occurrence COC, chloride, sulfate, total nitrogen, and total phosphorus as medium frequency of occurrence COC, and COD, turbidity, and fecal coliform as low frequency of occurrence COC in receiving waters during ambient conditions. TDS (as well as chloride and sulfate) is associated with importation of drinking water, irrigation, and potential recycled water uses (San Diego Regional 303(d) Workgroup, 2002). Indicator bacteria are also related to dry weather runoff and potentially bacterial re-growth in the receiving waters during low velocity conditions. The dry weather MS4 monitoring results suggest that the MS4 effluent may have the potential to contribute to receiving water problems for some constituents, particularly TDS.
	Ambient Urban Runoff Areas	Jurisdictional Dry Weather Monitoring	♦-Turbidity, Orthophosphate	NA		
		MS4 Random Dry and Targeted Dry Monitoring	♦♦♦-TDS, Total nitrogen, Enterococci ♦♦-Chloride, Total Phosphorus, Fecal coliform ♦-TSS	NA		
Wet Weather	Wet Weather Receiving Water	MLS, TWAS, and Bioassessment Monitoring	♦♦♦-TDS, Fecal coliform ♦♦-Bifenthrin ♦-Turbidity, Total coliform, Enterococci	No		TDS and fecal coliform were identified as high frequency of occurrence COC during wet weather conditions. Bifenthrin was identified as a medium frequency of occurrence COC and turbidity and indicator bacteria were identified as low frequency of occurrence COC. In addition to the wet weather results, TDS and indictor bacteria were identified as COC in the ambient receiving water assessment and the MS4 assessment, suggesting that the MS4 may have the potential to contribute to receiving water problems for these constituents. Bifenthrin was detected at concentrations greater than the benchmark in 50% of the wet weather samples in 2007-2008 and the single sample collected in 2008-2009. This is a region wide and state wide problem, and is currently being addressed by the Department of Pesticide Regulation.
	Wet Weather Urban Runoff Areas	MS4 Random Wet and Targeted Wet Monitoring	(Insufficient data for assessment from the programs to date)	NA		

Interim Triad Assessment

For each watershed, all three elements of the triad (chemistry, toxicity, and benthic community) are assessed. Chemistry data provide an indication of the pollutant concentration and load during storm events or ambient conditions. Toxicity data provide a direct measure of the ecological health during specific sample events in the receiving water and provides the ability to determine if water quality conditions are impacting aquatic organisms. Dry weather chemistry data provide an indication of urban runoff pollutants. The benthic community data collected during stream bioassessment surveys provide a more direct indication of the ecological health throughout the year of the watershed in terms of insect/benthic community abundance and diversity.

The triad assessment does not consider fecal coliform and total dissolved solids for the purposes of triggering a decision or action. The bacteria parameters are not considered in the triad because they are not believed to influence toxicity responses in bioassay test organisms. Further, the REC-1 (water contact) and REC-2 (non-contact) water quality benchmarks for bacterial indicators are set for the protection of human health. Total dissolved solids are not considered since the water quality objectives for this constituent as defined in the Basin Plan are set for municipal drinking water and do not necessarily reflect impacts to the ecology of the watersheds. However, fecal coliform and total dissolved solids data may be used to define high priority COC that lead to management actions even though they bypass the application of the triad decision matrix. Persistence in several indicators provides an indication of an ecological concern that triggers the need to conduct short-term actions, such as conducting a TIE to identify the constituents in the watershed that may be responsible for water column toxicity and/or benthic community degradation. Where long-term datasets are available, all the data are evaluated to identify persistent conditions. The majority of MLS are in their seventh year (2007–2008) of monitoring and have data from 20 storm events available for the triad assessment. The addition of TWAS in some watersheds adds to the total number of events in some cases and provides the ability to assess the watershed spatially. The addition of ambient events provides the ability to assess the watershed during different conditions which help to focus management actions and watershed priorities. Persistence was determined for three elements of monitoring (chemistry, toxicity, and benthic community assemblage) using the definitions in Table B-14.

Table B-14. Interim Triad Definitions for San Diego Storm Water Monitoring Program

Triad Component	Definition
Persistent Exceedance of Water Quality Benchmarks	A high frequency of occurrence constituent of concern based on receiving water data, jurisdictional dry weather data, and coastal storm drain monitoring data exceedances compared to established list of benchmarks or action levels.
Evidence of Persistent Toxicity	More than 50% of the toxicity tests for any given species have a NOEC of less than 100%.
Indication of Benthic Alteration	IBI score of Poor or Very Poor.

Once persistence is determined in each watershed, the determination of short-term actions, namely TIEs are made using the Triad Approach to Determining Follow-Up Actions (Table B-15). The tabular decision matrix was obtained from the Section III.A.4 (Table 3) of the permit.

Table B-15. Triad Approach to Determining Follow-Up Actions (Section III.A.4, Table 3 of the Receiving Waters and Urban Runoff Monitoring and Reporting Program, No. R9-2007-0001)

	Chemistry	Toxicity	Bioassessment	Action
1.	Persistent exceedance of water quality objectives (high frequency constituent of concern identified).	Evidence of persistent toxicity.	Indications of alteration.	Conduct TIE to identify contaminants of concern, based on TIE metric. Address upstream sources as a high priority.
2.	No persistent exceedances of water quality objectives.	No evidence of persistent toxicity.	No indications of alteration.	No action necessary.
3.	Persistent exceedance of water quality objectives (high frequency constituent of concern identified).	No evidence of persistent toxicity.	No indications of alteration.	Address upstream sources as a low priority.
4.	No persistent exceedances of water quality objectives.	Evidence of persistent toxicity.	No indications of alteration.	Conduct TIE to identify contaminants of concern, based on TIE metric. Address upstream sources as a medium priority.
5.	No persistent exceedances of water quality objectives.	No evidence of persistent toxicity.	Indications of alteration.	No action necessary to address toxic chemicals. Address potential role of urban runoff in causing physical habitat disturbance.
6.	Persistent exceedance of water quality objectives (high frequency constituent of concern identified).	Evidence of persistent toxicity.	No indications of alteration.	If chemical and toxicity tests indicate persistent degradation, conduct TIE to identify contaminants of concern, based on TIE metric and address upstream source as a medium priority.
7.	No persistent exceedances of water quality objectives.	Evidence of persistent toxicity.	Indications of alteration.	Conduct TIE to identify contaminants of concern, based on TIE metric. Address upstream sources as a high priority. Address potential role of urban runoff causing physical habitat disturbance.
8.	Persistent exceedance of water quality objectives (high frequency constituent of concern identified).	No evidence of persistent toxicity.	Indications of alteration.	Address upstream source as a high priority.

B.4.2 Water Quality Priority Ratings – Long-Term Effectiveness Assessment Methodology

The Baseline Long-Term Effectiveness Assessment (BLTEA) report (WESTON, MOE, & LWA, 2005) was used to create water quality priority ratings using the five years of monitoring data collected at the end of the 2005–2006 monitoring season. This data set was used by the Copermittees to prioritize activities based on the available data set for the next permit cycle. The water quality priority ratings establish a process to relate water quality information to the overall effectiveness of the management program. Water quality characterization and prioritization is achieved through the water quality priority rating process conducted for each of the constituent/stressor groups on a sub-watershed and watershed basis. These constituent groups include:

- Heavy Metals
- Dissolved Minerals (Manganese, TDS, Sulfate)
- Organic Compounds
- Oil and Grease
- Sediment (TSS, Turbidity)
- Pesticides (Chlorpyrifos, Diazinon, Malathion)
- Nutrients (forms of Phosphorus, Nitrogen)
- Gross Pollutants (pH, Ammonia, BOD, COD, MBAS)
- Bacteria/Pathogens

The tables are updated every five years and are presented for the purposes of reviewing program activities. The detailed methods used to prepare the 2005–2006 water quality priority ratings tables can be found in the San Diego County Municipal Copermittees 2005–2006 Urban Runoff Monitoring Report (Weston, 2007).

The water quality priority ratings were determined using the full data set collected over the five years for the program. The dry weather data set provided results on a sub-watershed basis. However, the data set was limited and focused on sampling of storm sewers as opposed to receiving waters. In order to augment the current data set, the wet weather data from the MLS was used to project results up into the watershed as discussed below. The assessment of the water quality on a sub-watershed basis for the constituent groups was also supplemented using the ABLM results for sediment analysis. Therefore, the water quality rating on a sub-watershed and watershed basis for the nine constituent groups was based on results from the dry weather program, data from the Surface Water Ambient Monitoring Program (SWAMP) and from Padre Dam Municipal Water District (Padre Dam), the wet weather results from the MLS, and the sediment results from the ABLM program.

The additional evaluated stressor groups included Benthic Alteration and Toxicity. These last two groups were evaluated separately as they represented a stressor group that may be impacted by multiple constituents and/or stressors, as compared to the other groups that represented specific constituents. The basis for the water quality ratings for the Toxicity stressor group included the toxicity testing results from the wet weather sampling at the MLS and the sediment sampling conducted as part of the ABLM program. Dry weather toxicity data from the SWAMP dataset (2002–2004) were also included. These results were projected up the watershed as discussed below to provide a rating on a sub-watershed basis. The Benthic Alteration stressor group rating was based on the results at the regional bioassessment stations (Index of Biological Integrity, IBI), and the ABLM benthic community structure results (Benthic Response Index, BRI) conducted on sediment samples.

The constituent data representing the highest frequency of exceedance were then used to develop the prioritization ratings based on a score of 0 – 3. From the numerical score, a prioritization rating was assigned. The highest priority rating is A, followed by a rating of B, C, and D. D therefore represents a low priority rating.

Six method steps were used in development of the water quality priority rating for the nine constituent groups listed above (Figure B-1). The tables are updated every five years and are presented for the purposes of reviewing program activities. The detailed methods used to prepare the 2005–2006 water quality priority ratings tables can be found in the San Diego County Municipal Copermittees 2005–2006 Urban Runoff Monitoring Report (Weston, 2007).

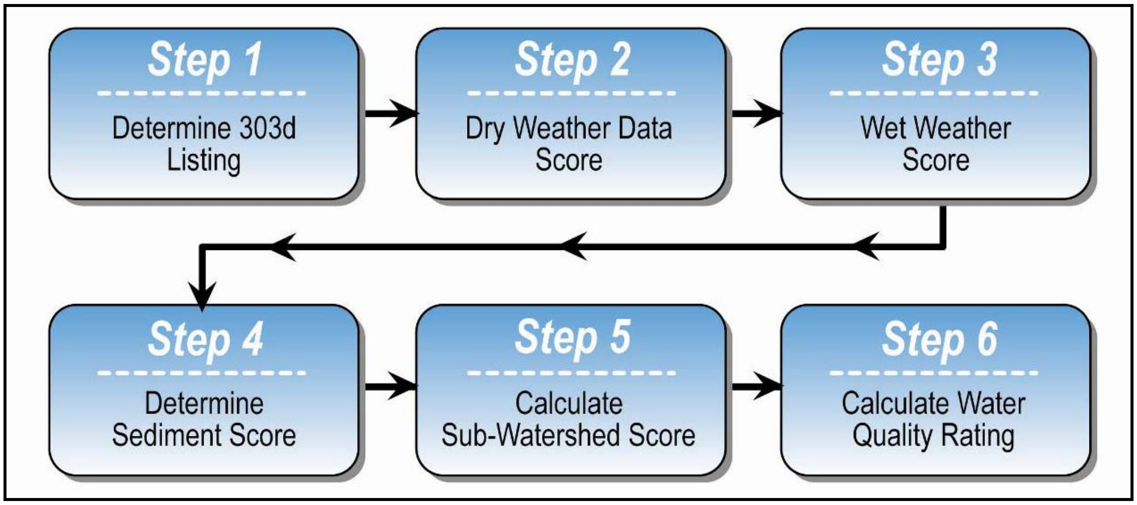

Figure B-1. Water Quality Priority Rating Methodology

B.5 Statistical Methods

The goals of the cross-watershed comparison are to assess all information from each watershed together to identify regional issues. Assessing all data from the region together also provides the ability to evaluate relationships among constituent and between toxicity effects and constituent.

B.5.1 Trend Analysis

Trend analysis was conducted for constituents and toxicity measured at each MLS station using current and historical data. Water quality data possess distributional characteristics that generally require specialized approaches to trend testing. Water quality data sets can contain censored (less than) values, outliers, multiple detection limits, missing values, and serial correlation. These characteristics commonly present problems in the use of conventional parametric statistics based on normally distributed data sets. The presence of censored data, non-negative values, and outliers generally lead to a non-normal data distribution which is common for many data sets. These skewed data sets require use of specific non-parametric statistical procedures for their analysis. Nonparametric statistical tests are more powerful when applied to non-normally distributed data, and almost as powerful as parametric tests when applied to normally distributed data (Helsel and Hirsch, 1992).

The nonparametric Mann-Kendall test for linear trend was used to evaluate whether a constituent or toxicity has increased or decreased significantly since the base year (Mann, 1945; Kendall, 1975). The test is non-parametric, rank order based, and insensitive to missing values. Sen's slope estimator (Sen, 1968) was used to estimate the magnitude of change over time when a significant trend was observed. Sen's slope estimator is a non-parametric method that is insensitive to outliers and can be used to infer the magnitude of a trend in the data.

The dataset contains constituent measurement with levels below the detection limit of the analytical method. These values were assigned the value of one-half the detection limit. Over time, several of the laboratory analytical techniques have lowered their limit of detection. An artifact of this advance is that the lower detection limit values of measurements later in the data record may be falsely detected as a downward trend. To avoid this, water quality values are censored to the one-half of highest detection limit of the analysis period as part of the data handling prior to analysis.

Data sets having large numbers of values below detection limit (BDLs) may create statistical problems for trend analyses. The Mann-Kendall test for trend adjusts variance estimates upward for ties in magnitude (Gilbert, 1990). Since BDL values in the raw data set produce such ties, trend analyses of data sets with high percentages of BDLs will be based upon greater variances than those without BDLs. Thus, the power of the trend analyses for the data sets with BDLs are reduced compared to those without detection limits censoring.

A simulation analysis on the effect of BDLs on Mann Kendall test and Sen slope estimator has provided standard guidelines for reporting trend statistics (Alden et al., 2000). These guidelines are widely accepted based on the percentage of BDLs present in the data set (Ebersole et al., 2002). The simulation analysis found that the power of the Mann-Kendall test begins noticeably to decline when censoring exceeds 35%. However, if the Mann-Kendall test produces a significant result when the level of censoring is between 35% and 50%, this result may be valid in spite of the loss of power. If the Mann-Kendall test fails to produce a significant result when censoring is in the 35% to 50% interval, this failure may have resulted from a loss of power. Also; the Sen slope estimator begins to exhibit noticeable bias when censoring exceeds 15%. At levels of censoring of 15% or less, both the Mann-Kendall test results and the Sen slope estimator were found to be reliable.

The following guidelines were used to report trend information:

- If the percentage of BDL observations is 15 or less, report the trend test p-value, direction, and magnitude of the trend (i.e., Sen Slope).
- If the percentage of BDL observations is greater than 15 and less than or equal to 35, report the trend test p-value and direction only. Do not report the trend magnitude.
- If the percentage of BDL observations is greater than 35 and less than or equal to 50 and the trend test p-value indicates a significant trend, report the trend test p-value and direction. Do not report the trend magnitude.
- If the percentage of BDL observations is greater than 35 and less than or equal to 50 and the trend test p-value does not indicate a significant trend, report that there are too many observations below the detection limit to determine the presence or absence of trend.
- If the percentage of BDL observations is greater than 50, report there are too many observations below the detection limit to determine the presence or absence of trend.

The current and historical data used in the trend analysis are shown in a series of scatterplots (Appendix C). Scatterplots provide a visual comparison across all the years of data of collection. Scatterplots provide a visual representation of the relative concentrations of constituents between stations and storm events. Scatterplots are simple plots of concentrations of constituents plotted on the y-axis against time identified on the x-axis. Relevant trend information is reported with each scatterplot based on the guidelines described above.

Regional trend analysis was completed for constituents that showed similar trends in four or more watersheds by testing the homogeneity of stations. Following the methods outlined in Gilbert (1987), data collected at several different stations were analyzed to test if a regional-wide statement could be made about trends. A general statement about the presence or absence of monotonic trends is meaningful if the trends at all stations are in the same direction (i.e., all upward or all downward). In order to do this the Mann-Kendall statistic, computed for each station as described above, was used in the procedure developed by van Belle and Hughes (1984) to test for homogeneity of trends across the region. The van Belle and Hughes procedure does the following:

- Computes the homogeneity chi-square statistic.
- Compares chi-square statistic with the critical value (M-1) in Table A19 (Gilbert, 1987).
- If the chi-square statistic exceeds the critical value, reject the null hypothesis (H_O) of homogeneous station trends (accepting the alternative hypothesis (H_A)). This would conclude that no regional-wide statements could be made about trend direction.
- Conversely, if the chi-square statistic is less than the critical value, accept the null hypothesis (H_O), concluding that homogeneity trend exists across the region (or stations) over the monitoring period.

B.5.2 Constituent Comparisons

Statistical analyses for regional assessment included the magnitude of the ratio of observed concentration to the benchmark WQOs and Mann-Kendall trend analysis. The regional assessment of the magnitude of benchmark WQO ratios for key constituents was based on the ratio of the annual mean concentration for all available data to the appropriate benchmark WQO. These comparisons provide for identification of water quality issues specific to a watershed or common among several or all watersheds in the region. Scatterplots for each constituent for the years monitored were discussed in the individual watershed sections and presented in Appendix H.

Scatterplots provide a visual representation of the relative concentrations of constituents between stations and storm events. Scatterplots are plots of the constituent concentrations plotted on the y-axis against time identified on the x-axis. Each constituent and toxicity test is represented by a series of scatterplots for each of the MLS monitoring during 2007–2008. Non-detectable results were plotted at one-half the detection limit. MLS not monitored during the 2007–2008 period are also included in Appendix H. All constituents were monitored at mass loading stations during three storms each year (with the exception of Santa Margarita River), prior to the 2007–

2008 monitoring period. During 2007–2008, two storms were monitored at a sub-set of MLS located in Northern San Diego County. All available data are included in scatterplots.

B.6 Discharge Volume Calculation and Flow Modeling for Loading Estimates

Pollutant loadings to each MLS were calculated for the monitored events by applying the average event mean concentration from the annual wet weather season to the volume of wet weather stream flow discharge as a result of precipitation during each runoff event. Event volumes were calculated by summing the incremental observed flow values multiplied by the time elapsed between observations as follows:

Cubic ft/sec * incremental time (seconds) = Cubic Feet

A graphical representation of each storm water hydrograph was used to determine the length of the runoff event. The event mean concentration (EMC), calculated from the samples collected during the monitoring period, was then applied to the total runoff volume to obtain event loadings for each storm.

Long term flow volumes to calculate annual loadings to each MLS were calculated using available USGS flow monitoring data for watersheds that contain gaging stations. For watersheds that do not contain USGS flow monitoring gages, WESTON estimated the annual surface water volumes to each MLS using a hydrologic computer model. The USACE HEC-HMS hydrologic model was originally proposed to simulate the watersheds. However, due to long run times and computational processing limitations for a year-long simulation of large watersheds lead to the selection of the United State Environmental Protection Agency (USEPA) Stormwater Management Model (SWMM) version 5.0.013. In addition to faster processing times, the SWMM model has water quality simulation capabilities that can be used in future efforts to evaluate pollutant sources based on land use and evaluate the impact of proposed BMPs.

B.7 USGS Gaged Watersheds

The larger watersheds, specifically Santa Margarita, San Luis Rey, and San Diego Rivers contain USGS flow monitoring gages. There are USGS gages in the Santa Margarita River, San Luis Rey, and San Diego River Watersheds at the same location or within relatively close proximity to each MLS. The USGS gaging stations were used to estimate annual flow volumes for those watersheds. The USGS gaging stations are also used to validate flow monitoring data collected at the MLS which uses standard flow rating techniques across all watersheds.

B.8 SWMM Model Overview

The USEPA SWMM model was selected to simulate the surface water flow to each MLS in the ungaged watersheds because the model has the capability to calculate storm water runoff based on drainage basin characteristics and route flow through a watershed. SWMM is a dynamic rainfall-runoff simulation model that can simulate single events or long-term (continuous) runoff quantity and quality. The runoff component of SWMM operates using a collection of subcatchment areas on which rain falls and runoff is generated. Depth of water over the subcatchment is continuously updated with time by solving a numerical water balance equation over the subcatchment. The routing portion of SWMM transports this runoff through a conveyance system of channels and pipes by selecting uniform flow, kinematic wave, or dynamic wave equations. Water quality parameters can also be input to SWMM to simulate pollutant loadings based on land use within each watershed.

The objectives of the surface water modeling effort were:

1. To more accurately determine the volume of stream flow at each MLS;
2. To obtain a calibrated hydrologic simulation of each watershed so that gaps in observed data can be estimated in the event of equipment failure; and,
3. To fill in historic data gaps for the purpose of investigating trends in watershed loadings over the course of several years.

The USEPA SWMM model can be used as a planning tool by updating the land use coverage or conveyance structures and simulating changes in storm water runoff from various development scenarios. The model was used only as a tool to estimate stream flow volumes for this reporting period. Water quality parameters can be assigned to each land use and BMP efficiencies can be assigned to proposed projects to evaluate their effectiveness in the future.

B.9 Hydrologic Input Parameters

Hydrologic parameters were developed from the USGS Medium-Resolution (1:100k) National Hydrography Dataset (NHD Plus), NRCS Soil Survey Geographic (SSURGO) Database (USDA, 2003) and 2007 land use data from San Diego Association of Governments (SANDAG). This section explains the source and purpose of the data input to the SWMM Runoff Model.

B.9.1 SWMM Runoff Module

The runoff component of SWMM simulates both the quantity and quality runoff phenomena of a subwatershed. The program accepts precipitation data and makes a step by step accounting of snowmelt, infiltration and evaporative losses, and surface detention and overland flow to calculate a runoff hydrograph for the subwatershed and direct these data to the routing module for surface flow routing.

The following characteristics affect the amount of precipitation that becomes storm water runoff:

- Precipitation distribution and intensity
- Evaporation rates
- Subwatershed properties
  - Area
  - Topography and slope
  - Land Use
  - Soils

Values to describe these characteristics for each watershed were developed and input to the SWMM model, as described in the following subsections.

B.9.1.1 Precipitation

WESTON has observed precipitation data at each MLS and TWAS for the period from 13 September 2007 through June 2008. These data were used to calibrate the model and produce runoff hydrographs that matched the observed flow data at each MLS as closely as possible.

Once a calibrated model was developed for each MLS, the long-term precipitation from the County of San Diego Flood Control ALERT network was entered into the model to simulate annual stream flows. Annual flow volumes were developed for the period from 1 July through 30 June beginning with 2002–2003 through 2007–2008.

B.9.1.2 Evaporation

The evaporation rate varies with temperature, wind speed, sunshine, and relative humidity. Rough daily evaporation rates for this model were extrapolated from maps of average monthly evaporation produced by the National Weather Service (http://www.cpc.ncepnoaa.gov/soilmst/e.html). Table B-16 lists the typical monthly evaporation (millimeters per month) and estimated daily evaporation rate for the San Diego area. This value is significant when running the model in continuous simulation mode.

Table B-16. Evaporation Rates for San Diego County

Month	Average Monthly Evaporation Rate (in/day)*
January	0.107
February	0.113
March	0.157
April	0.203
May	0.213
June	0.187
July	0.227
August	0.223
September	0.193
October	0.163
November	0.127
December	0.110

Source: National Weather Service CPC Soil Moisture Monitoring
*Based on monthly evaporation data divided by the number of days in the month

B.9.1.3 Drainage Area

The National Hydrography Dataset (NHD Plus) for California (Hydrologic Region 18, production unit a) was the source of the catchment boundaries (subwatersheds) for the area draining to each MLS. Elevation-based subwatersheds in the NHD Plus database were input to the SWMM model. Hydrologic input parameters, such as the watershed width, were calculated for each of catchments using data available in the NHD Plus database.

B.9.1.4 Topography and Slope

Surface slope and subwatershed shape have profound effects on runoff flow within a subwatershed. The overland flow path for headwater subwatersheds was measured from a point on the watershed boundary to the outlet. The overland flow path for the downstream subwatersheds was assumed to be the "flow-length" parameter in the NHD Plus database. Overland flow length is a constituent of the calculation for the watershed width parameter that describes the shape of each subwatershed and is the primary calibration parameter within the SWMM model. Watershed widths were calculated by dividing the subwatershed area by the maximum overland flow length. The calculated watershed width parameter was adjusted during model calibration as to produce output hydrograph results from the model that match the observed hydrographs at the MLSs as closely as possible.

B.9.1.5 Land Use

Land use is an important and variable originator of storm water runoff. As natural vegetation is replaced with impermeable surfaces such as pavement and buildings, the amount of rainfall that runs off the land surface and the rate at which it flows are greatly increased. The 2007 land use coverage from SANDAG was the source of land use information (SANDAG, 2007). Land uses with similar hydrologic characteristics, such as percent impervious cover, were aggregated into one category to simplify input to the SWMM model by reducing the number of necessary input parameters. Table B-17 includes the land use-dependent input values for each land use in the SWMM simulation of the San Diego County watersheds.

Table B-17. Hydrologic Parameters for Each Land Use

Model Land Use	Manning's Roughness Coefficient		Impervious Area (%)	
	Impervious	Pervious	Total Impervious Area %	Directly Connected Impervious Area %
Agriculture	0.015	0.300	2	1
Commercial	0.015	0.100	70	60
Commercial with Open Land	0.015	0.200	50	35
Parks and Recreation	0.015	0.400	5	3
Industrial	0.015	0.100	65	60
Military Open Land	0.015	0.150	5	3
Open Space Beaches	0.015	0.100	2	1
Open Space Landscape	0.015	0.350	2	1
Open Space	0.015	0.350	2	1
Residential	0.015	0.300	40	25
Rural Residential	0.015	0.350	10	5
Construction Site	0.015	0.030	70	60
Transportation	0.015	0.100	50	40
Water	0.015	0.100	100	100

Note: Initial Estimates for Manning's Roughness Coefficients for overland flow were obtained from Huber and Dickinson, 1998, p.107

B.9.1.6 Directly Connected Impervious Area (DCIA)

The percent impervious area for each land use category is an important input parameter for hydrologic simulation. The impervious surface area within a subwatershed tends to increase as development intensity increases. For example, commercial development will typically have more impervious surface than single family residential development. A refinement of the estimate of impervious area in each land use category to a more specific parameter, the amount of directly connected impervious area (DCIA), is required to simulate storm water runoff in SWMM. DCIA includes only impervious surfaces that flow directly into storm sewers, drains, channels, or other waterways without flowing over any pervious surfaces.

Impervious surfaces collect pollutants that can be rapidly washed into streams when it rains. These surfaces include rooftops, driveways, sidewalks, paved roads, and parking lots. Impervious surfaces prevent natural filtering of polluting materials that normally occurs before storm water enters a stream. The amount of impervious area within each land use category was obtained from literature values found in Dallman and Piechota, 2000 and Camp, Dresser, and McKee, 1996.

Initial assumptions for percent impervious area were derived from the Back River Watershed Water Quality Management Plan (Camp, Dresser & McKee, 1996), Stormwater: Asset not Liability (Dallman and Piechota, 2000), and from professional judgment. The initial DCIA assumptions were refined during the hydrologic calibration of the model. Values of DCIA and other hydrologic input parameters for the subareas within each modeled watershed are presented in subsequent sections of this report.

B.9.1.7 Soils

The soils underlying the land uses also control how much rainfall can infiltrate in areas that remain in pervious land cover. Infiltration rate values for each soil type that were input to the SWMM model are shown in Table B-18.

Table B-18. Hydrologic Parameters for Soils

NRCS	Maximum	Minimum
	Infiltration Rate	Infiltration Rate
Hydrologic Soil Group	Inches per hour (in/hr)	Inches per hour (in/hr)
A	5.0	0.3
B	3.0	0.15
C	1.5	0.05
D	0.5	0.0

Source: James et al., 1999.

B.9.2 Calculation of Hydrologic Data Input Using ArcGIS

The following GIS files were compiled to perform the data conversion to SWMM input:

- Topographic data, including watershed boundaries and subwatershed boundaries.
- Hydrologic soil groups.
- Land use categories.

Land uses were aggregated into the 14 categories listed in Table B-17. The land use coverage was overlaid onto the subwatershed boundaries to determine the land use composition of each subwatershed. Land use percentages were used to calculate area weighted percent DCIA, pervious/impervious Manning's coefficients, and pervious/impervious depression storage.

The SSURGO database for San Diego County and portions of Riverside County was used to map the hydrologic soil group (A-D) for the watershed management areas. These data were then intersected with the land use data by subwatershed. Through this process, the runoff characteristics of each variation in soil/land use combination were determined. The ability to rapidly calculate the many variations in these combinations have maximized the accuracy and utility of hydrologic simulations when compared to those performed with manually calculated input data.

B.10 Hydraulic Simulation Input Parameters

The routing portion of SWMM performs dynamic routing of storm water flows throughout the major storm drainage system to the outfall point and the receiving water body. Hydrographs generated by the runoff component are automatically interfaced with the routing portion and storm water runoff is routed through the network. The stream channels were simulated in the models as conduits. Nodes were created to connect the conduits and route the storm water through the system. The NHD Plus database contains upstream and downstream nodes for each subwatershed. Channel slope was automatically calculated from the channel length and the elevations associated with the upstream and downstream node associated with each channel.

For this initial effort, channel dimensions were assumed based on the Stream Order (obtained from the NHD Plus database). Channels were assumed to be eight-point trapezoids with the following dimensions (Table B-19).

Table B-19. Stream Order Assumed Dimensions

Stream Order	Bottom Width (ft)	Bank to Bank Width (ft)	Total Width (ft)	Bankfull Depth (ft)
1	2	4	26	2
2	5	9	49	2
3	10	16	56	3
4	15	45	85	5
5	20	60	100	5

A Mannings roughness coefficient value of 0.09 for all channels and overbank areas was assigned to all channels for this effort. Channel dimensions and roughness characteristics can be refined during future efforts to increase the level of detail for model input parameters.

B.11 SWMM Model Calibration

After the input parameters were calculated and the best estimate was assigned to all of the coefficients, the SWMM model was run. Assigning the appropriate precipitation gage to each subwatershed was the initial calibration effort. Data from the closest ALERT rain gages were used to supplement the precipitation recorded at the MLS. The area influenced by each available source of rainfall data was adjusted until the output hydrograph shape matched the shape of the observed stream flow hydrograph at the MLS. Once the rainfall data source was set, other parameters were adjusted to obtain the magnitude of runoff being recorded at the MLS. Parameters input to SWMM, such as the watershed width, percent DCIA, and Manning's Roughness Coefficient for overland flow were adjusted for each land use until the SWMM outflow hydrograph at the MLS most closely matched the observed hydrograph at the MLS.

ATTACHMENT 1

Trash Monitoring Methods

ATTACHMENT 1: Trash Monitoring Methods

Assessment of Trash

The Receiving Waters and Urban Runoff Monitoring and Reporting Program for the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit Order No. R9-2007-0001 requires the Copermittees to assess the presence of trash in receiving waters and urban runoff at each dry weather field screening site and MLS in San Diego County Watersheds. The trash monitoring program is designed to provide information on the spatial extent, relative amount, and nature of trash present in San Diego County waters. The monitoring program seeks to answer the following three questions:

1. Where is trash being detected in San Diego Watersheds?

2. How many sites are identified as submarginal or poor?

3. In locations identified as submarginal or poor, what is the nature of the types of trash present?

The Copermittees will assess approximately 1,000 sites per year under the trash assessment program. Through this assessment, a spatial determination of where trash is being detected will be done. The Copermittees will, upon receiving the spatial trash information, determine regional and watershed priorities with regard to trash reduction BMPs. At sites identified as submarginal or poor, the spatial extent, relative amounts, and nature of trash present were evaluated through the use of standardized trash monitoring forms. Results from this will allow the Copermittees to identify problem areas for trash on jurisdictional and regional watershed levels. Following the initial monitoring period (first reporting cycle), refinements can be made to the program based on the data gathered during the first year. Identifying the nature of the trash allows for a determination of potential sources and routes of trash that, ultimately can guide management actions. Detailed methods of the trash monitoring program can be found in *the Final Monitoring Workplan for the Assessment of Trash in San Diego County Watersheds* (WESTON, 2007a). The methods are summarized below.

Monitoring Design

Trash assessments were performed at least once at 11 MLS during both dry ambient monitoring and storm event monitoring during the 2008-2009 Permit year. Monitoring event requirements were reduced during 2008-2009 as a result of the Copermittees' participation in the Bight '08 monitoring program. A complete trash monitoring schedule through 2011-2012 is shown in Table 1.

Table 1. Trash Monitoring Locations and Number of Annual Monitoring Events.

	2007-2008		2008-2009		2009-2010		2010-2011		2011-2012	
Watershed	**MLS**	**TWAS**	**MLS**	**TWAS**	**MLS**	**TWAS**	**MLS**	**TWAS**	**MLS**	**TWAS**
Santa Margarita River	4		1				4			
San Luis Rey River	4	4	1				4	4		
Loma Alta Creek		4						4		
Buena Vista Creek		4						4		
Agua Hedionda Creek	4	4	1				4	4		
Escondido Creek	4	4	1				4	4		
San Dieguito Creek	4	8	1				4	8		
Los Peñasquitos Creek	4	8	1				4	8		
Rose Creek						4				4
Tecolote Creek			1		4	4			4	4
San Diego River			1		4	12			4	12
Chollas Creek	4		1		4		4		4	
Sweetwater River			1		4	4			4	4
Otay River						4				4
Tijuana River			1		4	8			4	8

Trash Assessment Procedures

Site boundaries were established in field notebooks so that distinctive landmarks could be used to consistently identify the assessment area and to also determine if trash has been mobilized by water at the defined locations. Upon arrival at a site, a qualitative estimate of the presence of trash was documented in the Trash Assessment Form. This assessment was made using the following criteria to describe the amount and extent of trash at each site:

- **Optimal***:* Little or no trash is evident upon close examination (less than 10 pieces).
- **Suboptima***l*: Small levels of trash are evident upon close examination (~10-50 pieces).
- **Marginal**: Trash is evident in low to medium levels (~51-100 pieces) with evidence of site being used by people.
- **SubMarginal**: Trash is substantial with evidence of site being used frequently by people.
- **Poor**: Site is significantly impacted by trash (greater than 400 pieces). Substantial levels of litter and debris. Evidence of trash accumulation behind a constriction point or evidence of excessive dumping.

Sites were also evaluated to determine the threat posed to human health and the threat posed to aquatic health using the following definitions:

- **Threat to Human Health-** site poses swimming, wading, or walking hazards due to debris. Trash and debris has the potential to contain chemicals that bioaccumulate, transmit bacteria, or cause physical harm (sharps, entanglements, nails, etc.).
- **Threat to Aquatic Health-** site poses threat to aquatic life through contact, ingestion, entanglement, etc. from trash and debris.

If the quantity of trash fell into the submarginal or poor category, an assessment of the types of trash present, the potential mobilization route, and the potential source of trash was performed. Categories of trash were ranked from 1 to 12 based on the most prevalent trash (1 was ranked most prevalent). Categories of trash included:

- Automotive
- Biohazard waste
- Business related waste
- Cigarette butts
- Construction materials
- Fabric/Clothing
- Food packaging
- Household
- Shopping carts
- Toxic
- Yard waste

An estimation of the potential mobilization route was also documented. If the route could not be determine, the route was labeled “unable to determine” on the Trash Assessment Form. Source categories consisted of: Household, Construction, Commercial, Industrial, School, and Transient.

Assessment and Reporting

Data from the trash assessment provides the Copermittees with valuable information from which to make informed decisions on how to address trash problem areas. Information on the potential sources and types of trash may guide efforts on outreach to the appropriate target groups. Maps depicting the presence of trash in receiving waters and MS4 locations were created to give an overview of the relative amounts of trash at monitoring stations throughout San Diego County to answer the question “Where is trash being detected in San Diego Watersheds?”

To answer the question “How many sites are identified as submarginal or poor?” information on how many sites were rated as having either submarginal or poor trash levels was quantified. This information was assessed on both a regional and watershed scale, as well as jurisdictionally in dry weather monitoring reports and is presented in tabular and graphical formats in each WMA section.

To answer the question “In locations identified as submarginal, or poor, what is the nature of the types of trash present?” analyses were performed to categorize the predominant trash types and their potential sources. These findings are presented in each WMA section, along with the number of sites which were determined to pose a threat to either human or aquatic health. These data will help guide the selection of future trash management actions.

ATTACHMENT 2

Synthetic Pyrethroids Monitoring Methods

ATTACHMENT 2: Synthetic Pyrethroids Monitoring Methods

Assessment of Synthetic Pyrethroids

The Receiving Waters and Urban Runoff Monitoring and Reporting Program for the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit Order No. R9-2007-0001 requires the Copermittees to assess the occurrence and effects of synthetic pyrethroids in San Diego County Watersheds. The pyrethroid monitoring program focuses on sediment and water column assessments to evaluate potential effects of pyrethroids (County of San Diego 2007). Pyrethroids have been previously been linked to toxicity in *Hyalella azteca.* The monitoring program seeks to answer the following two questions:

1. Are synthetic pyrethroids detected in San Diego County Watersheds, and if so, at what concentrations?

2. If detected, are synthetic pyrethroids in San Diego County Watersheds causing toxicity to aquatic organisms in the water column or detected at equal to or above published LC_{50}s for *Hyalella azteca* in sediment?

To answer these questions, sediment and water samples were collected at MLS locations throughout Sand Diego County. Detailed methods of the pyrethroid monitoring program can be found in *the Monitoring Workplan for the Assessment of Synthetic Pyrethroids in San Diego County Watersheds* (SDCRC, 2007b). The methods are summarized below.

Sample Collection and Analysis

Sediment

Sediment samples were collected from 15 MLS locations using a piston core during the 2008-2009 permit year. Only the top two centimeters of sediment were collected to ensure that only recently deposited sediments were used for analysis. At each site three transects were chosen and five locations equidistant from one another along the transect were sampled, for a total of 15 samples from each site. All samples from a given site were then composited and homogenized before being placed into a laboratory-certified sterile glass jar. Samples were immediately stored on ice following processing and transferred to the analytical laboratory within holding time. Field measurements were taken of water column pH, conductivity, temperature, and turbidity at each site and field data logs summarizing empirical observations of the site, sediment, and water quality were completed. The complete list of analyses performed on composited sediment samples is provided in Table 1.

Table 1. Constituents Analyzed in the Assessment of Pyrethroids in Sediments

Group	Analyte	Method	Fraction	Units	MDL	RL
Synthetic Pyrethroids	Allethrin	EPA 8270 NCI-GCMS	Total	ng/g	5	10
	Bifenthrin				5	25
	Cyfluthrin				5	25
	Cypermethrin				5	25
	Danitol				5	25
	Deltamethrin				5	25
	L-Cyhalothrin				5	25
	Permethrin				5	25
	Prallethrin				5	25
	Pipernyl Butoxide				5	25
Conventionals	TOC	ASTM D-2567	Total	%	0.5	1
	Grain Size	Plumb, 1981	N/A	%	N/A	N/A

Water

Water quality samples for pyrethroid analysis were collected only during storm events from 11 MLS as part of the Regional Monitoring Program analytical constituent list for the County of San Diego. Since pyrethroids are generally only associated with suspended particulates, dry weather monitoring was not expected to contain detectable concentrations of pyrethroids. Storm event monitoring was performed once per year at 11 MLS in San Diego. Automated sampling equipment was used to collect flow-weighted composite samples during storm events. Once collected, samples were kept on ice and transferred to the analytical laboratory. The complete list of laboratory analyses performed on composited water samples is provided in Table 2. Field measurements were taken of water column pH, conductivity, temperature, and turbidity at each site and field data logs summarizing empirical observations of the site and water quality were completed.

Table 2. : Constituents Analyzed in the Assessment of Pyrethroids in Water

Group	Analyte	Method	Fraction	Units	MDL	RL
Synthetic Pyrethroids	Allethrin	EPA 625 NCI-GCMS	Total	ng/g	2	5
	Bifenthrin				2	5
	Cyfluthrin				2	5
	Cypermethrin				2	5
	Danitol				2	5
	Deltamethrin				2	5
	L-Cyhalothrin				2	5
	Permethrin				2	5
	Prallethrin				2	5
	Pipernyl Butoxide				2	5

Quality Assurance/ Quality Control

Quality assurance and quality control measures for sampling processes included proper collection of samples to minimize the possibility of contamination. All samples were collected using clean equipment and stored in laboratory certified, contaminant-free glass jars. Field measurements were made using calibrated instruments in accordance with the manufacturer's specifications. Duplicate samples and equipment rinse blanks were collected to assess sample variability and contamination arising from collection, transport or storage of samples.

Synthetic Pyrethroid Assessment

Synthetic pyrethroid results were presented in maps and data tables to answer the question "Where are synthetic pyrethroids being detected in San Diego County Watersheds?" To answer the question "If detected, are synthetic pyrethroids in San Diego County Watersheds causing toxicity to aquatic organisms in the water column or detected at equal to or above published LC_{50}s for *Hyalella azteca* in sediment?" results of analyses were compared to values provided in Table 3. Water column sample results were included as part of the triad assessment with toxicity and biology results.

Reporting

Reporting of synthetic pyrethroid sediment and water results were included as part of each Watershed Management Area Assessment.

Table 3. LC50 Values for Pyrethroids and Associated references

Analyte	Exposure Period	LC50 (ug/kg sediment)	LC50 (ug/g organic carbon) or % OC	Reference
Bifenthrin	10 days	-	0.52	Amweg et al. 2005
Bifenthrin	96 hour	0.0093	NA	Anderson et al. in press
Bifenthrin	96 hour	0.013	NA	Weston Solutions 2006
Bifenthrin	96 hour	-	0.52	Amweg et al. 2005
Cyfluthrin	10 days	-	1.08	Amweg et al. 2005
Deltamethrin	10 days	-	0.79	Amweg et al. 2005
Esfenvalerate	10 days	-	1.54	Amweg et al. 2005
L-Cyhalothrin	10 days	-	0.45	Amweg et al. 2005
Cypermethrin	10 days	-	0.38	Amweg et al. 2005
Cypermethrin	10 days	-	1%	Maund et al. 2002
Cypermethrin	10 days	-	3%	Maund et al. 2002
Cypermethrin	10 days	-	13%	Maund et al. 2002
Permethrin	10 days	-	10.83	Amweg et al. 2005
Permethrin	96 hour	0.039-0.047	NA	Wheelock et al. 2005
Permethrin	96 hour	0.021	NA	Anderson et al. in press

ATTACHMENT 3

Draft SMC Workplan

Regional Monitoring of Southern California's Coastal Watersheds

Stormwater Monitoring Coalition
Bioassessment Working Group

FINAL DRAFT

November 12, 2007

Introduction

Watersheds in the coastal range of southern California are a valuable aquatic resource. Comprising over 5,000 stream miles, both humans and wildlife use these watershed resources for fish habitat and fishing, drinking water, swimming and other recreational uses, water augmentation and groundwater recharge, agriculture, and many others.

Despite the many beneficial uses derived from the rivers and streams, southern California's burgeoning population also places a large number of potential stressors on its coastal watersheds. Habitat alteration, hydromodification through increased imperviousness, flood control, water augmentation and diversion, discharge of treated and industrial wastewaters, and contributions from urban runoff can all result in impairments to aquatic life in the region's rivers and streams.

At this point in time, the regional health of southern California's rivers and streams cannot be determined. One reason the regional health cannot be determined is because so little of the region's streams and rivers are monitored. Based on existing monitoring effort, only 29% the stream miles in southern California are monitored on an ongoing basis. Some watersheds, such as the San Gabriel River have many sampling locations and are well-monitored, but the status of other watersheds like Calleguas Creek remain virtually unmonitored. The reason for this uneven level of effort is due mostly to the presence of instream discharges, where monitoring is mandated. Otherwise, monitoring is typically not conducted. As a result, the most monitoring occurs in locations where impacts are expected to occur and the potential for a biased picture of aquatic health is likely.

Even if expansive monitoring programs of aquatic health were conducted, the monitoring is currently conducted by over a dozen different organizations. Each of these organizations has disparate programs that vary in design, frequency, and indicators selected for measurement. Even where designs are similar, often the field techniques, laboratory methods, and quality assurance requirements are not comparable so cumulative assessments are infeasible. Finally, assuming all programs were of comparable design and quality, there is no overarching information management system so sharing data is extremely labor intensive if not entirely impracticable.

The goal of this document is to describe a large-scale, regional monitoring program of southern California's coastal streams and rivers. The objective is to create a comprehensive monitoring design that integrates many elements of the individualized monitoring programs that currently exist within the region. As part of this design, a necessary component will facilitate comparability in the field and the laboratory, set performance-based QA guidelines, and initiate an information management system for sharing data. Data analysis elements will be described for creating assessment endpoints of stream health. This integrated regional monitoring program is designed to be collaborative, so that each individual program can assess their local geography, then contribute their portion to the whole of the region to address large-scale management needs and provide answers to the public about the health of southern California's streams and rivers.

The motivation behind the integrated regional watershed monitoring is the Stormwater Monitoring Coalition (SMC) and the Surface Water Ambient Monitoring Program (SWAMP). The SMC is a coalition of stormwater management agencies and Regional Water Quality Control Boards (RWQCBs) from Ventura to San Diego (Table 1). Unlike any other organization in the United States, the SMC's mission is to cooperatively answer the technical questions that enable better environmental decision-making regarding stormwater management. The SWAMP is a statewide receiving water monitoring program administered by the Sate Water Resources Control Board (SWRCB). The two programs effectively cross paths in the area of wadeable streams in southern California with the parallel objective of assess health of the region's aquatic resources. As such, the two programs have joined forces to create the regional watershed monitoring program described herein.

MONITORING QUESTIONS AND GENERAL APPROACH

The Regional Watershed Monitoring Program addresses three questions of importance to regulated agencies, regulatory organizations, and public:

1. What is the condition of streams in Southern California?
2. What are the major stressors to aquatic life?
3. Are conditions in locations of special interest getting better or worse?

Each of these questions is answered by a different component of the monitoring program. Together, these components determine the spatial and temporal extent of impacts, their magnitude, and potential causes.

The first question addresses the magnitude and spatial extent of impacts of all streams in the region using a probabilistic sampling design. The goal will be to achieve an estimate of impacted stream miles at varying severity of impairment. In addition, the spatial extent of impact will be compared among watersheds and land uses. Therefore, stratification of the probabilistic design will occur across 15 different watershed areas that are defined by management units. Stratification will also occur across three different land uses defined as urban, agricultural, and open. At each site, multiple indicators will be used to assess the ecological health of the stream including water chemistry, aquatic toxicity, benthic macroinvertebrate community structure, periphyton, and physical and riparian habitat. Impacts will be defined by thresholds for each indicator, such as comparison with established benchmarks or standards for water quality. Macroinvertebrate communities will be evaluated by calculating the Southern California Index of Biotic Integrity (IBI, Ode et al. 2005) and by multivariate tools, such as the RIVPACS ratio of observed to expected taxa (O/E, Hawkins et al. 2000).

The second question addresses the stressors that affect the health of streams in Southern California. The goal of this component is to build upon the stressor and response data collected in the first component to develop a relative risk index (Van Sickle et al. 2006). The response variables will focus on ecological health endpoints such as biological measures of assemblage metrics or indices (i.e., IBI or O/E). Example stressors will include elevated nutrients, trace metals, degraded physical habitat, and increased toxicity. The relative risk of each stressor will be calculated by comparing the ecological health response variables at sites where the stressor is above or below thresholds of concern. This component requires no sampling effort beyond that required by the first component, but merely a more thorough analysis or the data.

The third question addresses the temporal changes in stream health at locations of primary interest to managers. The goal is to assess if stream health is improving, degrading, or remaining static over time. A targeted monitoring design that focuses on watershed sites that integrate upstream inputs is preferred. To answer this question, we will set up a network of long-term monitoring sites across the region. All coastal watersheds will have at least one long-term monitoring site located at the bottom of the watershed. Additional sites may be located in the interior below major tributaries and other regions of interest. At each site, water chemistry and toxicity will be evaluated at least once per year during dry weather. Ideally, these sites will be co-located at existing sites so that historical data can be used to help assess trends.

SPECIFIC APPROACH

The specific approach to the regional monitoring design is broken into two sections according to design. The first section addresses the first and second questions and is focused on spatial extent. The next section addresses the third question and is focused on trends.

Spatial Extent

The questions regarding spatial extent has several study design characteristics including sampling frame, sample size, frequency, indicators, and methods.

Sampling Frame

Sample sites were selected using a probabilistic approach weighting by watershed, land use, and stream order (Stevens and Olsen 2004). The sampling frame includes 15 watershed units located from Ventura to San Diego and as far east as San Bernardino and Riverside Counties (Figure 1). These watersheds equate to combinations of management units utilized by the RWQCBs or SMC member agencies. Altogether these 15 watershed units are comprised of roughly 28,051 km^2 (Table 2). The streamlines used to define the sampling frame were derived from the National Hydrography Dataset (NHD Plus) (US

EPA and USGS 2007). Altogether, there are 9,492 stream miles of Strahler order 2 and greater in the sampling frame. Land use was defined as either urban, agriculture, or open based on CCAP remote imaging algorithms (National Oceanic and Atmospheric Administration 1995) (Figure 2). CCAP defines 35 different land use classes that have been aggregated into the three categories for this study (i.e., open, agriculture, urban, and water) (Table 3). The dominant land use within a 500-m buffer was assigned to each stream reach. Individual watersheds are described in Appendix 1.

Sample size

Sample size was defined based on the relative effort to obtain estimates of spatial extent with known estimates of precision. These estimates are defined by a power curve from a binomial distribution (Figure 3). In this case, a sample of 30 provides an estimate of spatial extent $\pm$ 12%, which was considered sufficient by managers in this region for making decisions. So, if each watershed requires 30 samples, and there are 15 watersheds, the total sample size for the spatial extent question will be 450 samples (Table 4). Since there are only three land use strata, there will be more than 30 sites in each land use (Table 4). The number of sites representing each land use type reflects the abundance of the land use type within the entire region. Figure 4 shows the distribution of sites in the sample draw, according to watershed and land use.

Frequency

Each site shall be sampled only once during an index period beginning 4 weeks following the last significant rainfall and no more than 12 weeks following the last rainfall. Significant rainfall is defined as precipitation that produces sufficient scouring to disrupt benthic communities. In addition, no sampling shall occur within 72 hours of any measureable rainfall. Based on historical rainfall records, the wet season in southern California ends April 15th (Figure 5). Without apriori knowledge of rainfall, the default index period will occur from May 15 to July 15.

Although all sampling must occur within the index period, not all sites need to be collected during the same year (Table 4). In fact, it is better to collect the sites across multiple years to incorporate the effects of differences in rainfall and subsequent hydrology. What was important to the SMC and SWAMP was to get an answer to the first monitoring question after five years (i.e., one NPDES permit cycle). Therefore, one-fifth of the samples will be collected each year. This equates to six sites per watershed or 90 sites per year total. After five years, a rolling five-year window can be used to assess trends in spatial extent.

Indicators

There are six different types of indicators used answer the question about spatial extent. All of these indicators will be measured in a manner comparable to SWAMP to ensure integration with statewide data sets. The first indicator is water chemistry. Water chemistry shall include conventional water quality, nutrients, trace metals, and pyrethroid pesticides (Table 5). The water chemistry variables shall be collected and analyzed according to Puckett (2002) and Ode (2005). The second indicator is aquatic toxicity to the water flea, *Ceriodaphnia dubia*. Chronic toxicity shall be measured as a 7-day exposure with effects endpoints of lethality and reproduction according to US EPA (1993). The freshwater amphipod, *Hyalella azteca*, in a water phase text, can be used as a back up species if conductivity is too high for *Ceriodaphnia* control survival. The third indicator is physical habitat that includes several types of measures of stream condition including flow, channel morphology, riparian cover, substrate, and human alterations. Measurements shall be collected according to Ode (2007). The fourth indicator is benthic macroinvertebrates. Benthos shall be collected using the multi-habitat method described in the SWAMP protocol (Ode 2007). Identifications will be done according to the Standard Taxonomic Effort Level 2 for California benthic macroinvertebrates, as described in Richards and Rogers (2007). The fifth indicator is wetland status. Wetland status shall be measured using the California Rapid Assessment Method (CRAM). CRAM is a cost effective diagnostic tool that is part of a comprehensive statewide program to monitor the health of wetlands and riparian habitats throughout California (Collins et al., 2007). The sixth indicator is periphyton. Periphyton, or attached algae, shall be measured in two ways; biomass and taxonomic identification. SWAMP is currently developing standardized methodology for periphyton. In an effort to maintain comparability, the reginal monitoring program shall adopt these same methods.

Trends

The question regarding temporal trends has several study design characteristics including sample sites, frequency, indicators and methods.

Sampling Sites

Sample sites were selected using a targeted approach weighting. The criteria for site selection included: 1) located near the terminus of the stream or river so that it integrates all discharges upstream of the site; and 2) is a previously monitored location so prior data collection can be utilized. One site per watershed examined in the spatial extent design was selected for a total of 15 sites (Figure 1, Table 6). Additional sites can be selected as desired.

Frequency

Sampling frequency is a function of data variability, amount of change to detect, and time to detect change. These three factors are best evaluated using power analysis at each site for each indicator. Based on power analysis from a subset of sites, a minimum of 1 sample per year shall be collected during a dry weather index period from each site (Figure 6). Additional samples may be collected to increase the power to detect trends on a site-by-site basis. The index period shall match the index period used for the spatial extent question.

Indicators

There are two different types of indicators used answer the question about trends: water chemistry and aquatic toxicity. Both of these indicators will be measured in a manner comparable to SWAMP to ensure integration with statewide data sets. Water chemistry shall include conventional water quality, nutrients, trace metals, PAHs, and pyrethroid pesticides (Table 5). The water chemistry variables shall be collected and analyzed according to Puckett (2002) and Ode (2005). The second indicator is aquatic toxicity to the water flea, *Ceriodaphnia dubia*. Chronic toxicity shall be measured as a 7-day exposure with effects endpoints of lethality and reproduction according to US EPA (1993).

PRODUCTS

There will be four types of products generated for the regional monitoring program. The first product will be a field manual. This manual will document all of the recommended methods for field activities including necessary equipment, sampling protocols, training requirements, field data sheets, and sample site assignments. As part of the field manual, there will be a meeting of all of the field team leaders to ensure consistency and comparability among agencies conducting sampling. One such training and intercalibration occurred in February 2004 and a second in May 2006.

The second product from the regional monitoring program will be a quality assurance manual. The quality assurance manual will document the recommended data quality objectives (DQOs) for field and laboratory activities. The DQOs set minimum standards for sensitivity, accuracy, precision, and representativeness. Only with this level of quality control can data be made comparable enough for compilation. The SMC has already undergone two laboratory intercalibrations and created a laboratory guidance manual for many of the water chemistry constituents required for this workplan.

The third product from the regional monitoring program will be an Information Management (IM) Manual. The IM Manual will be the key document that enables the various agencies share data. The IM Manual will consist of standardized data formats (SDTFs). SDTFs detail the data types and formats (i.e., order of variables) enabling laboratories to deliver complete data sets in any software format, including delimited ASCII code. No new software, hardware, or extensive personnel training is required for SDTFs. The SMC has already created and shared SDTFs for most of the data types being collected in the Regional Monitoring Program (Cooper et al. 2004).

The fourth product from the regional monitoring program will be an assessment report. The assessment report will be a synopsis of the findings of the survey that addresses the three questions. While there are a large number of potential data products from this type of a survey, a few examples are listed here. To answer the first question, an assessment of stream-miles impacted will be conducted (Figure 7). This will provide a statistically valid answer to the question of overall health of streams regionally. This assessment will include the percent of stream-miles for southern California as a whole and by individual watersheds. A similar data product can be developed, but replacing watersheds with different land uses along the x-axis.

To answer the second question, the relative risk of various stressors will be evaluated by dividing the extent of stream-miles impacted by that stressor by the extent of impacted stream-miles not impacted by that same stressor (Figure 8). Quotients near unity represent limited or no increased risk to aquatic life for that stressor. Quotients greater than one represent an increased risk for that stressor. The greater the quotient, the greater the relative risk. This data can be used to assess the potential risk in future site specific applications, help to determine sources of impact at individual sites, or to help assess important factors in remediation/restoration projects.

To answer the third question, the temporal trends of stream health indicators will be plotted over time to determine if resources are improving, degrading, or remaining unchanged (Figure 9). This will be useful at the watershed specific level to determine if site-specific management actions have been successful at improving water quality impacts. This will also be useful at the regional level to determine if large-scale changes may be influencing local or site specific trends. That is, decreases (or increase) in stream health may be a reflection of large-scale phenomenon such as global warming, nonindigenous species, or other event, rather than watershed specific activities.

SCHEDULE

The regional monitoring program will be a five-year process (Figure 10). Sample preparation, including field and QA manuals will occur prior to the first year of sampling. Sampling will be completed by July and Laboratory analysis should take approximately 6 months. Compiling data, examining results, and making our first year assessments should require approximately three months (March). This will provide sufficient time to use what lessons were learned during year 1 and improve the program for year 2. An oral report of results from the first year will be presented by March, and a written first year report should be completed by June. This process is then repeated each year.

REFERENCES

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Table 1. List of member agencies in the Stormwater Monitoring Coalition.

California Regional Water Quality Control Board, Los Angeles Region
California Regional Water Quality Control Board, San Diego Region
California Regional Water Quality Control Board, Santa Ana Region
California Department of Transportation, Caltrans
City of Long Beach
City of Los Angeles, Watershed Protection Division
County of Orange, Public Facilities and Resources Dept.
County of San Diego Stormwater Management Program
Los Angeles County Department of Public Works
Riverside County Flood Control and Water Conservation District
San Bernardino County Flood Control District
Southern California Coastal Water Research Project
State Water Resources Control Board
US Environmental Protection Agency, Office of Research and Development
Ventura County Watershed Protection District

Table 2. Watersheds included in the monitoring program.

Watershed	Area (km^2)	Stream order	Total stream length (km)	Land use by area (proportion) Open	Agricultural	Urban	Water
Ventura	642	6	264	0.88	0.05	0.05	0.03
Santa Clara	4,327	7	1,763	0.85	0.07	0.05	0.03
Calleguas	891	5	391	0.46	0.31	0.21	0.03
Santa Monica Bay	1,171	4	260	0.59	0.03	0.37	0.06
Los Angeles	2,160	5	626	0.44	0.02	0.53	0.06
San Gabriel	1,758	5	586	0.49	0.02	0.47	0.05
Santa Ana River	7,092	6	2,202	0.58	0.10	0.29	0.04
--Lower Santa Ana	1,253	6	349	0.35	0.06	0.54	0.07
--Middle Santa Ana	2,135	6	622	0.43	0.13	0.41	0.04
--Upper Santa Ana	1,721	5	654	0.78	0.04	0.15	0.03
--San Jacinto	1,984	4	576	0.71	0.14	0.12	0.02
San Juan	1,019	4	400	0.75	0.03	0.19	0.03
Northern San Diego	3,640	6	1,299	0.80	0.12	0.06	0.02
Carlsbad	1,725	5	513	0.57	0.08	0.32	0.04
Mission Bay	1,270	5	390	0.71	0.03	0.23	0.04
Southern San Diego	2,355	5	798	0.78	0.04	0.15	0.04
Entire region	28,051	7	9,492	0.66	0.08	0.23	0.03

Table 3: Land use classes defined by the SMC and CCAP.

SMC class	CCAP class
Agriculture	Cultivated Land
Agriculture	Managed Grassland
Agriculture	Orchards
Agriculture	Pasture
Agriculture	Row Crop
Open	Bare Land
Open	Chaparral
Open	Deciduous Forest
Open	Estuarine Emergent Wetland
Open	Estuarine Forested Wetland
Open	Estuarine Scrub/Shrub Wetland
Open	Evergreen Forest
Open	Golf Courses
Open	Mixed Forest
Open	Palustrine Emergent Wetland
Open	Palustrine Forested Wetland
Open	Palustrine Scrub/Shrub Wetland
Open	Parks / Lawns
Open	Rangeland
Open	Sage
Open	Scrub/Shrub
Open	Unmanaged Grassland
Urban	Commercial/Industrial
Urban	High Intensity Developed
Urban	High Intensity Urban Residential
Urban	Low Intensity Developed
Urban	Rural Residential
Urban	Suburban Residential
Urban	Urban Residential
Excluded	Background
Excluded	Estuarine Aquatic Bed
Excluded	Palustrine Aquatic Bed
Excluded	Unclassified
Excluded	Unconsolidated Shore
Excluded	Water

Table 4. Projected number of samples by year.

Year	Number of samples in all watersheds	Number of samples in each watershed	Number of samples by land use		
			Open	Agriculture	Urban
2009	90	6	40	15	35
2010	90	6	28	21	41
2011	90	6	36	21	33
2012	90	6	28	32	30
2013	90	6	30	28	32
Total after five years	450	30	162	117	171

Table 5. Variables measured at each site in the. P = variables measured at sites included in the probabilistic components of the project (i.e., questions 1 and 2). T = variables measured at sites included in the network of long-term trends sites.

Variable	P/T	Method	Accuracy	Precision	Reporting Limit
Biological					
Benthic macroinvertebrates	P	Ode 2007	Re-sort frequency: 100% Re-sort accuracy: ≥95% Lab ID frequency: 10% Lab ID Accuracy: ≥95%	Field duplicates: 10%	SAFIT Level 2
Periphyton: Chlorophyll a Ash-free dry mass Taxonomy	 P P P		 ±20% of SRM. NA Diatoms,archive macroalga	Field duplicates: 10%	 10 μg/cm^2 1 mg/ cm^2
Riparian condition (CRAM)	P	Collins 2007			
Toxicity					
Ceriodaphnia dubia assays	P,T	EPA 1993	NA	Lab duplicates 10%	NA
Water Chemistry					
Conventional water chemistry Temperature pH Conductivity Dissolved oxygen Alkalinity Hardness	P,T	 Probe Probe Probe Probe	 NA ± 0.5 units of SRM ±5% of SRM ±0.5 mg/L of SRM ±10% of SRM	 ± 0.5 C ± 0.5 units ±5% ±0.5 mg/L ±10%	 NA 0 - 14 pH units 2.5 mS/cm 0.5 mg/L 10 mg/L
Nutrients Ammonia Nitrite Nitrate Total nitrogen Orthophosphate Total phosphorous	P,T		Within 80% to 120% of true value	Field replicate, laboratory duplicate 10%, or MS/MSD ± 25% RPD. Laboratory duplicate minimum.	 0.1 mg/L 0.01 mg/L 0.1 mg/L 0.1 mg/L 0.01 mg/L 0.1 mg/L
Major ions Calcium Sulfate	P,T		Within 80% to 120% of true value	Field replicate, laboratory duplicate 10%, or MS/MSD ±	 0.05 mg/L 0.25 mg/L

					25% RPD. Laboratory duplicate minimum.	
	Metals (dissolved and Total) Arsenic Cadmium Chromium Copper Iron Lead Nickel Zinc	P,T	EPA 200.8	Within 80% to 120% of true value	Field replicate, laboratory duplicate, or MS/MSD $\pm$ 20% RPD. Laboratory duplicate minimum.	 1.0 µg/L 0.5 µg/L 1.0 µg/L 1.0 µg/L 10 µg/L 1.0 µg/L 1.0 µg/L 1.0 µg/L
	Organic constituents Pyrethroid pesticides Organophosphate pesticides PCBs PAHs	 P,T T T T	 8081/82 EPA 8270	50% to 150% of true value.	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	 ng/L ng/L 1.0 ng/L 0.5 – 1.0 ng/L
Physical habitat						
	Location (latitude and longitude) Channel dimensions Channel substrate Embeddedness Gradient and sinuosity Human influence Riparian vegetation Instream habitat complexity Flow habitats Discharge Rapid bioassessment scores Additional habitat characterization		Ode 2007	NA	NA	$10^{-5\circ}$ 1 cm 1 mm NA NA NA NA NA NA NA NA NA

SRM: Standard Reference Material
CI: Confidence Interval
MS: Matrix Spike
MSD: Matrix Spike Duplicate
RPD: Relative Percent Difference
NA: Not applicable

Table 6. List of trend monitoring sites.

Watershed	Stream	Location
Ventura	Ventura River	at Foster Park
Santa Clara	Santa Clara River	Freeman Diversion
Calleguas	Calleguas Creek	at University Drive
Santa Monica Bay	Ballona Creek	at Sawtelle
Los Angeles	Los Angeles River	at Willow
San Gabriel	San Gabriel River	R9W
San Gabriel	San Gabriel River	R9E
Lower Santa Ana	San Diego Creek	at Campus Drive
Middle Santa Ana	Santa Ana River	at River Road
Upper Santa Ana	Santa Ana River	MWD Crossing
San Jacinto	San Jacinto River	at Goetz/TMDL site
San Juan	San Juan Creek	at Novia
Northern San Diego	Santa Margarita	at Basilone
Carlsbad	Escondido Creek	at Mass Emissions Site
Mission Bay	San Diego River	at Fashion Valley Rd
Southern San Diego	Tijuana River	at Hollister Rd

Figure 1. Map of watersheds included in the regional watershed monitoring program.

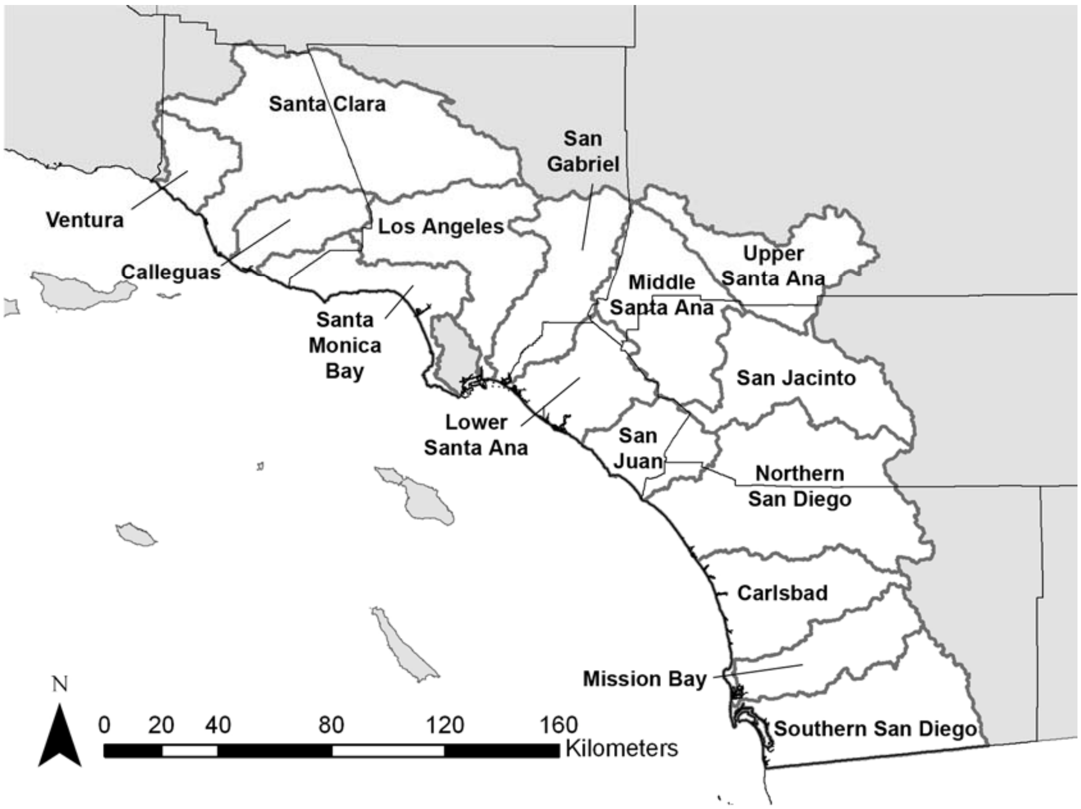


Figure 2. A. CCAP remote imaging of land use in the southern California region. B. Land use assignments for the watersheds included in the study.

A

B

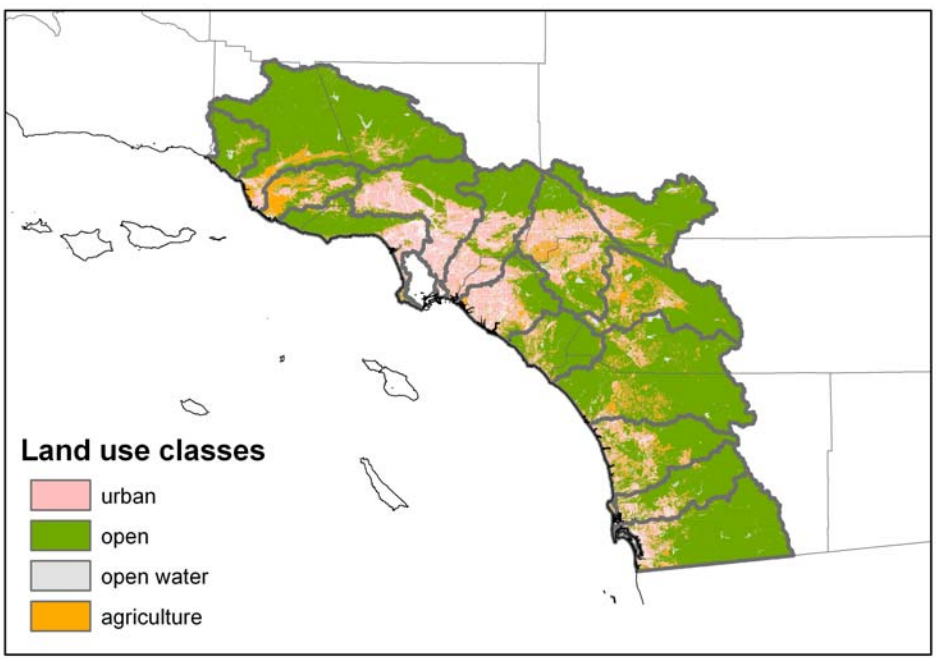


Figure 3. Size of confidence intervals about areal estimates (i.e., percent stream-miles) for different sample sizes.

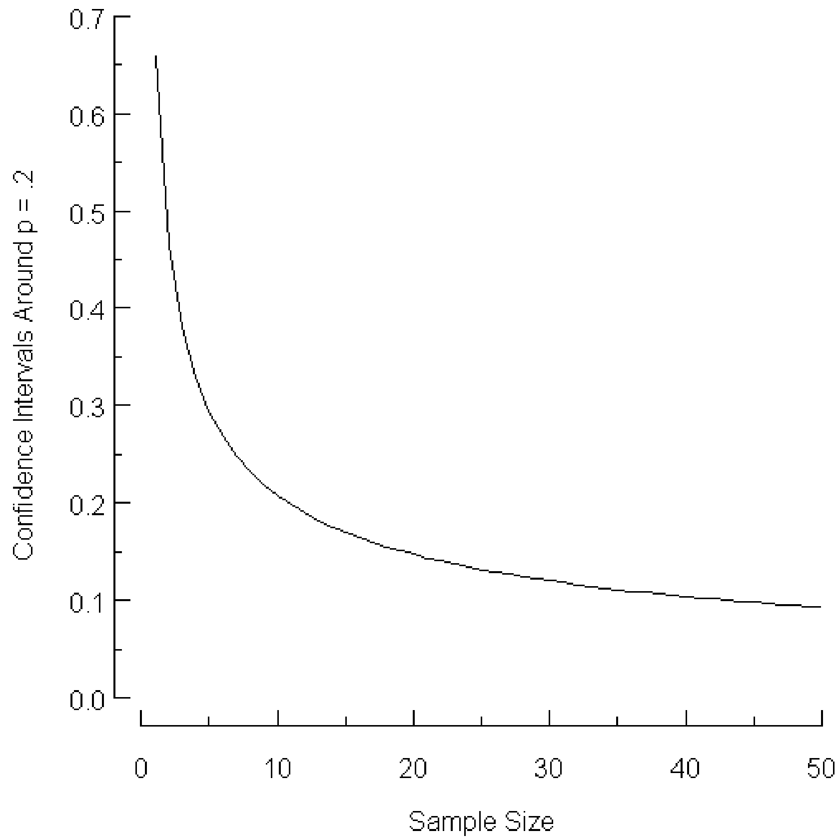


Figure 4. Locations of sample sites for the SMC regional watershed monitoring program.

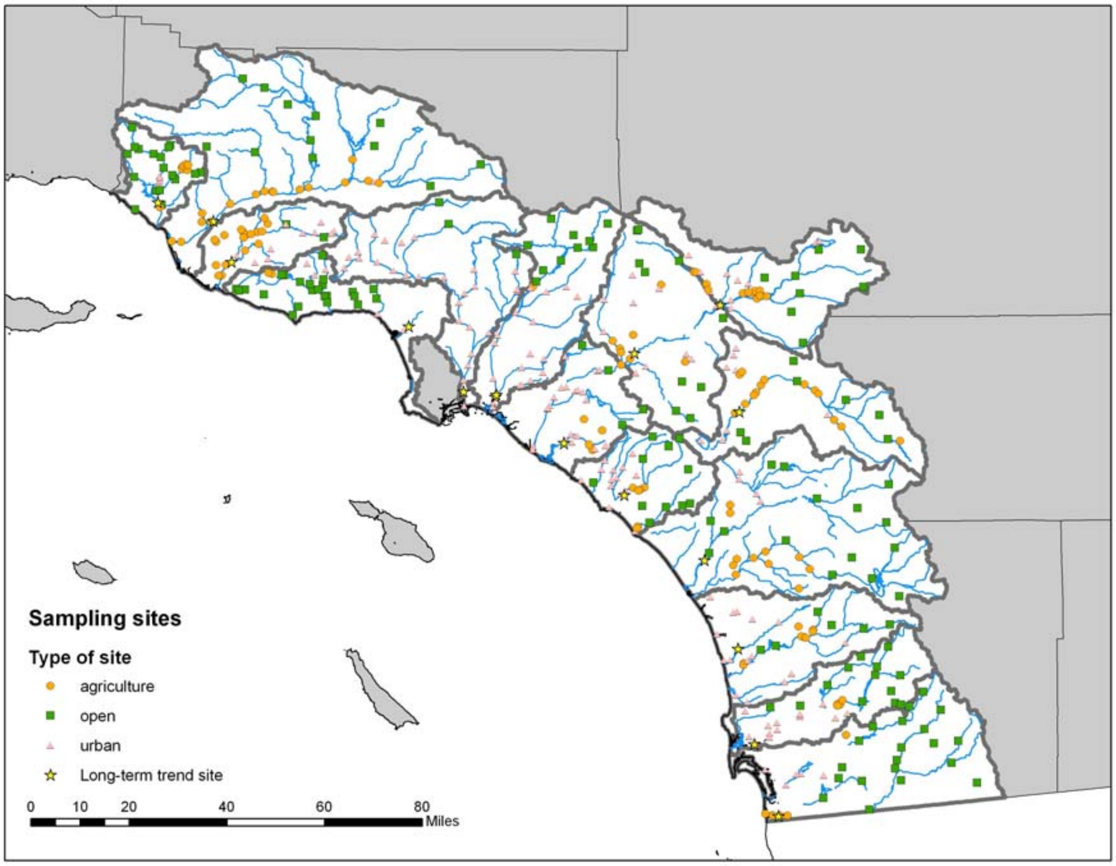


Figure 5. Avergae monthly rainfall quantities at Lindbergh Field, San Diego from 1905 to 2006.

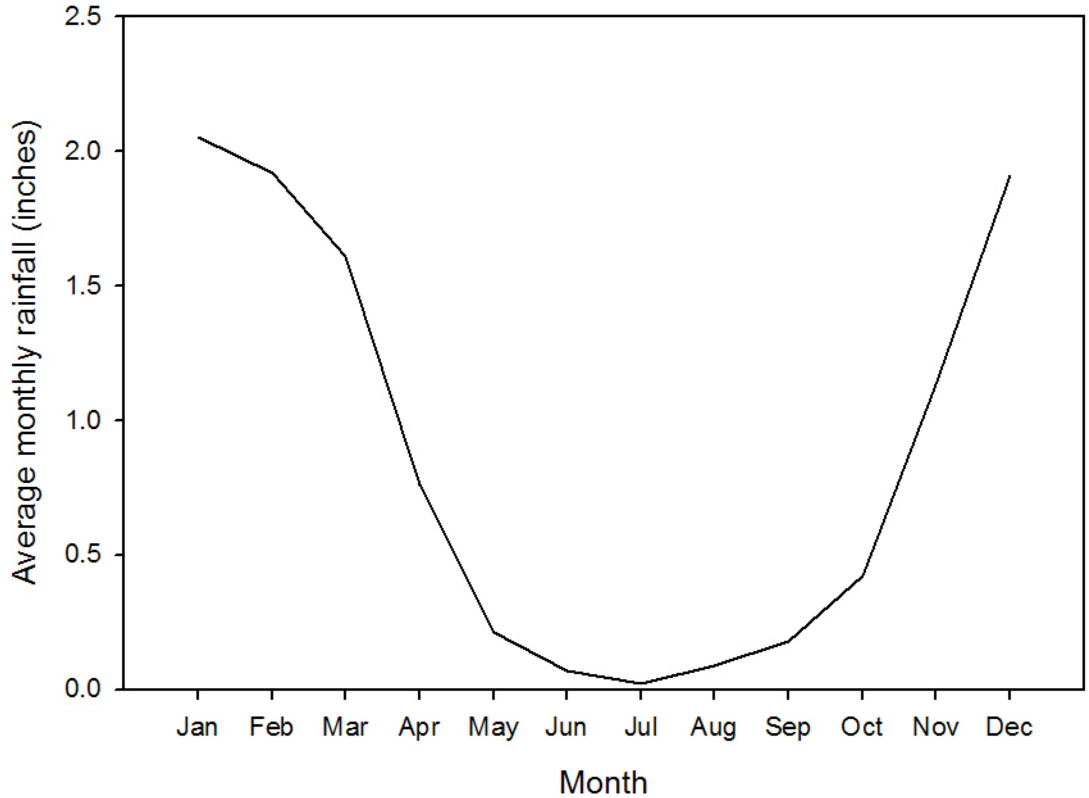


Figure 6. Power curves to detect changes in a constituent at a long-term monitoring site (Hemet NPDES site in Riverside County). The right-most solid line represents power of one sample per year; from left to right, the remaining samples represent 2, 3, and 4 samples per year. [

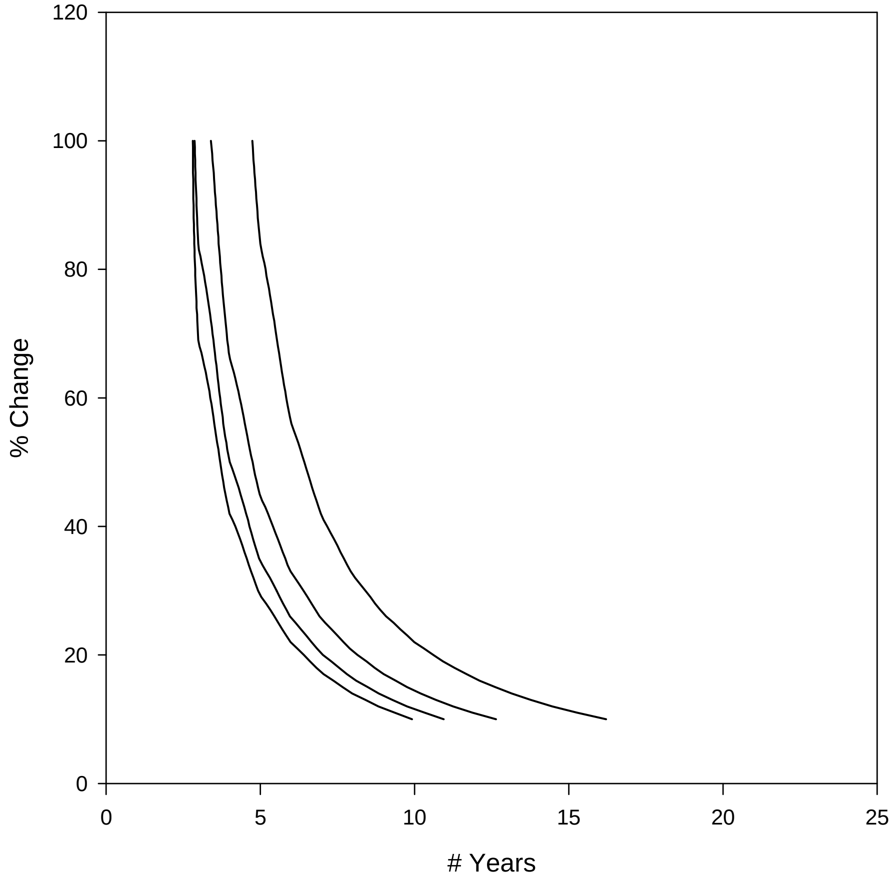


Figure 7. Hypothetical distribution of degraded stream miles among different watersheds.

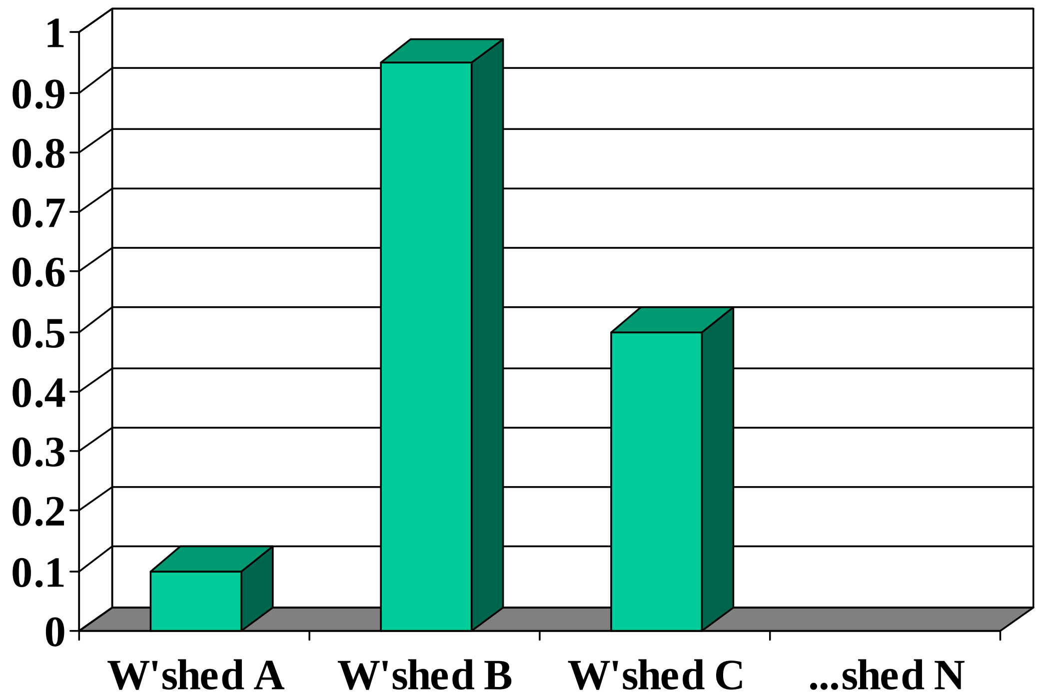


Figure 8. Hypothetical relative risks for stressors to an indicator.   Relative risk is the quotient of extent (as %) of stream miles impaired by stressor x in an anthropogenic stratum and the extent of stream miles (as %) of stream miles impaired by stressor x in open (or reference) stratum.

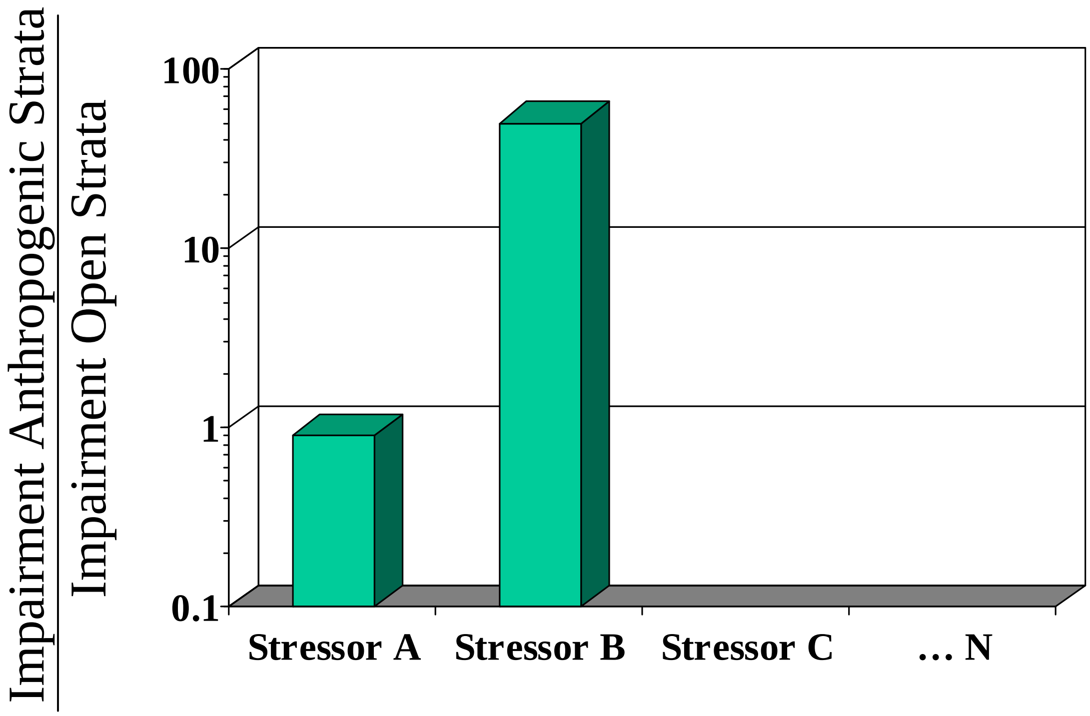


Figure 9. Hypothetical trends in a constituent measured at a trends site. Points reflect differences in values relative to Year 1 values at an integrator site.

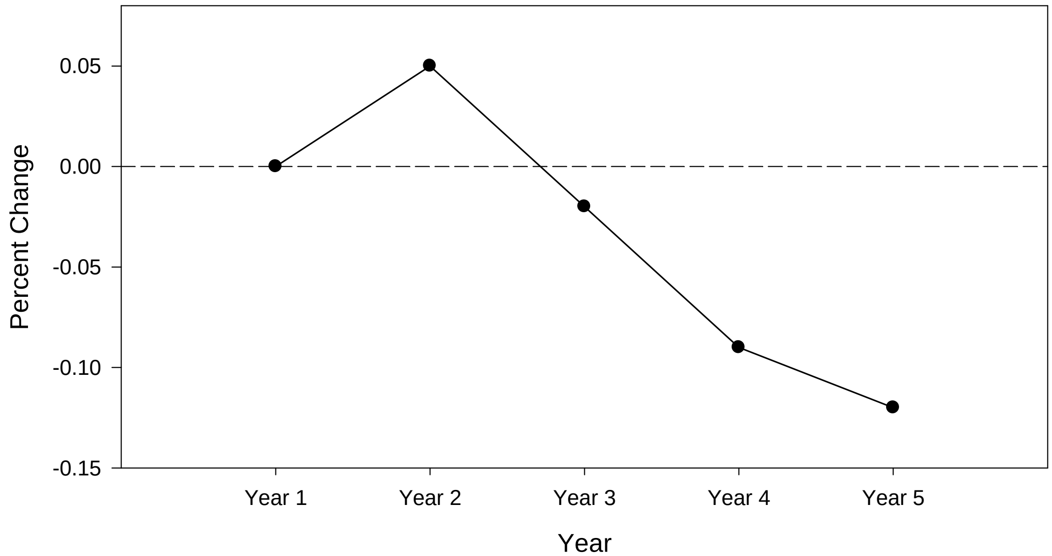
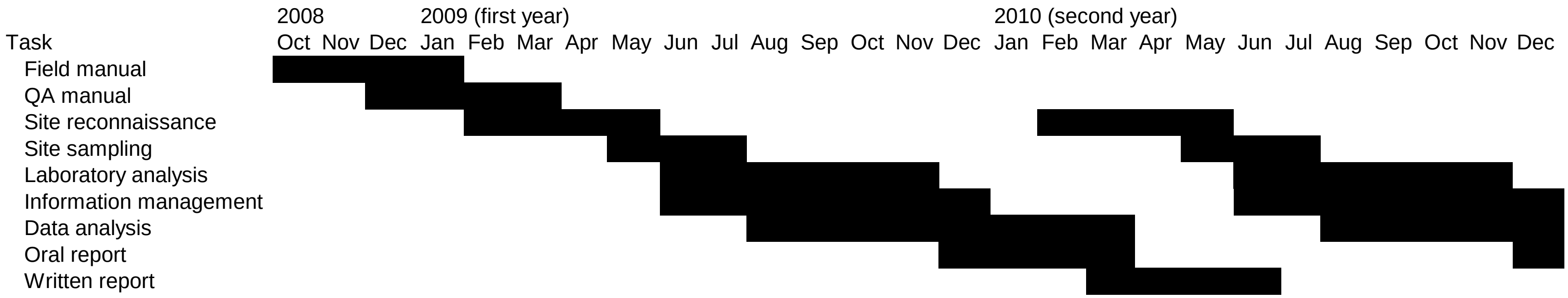


Figure 10. Timeline of activities through the first two years



ATTACHMENT 4

Bight 2008 Monitoring Methods

ATTACHMENT 4: Bight 2008 Monitoring Methods

Bight 2008 Monitoring Methods

The 2008–2009 monitoring program included surveying the aquatic health of San Diego's bays, estuaries, and lagoons as part of a regional assessment of the Southern California Bight (SCB). The Copermittees chose to participate in the Bight '08 Survey in lieu of conducting the complete regional stormwater monitoring requirements as presented in the San Diego Region Municipal NPDES Permit Order No. 2007-0001. By doing so, the Copermittees are not only providing data useful in answering the five core management questions of the San Diego Regional Permit, but are also simultaneously helping to build datasets used to analyze coastal marine health and provide an assessment of the health of local lagoons. Detailed methods of the Bight '08 monitoring program can be found in *the San Diego County Municipal Copermittees Bight 2008 Workplan*. The methods are summarized below.

Field Sampling

Site Selection

The Copermittees selected the following eight lagoons/estuaries in the San Diego Region for inclusion in the Bight '08 program: Santa Margarita Lagoon, Agua Hedionda Lagoon, Batiquitos Lagoon, San Elijo Lagoon, Los Peñasquitos Lagoon, San Diego River Estuary, Sweetwater River Estuary, and Tijuana River Estuary. In accordance with the Bight '08 Workplan, a longitudinal-transect study was used to investigate changes in sediment conditions at increasing distances from freshwater input areas of the lagoons. Lagoons were partitioned into five segments and sampling stations were selected using a tessellated random sampling design. If a site was located in an area that was recently dredged, as the result of maintenance dredging, or if the site was inaccessible due to unforeseen reasons, Bight '08 protocols (SCCWRP 2008b) were followed to select an appropriate substitute site outside of the randomly selected area of influence. Sample locations for the eight lagoons/estuaries in the San Diego Region are shown in Figure 1. In this figure, random sample draw points are shown in red while the actual sample sites are shown in yellow.

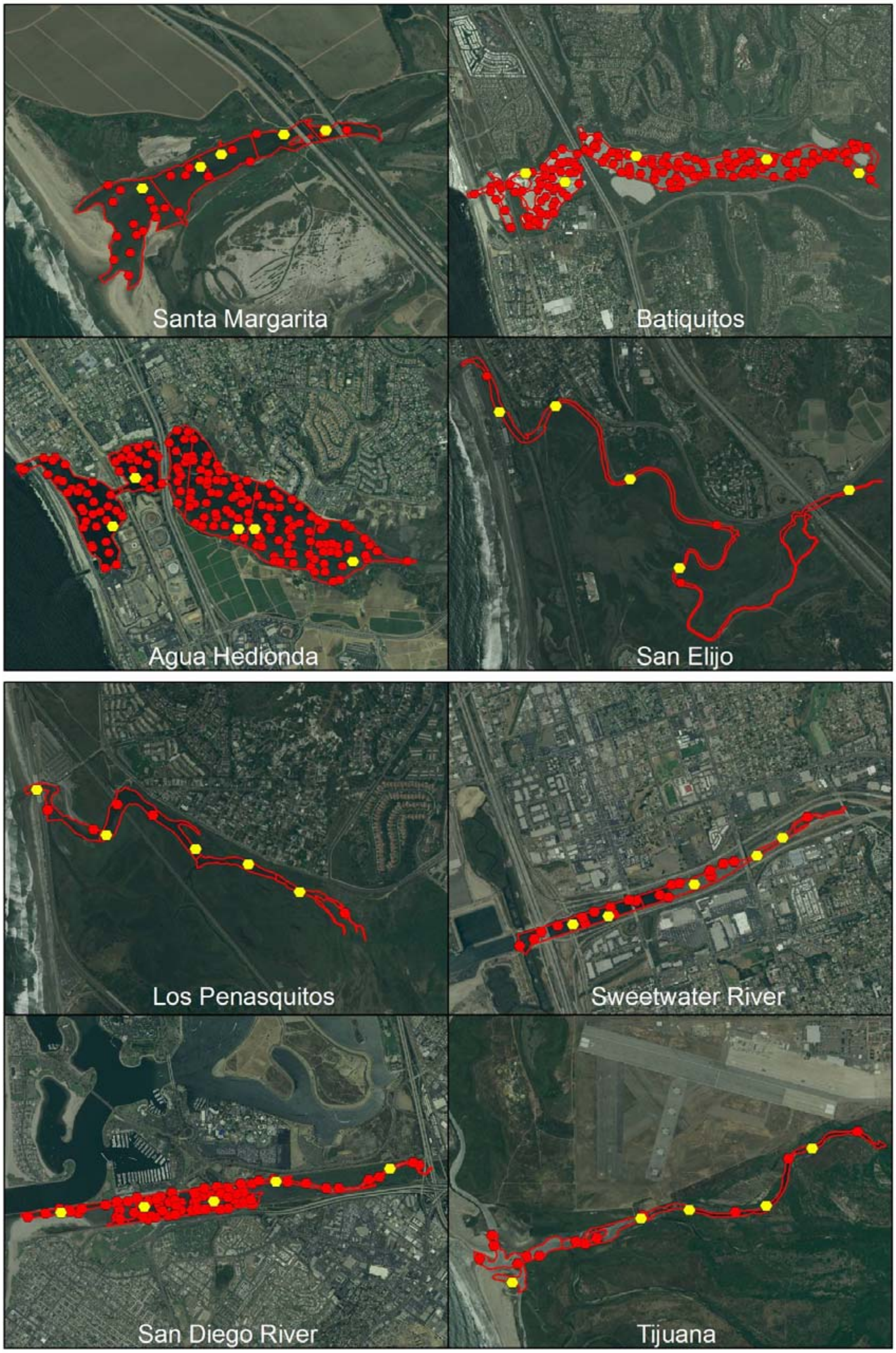


Figure 1. Segment Strata Design Maps Showing Random Sample Draw Points (red) and Actual Sample Locations (yellow).

Water Sampling

Water quality samples were collected as part of a San Diego Region special study to answer questions related to ambient water quality conditions in lagoons. Water quality samples were collected at each sediment location prior to the collection of sediment samples. Samples were collected 0.2 m below the surface within each lagoon/estuary segment. Water samples were analyzed for total suspended solids (TSS), total and fecal coliform, and enterococci. Water quality parameters were collected using a YSI 6600 data sonde at 0.2 m below the surface, mid-depth, and 0.2 m above the bottom. Water quality parameters analyzed were pH, salinity, temperature, dissolved oxygen (DO), and turbidity. A complete list of analyses with corresponding analytical methods and reporting limits is provided in Table 1. TSS analysis was performed by CRG Marine Laboratories, Inc. (CRG). Bacteria samples were analyzed by WESTON.

Table 1. Water Analytical list, Methods, and Reporting Limits

Analyte	Method/ Instrument	Units	Reporting Limit	Laboratory
pH	Field/YSI 6600	pH Units	14-Jan	Field
Salinity	Field/YSI 6600	ppt	Jan-75	Field
Temperature	Field/YSI 6600	°C	0-100	Field
Dissolved oxygen	Field/YSI 6600	mg/l	0.2	Field
Turbidity	Field/YSI 6600	ntu	0.1	Field
Total Suspended Solids	SM 2540 D	mg/l	1	CRG
Total Coliform	SM 9221 B,E	MPN/100 ml	2-1,600,000	Weston.
Fecal Coliform	SM 9221 B,E	MPN/100 ml	2-1,600,000	Weston
Enterococci	SM 9230	MPN/100 ml	2-160,000	Weston

Sediment Sampling

Lagoon and estuary sampling occurred during the summer of 2008 following Bight '08 protocols (SCCWRP 2008b). Benthic sediments were collected using a stainless steel, 0.1-m^2 Van Veen grab sampler. A minimum of four sediment grabs per station were collected for the following analyses: benthic infauna, chemistry, grain size, and toxicity. A sample was determined to be acceptable if the surface of the grab was even, there was minimal surface disturbance, and there was a penetration depth of at least 5 centimeters (cm). Rejected grabs were discarded and re-sampled. In accordance with Bight '08 protocols, each of the infaunal samples was sub-sampled and split into three fractions. Sub-sampling occurred using two 0.01 m^2 subcores (considered to be fractions A and B) inserted into the Van Veen, while fraction C was considered to be the remaining sediment in the grab. The purpose of the sub-sampling was for a separate study being performed by the Southern California Coastal Water Research Project (SCCWRP) that was focused on comparing benthic infauna results from a smaller surface area sampler than those from Van Veen samples in embayments (harbors, lagoons, and estuaries). Samples were analyzed as separate fractions to be in compliance with the Bight '08 program; however, for the purposes of this monitoring program, the data for all three fractions were combined as one sample.

Samples collected for infaunal analysis were rinsed through a 1.0-mm mesh screen and transferred to a labeled quart jar. A 7% magnesium sulfate ($MgSO_4$) seawater solution was added for approximately 30 minutes to relax the collected specimens. The samples were then fixed in a 10% buffered formalin solution. Infaunal samples were analyzed by WESTON.

Sediment toxicity and chemistry samples were collected from the top 5 cm of the grab, avoiding sediment within 1 cm of the sides of the grab. A total of 5 liters (L) of sediment was collected for acute and chronic toxicity and placed into five 1-L jars. Toxicity samples were kept at 4°C on ice in coolers. Sediment to be analyzed for percent solids, acid volatile sulfides, total organic carbon (TOC), total nitrogen, trace metals, synthetic pyrethroids, organochlorine pesticides, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs) was placed into one 250 ounce jar (oz), stored at 4°C on ice, and frozen within 24 hours. Approximately 150-200 grams of sediment were collected for grain size. Samples were placed into a 4 oz plastic container and stored on ice. Chemistry samples were shipped frozen to CRG Marine Laboratories, Inc. (CRG) within one week of collection for analyses. The samples for acute and chronic toxicity were analyzed by WESTON. Grain size analysis was performed by the City of San Diego Marine Laboratory using a Horiba LA-920 laser scattering particle analyzer.

Laboratory Analysis

Chemistry

Chemical analyses were performed on sediment samples; a complete list of chemical analytes for sediment analyses with corresponding analytical methods and detection limits is provided in Table 2. Sediment samples were analyzed for percent solids, grain size distribution, acid volatile sulfides, TOC, total nitrogen, trace metals, synthetic pyrethroids, organochlorine pesticides, PCBs, and PAHs.

Table 2. Sediment Analytical list, Methods, and Detection and Reporting Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
General Chemistry				
Acid Volatile Sulfides	Plumb, 1981/TERL	mg/dry kg	0.05	0.1
Percent Solids	EPA 160.3	Percent	0.1	0.1
Total Nitrogen	SM 4500-N	mg/dry kg	2	4
Total Organic Carbon	SM 5310B	%	0.01	0.02
Grain Size Analysis	Plumb, 1981	%	-	-
Total Metals-Standard				
Aluminum (Al)	EPA 6020	µg/dry g	1	5
Antimony (Sb)	EPA 6020	µg/dry g	0.025	0.05
Arsenic (As)	EPA 6020	µg/dry g	0.025	0.05
Barium (Ba)	EPA 6020	µg/dry g	0.025	0.05
Beryllium (Be)	EPA 6020	µg/dry g	0.025	0.05

Table 2. Sediment Analytical list, Methods, and Detection and Reporting Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
Cadmium (Cd)	EPA 6020	µg/dry g	0.025	0.05
Chromium (Cr)	EPA 6020	µg/dry g	0.025	0.05
Cobalt (Co)	EPA 6020	µg/dry g	0.025	0.05
Copper (Cu)	EPA 6020	µg/dry g	0.025	0.05
Iron (Fe)	EPA 6020	µg/dry g	1	5
Lead (Pb)	EPA 6020	µg/dry g	0.025	0.05
Manganese (Mn)	EPA 6020	µg/dry g	0.025	0.05
Mercury (Hg)	EPA 245.7	µg/dry g	0.01	0.02
Molybdenum (Mo)	EPA 6020	µg/dry g	0.025	0.05
Nickel (Ni)	EPA 6020	µg/dry g	0.025	0.05
Selenium (Se)	EPA 6020	µg/dry g	0.025	0.05
Silver (Ag)	EPA 6020	µg/dry g	0.025	0.05
Strontium (Sr)	EPA 6020	µg/dry g	0.025	0.05
Thallium (TI)	EPA 6020	µg/dry g	0.025	0.05
Tin (Sn)	EPA 6020	µg/dry g	0.025	0.05
Titanium (Ti)	EPA 6020	µg/dry g	0.025	0.05
Vanadium (V)	EPA 6020	µg/dry g	0.025	0.05
Zinc (Zn)	EPA 6020	µg/dry g	0.025	0.05
Total Metals-AVS-SEM				
Aluminum (Al)	EPA 200.8	µmol/dry g	0.1852	0.926
Antimony (Sb)	EPA 200.8	µmol/dry g	0.0008	0.0016
Arsenic (As)	EPA 200.8	µmol/dry g	0.0027	0.0054
Barium (Ba)	EPA 200.8	µmol/dry g	0.0015	0.003
Beryllium (Be)	EPA 200.8	µmol/dry g	0.0222	0.0444
Cadmium (Cd)	EPA 200.8	µmol/dry g	0.0018	0.0036
Chromium (Cr)	EPA 200.8	µmol/dry g	0.0019	0.0038
Cobalt (Co)	EPA 200.8	µmol/dry g	0.0017	0.0034
Copper (Cu)	EPA 200.8	µmol/dry g	0.0062	0.0124
Iron (Fe)	EPA 200.8	µmol/dry g	0.0877	0.4385
Lead (Pb)	EPA 200.8	µmol/dry g	0.0002	0.0004
Manganese (Mn)	EPA 200.8	µmol/dry g	0.0036	0.0072
Molybdenum (Mo)	EPA 200.8	µmol/dry g	0.0021	0.0042
Nickel (Ni)	EPA 200.8	µmol/dry g	0.0033	0.0066
Selenium (Se)	EPA 200.8	µmol/dry g	0.0024	0.0048
Silver (Ag)	EPA 200.8	µmol/dry g	0.0047	0.0094
Strontium (Sr)	EPA 200.8	µmol/dry g	0.0011	0.0022
Thallium (TI)	EPA 200.8	µmol/dry g	0.0005	0.001
Tin (Sn)	EPA 200.8	µmol/dry g	0.0008	0.0016
Titanium (Ti)	EPA 200.8	µmol/dry g	0.0043	0.0086
Vanadium (V)	EPA 200.8	µmol/dry g	0.0039	0.0078
Zinc (Zn)	EPA 200.8	µmol/dry g	0.0015	0.003
Chlorinated Pesticides				
2,4'-DDD	EPA 8270C	ng/dry g	1	5

Table 2. Sediment Analytical list, Methods, and Detection and Reporting Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
2,4'-DDE	EPA 8270C	ng/dry g	1	5
2,4'-DDT	EPA 8270C	ng/dry g	1	5
4,4'-DDD	EPA 8270C	ng/dry g	1	5
4,4'-DDE	EPA 8270C	ng/dry g	1	5
4,4'-DDT	EPA 8270C	ng/dry g	1	5
Aldrin	EPA 8270C	ng/dry g	1	5
BHC-alpha	EPA 8270C	ng/dry g	1	5
BHC-beta	EPA 8270C	ng/dry g	1	5
BHC-delta	EPA 8270C	ng/dry g	1	5
BHC-gamma	EPA 8270C	ng/dry g	1	5
Chlordane-alpha	EPA 8270C	ng/dry g	1	5
Chlordane-gamma	EPA 8270C	ng/dry g	1	5
DCPA (Dacthal)	EPA 8270C	ng/dry g	5	10
Dicofol	EPA 8270C	ng/dry g	1	5
Dieldrin	EPA 8270C	ng/dry g	1	5
Endosulfan Sulfate	EPA 8270C	ng/dry g	1	5
Endosulfan-I	EPA 8270C	ng/dry g	1	5
Endosulfan-II	EPA 8270C	ng/dry g	1	5
Endrin	EPA 8270C	ng/dry g	1	5
Endrin Aldehyde	EPA 8270C	ng/dry g	1	5
Endrin Ketone	EPA 8270C	ng/dry g	1	5
Heptachlor	EPA 8270C	ng/dry g	1	5
Heptachlor Epoxide	EPA 8270C	ng/dry g	1	5
Methoxychlor	EPA 8270C	ng/dry g	1	5
Mirex	EPA 8270C	ng/dry g	1	5
Oxychlordane	EPA 8270C	ng/dry g	1	5
Perthane	EPA 8270C	ng/dry g	5	10
Toxaphene	EPA 8270C	ng/dry g	10	50
cis-Nonachlor	EPA 8270C	ng/dry g	1	5
trans-Nonachlor	EPA 8270C	ng/dry g	1	5
Pyrethroids by NCI				
Allethrin	EPA 8270 NCI	ng/dry g	0.5	2
Bifenthrin	EPA 8270 NCI	ng/dry g	0.5	2
Cyfluthrin	EPA 8270 NCI	ng/dry g	0.5	2
Cypermethrin	EPA 8270 NCI	ng/dry g	0.5	2
Danitol	EPA 8270 NCI	ng/dry g	0.5	2
Deltamethrin	EPA 8270 NCI	ng/dry g	0.5	2
Esfenvalerate	EPA 8270 NCI	ng/dry g	0.5	2
Fenvalerate	EPA 8270 NCI	ng/dry g	0.5	2
Fluvalinate	EPA 8270 NCI	ng/dry g	0.5	2
L-Cyhalothrin	EPA 8270 NCI	ng/dry g	0.5	2
Permethrin	EPA 8270 NCI	ng/dry g	5	25
Prallethrin	EPA 8270 NCI	ng/dry g	0.5	2

Table 2. Sediment Analytical list, Methods, and Detection and Reporting Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
Resmethrin	EPA 8270 NCI	ng/dry g	5	25
PCB Congeners				
PCB003	EPA 8270C	ng/dry g	1	5
PCB008	EPA 8270C	ng/dry g	1	5
PCB018	EPA 8270C	ng/dry g	1	5
PCB028	EPA 8270C	ng/dry g	1	5
PCB031	EPA 8270C	ng/dry g	1	5
PCB033	EPA 8270C	ng/dry g	1	5
PCB037	EPA 8270C	ng/dry g	1	5
PCB044	EPA 8270C	ng/dry g	1	5
PCB049	EPA 8270C	ng/dry g	1	5
PCB052	EPA 8270C	ng/dry g	1	5
PCB056/060	EPA 8270C	ng/dry g	1	5
PCB066	EPA 8270C	ng/dry g	1	5
PCB070	EPA 8270C	ng/dry g	1	5
PCB074	EPA 8270C	ng/dry g	1	5
PCB077	EPA 8270C	ng/dry g	1	5
PCB081	EPA 8270C	ng/dry g	1	5
PCB087	EPA 8270C	ng/dry g	1	5
PCB095	EPA 8270C	ng/dry g	1	5
PCB097	EPA 8270C	ng/dry g	1	5
PCB099	EPA 8270C	ng/dry g	1	5
PCB101	EPA 8270C	ng/dry g	1	5
PCB105	EPA 8270C	ng/dry g	1	5
PCB110	EPA 8270C	ng/dry g	1	5
PCB114	EPA 8270C	ng/dry g	1	5
PCB118	EPA 8270C	ng/dry g	1	5
PCB119	EPA 8270C	ng/dry g	1	5
PCB123	EPA 8270C	ng/dry g	1	5
PCB126	EPA 8270C	ng/dry g	1	5
PCB128	EPA 8270C	ng/dry g	1	5
PCB138	EPA 8270C	ng/dry g	1	5
PCB141	EPA 8270C	ng/dry g	1	5
PCB149	EPA 8270C	ng/dry g	1	5
PCB151	EPA 8270C	ng/dry g	1	5
PCB153	EPA 8270C	ng/dry g	1	5
PCB156	EPA 8270C	ng/dry g	1	5
PCB157	EPA 8270C	ng/dry g	1	5
PCB158	EPA 8270C	ng/dry g	1	5
PCB167	EPA 8270C	ng/dry g	1	5
PCB168+132	EPA 8270C	ng/dry g	1	5
PCB169	EPA 8270C	ng/dry g	1	5
PCB170	EPA 8270C	ng/dry g	1	5

Table 2. Sediment Analytical list, Methods, and Detection and Reporting Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
PCB174	EPA 8270C	ng/dry g	1	5
PCB177	EPA 8270C	ng/dry g	1	5
PCB180	EPA 8270C	ng/dry g	1	5
PCB183	EPA 8270C	ng/dry g	1	5
PCB187	EPA 8270C	ng/dry g	1	5
PCB189	EPA 8270C	ng/dry g	1	5
PCB194	EPA 8270C	ng/dry g	1	5
PCB195	EPA 8270C	ng/dry g	1	5
PCB200	EPA 8270C	ng/dry g	1	5
PCB201	EPA 8270C	ng/dry g	1	5
PCB203	EPA 8270C	ng/dry g	1	5
PCB206	EPA 8270C	ng/dry g	1	5
PCB209	EPA 8270C	ng/dry g	1	5
Polynuclear Aromatic Hydrocarbons				
1-Methylnaphthalene	EPA 8270C	ng/dry g	1	5
1-Methylphenanthrene	EPA 8270C	ng/dry g	1	5
2,3,5-Trimethylnaphthalene	EPA 8270C	ng/dry g	1	5
2,6-Dimethylnaphthalene	EPA 8270C	ng/dry g	1	5
2-Methylnaphthalene	EPA 8270C	ng/dry g	1	5
Acenaphthene	EPA 8270C	ng/dry g	1	5
Acenaphthylene	EPA 8270C	ng/dry g	1	5
Anthracene	EPA 8270C	ng/dry g	1	5
Benz[a]anthracene	EPA 8270C	ng/dry g	1	5
Benzo[a]pyrene	EPA 8270C	ng/dry g	1	5
Benzo[b]fluoranthene	EPA 8270C	ng/dry g	1	5
Benzo[e]pyrene	EPA 8270C	ng/dry g	1	5
Benzo[g,h,i]perylene	EPA 8270C	ng/dry g	1	5
Benzo[k]fluoranthene	EPA 8270C	ng/dry g	1	5
Biphenyl	EPA 8270C	ng/dry g	1	5
Chrysene	EPA 8270C	ng/dry g	1	5
Dibenz[a,h]anthracene	EPA 8270C	ng/dry g	1	5
Dibenzothiophene	EPA 8270C	ng/dry g	1	5
Fluoranthene	EPA 8270C	ng/dry g	1	5
Fluorene	EPA 8270C	ng/dry g	1	5
Indeno[1,2,3-c,d]pyrene	EPA 8270C	ng/dry g	1	5
Naphthalene	EPA 8270C	ng/dry g	1	5
Perylene	EPA 8270C	ng/dry g	1	5
Phenanthrene	EPA 8270C	ng/dry g	1	5
Pyrene	EPA 8270C	ng/dry g	1	5

Toxicity

Solid Phase (SP) Testing

Solid phase bioassays were performed to estimate the potential toxicity of the collected sediments to benthic organisms. The sediments were tested in a 10-day SP test using the marine amphipod *Eohaustorius estuarius*. SP bioassays were conducted in accordance with procedures outlined in the amphipod testing manual (USEPA 1994) and the American Society for Testing and Materials (ASTM) method E1367-03 (ASTM 2006). On the day before test initiation, 2-cm aliquots of sample sediment were placed in each of five replicate glass jars followed by approximately 800 mL of prepared seawater. Five replicate controls were also set up to determine the health of the amphipods; this was done by exposing the amphipods to clean sediment according to the same protocols used for the test sediments. The test chambers were left overnight to allow establishment of equilibrium between the sediment and overlying water. On day zero of the test, 20 amphipods were randomly placed in each of the test chambers. Any amphipods that did not bury in the sediment within an hour were removed and replaced. Samples were monitored daily for obvious mortality, sublethal effects, and abnormal behavior. Water quality, including dissolved oxygen, temperature, salinity and pH, was monitored daily. Overlying and interstitial ammonia were also measured at test initiation and test termination. At the end of the test, organisms were removed from the test chambers by sieving the sediment through a 0.5-mm mesh screen and the numbers of live and dead amphipods in each test chamber were recorded. The percent survival was calculated for the control and test sediments. The acceptability of the test was determined by evaluating the response of the control organisms. The test was considered acceptable if there was 90% mean control survival.

A 96-hour reference toxicity test was conducted concurrently with the sediment test to establish sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The reference toxicant test was performed using the reference substance ammonium chloride with target concentrations of 15.62, 31.25, 62.50, 125.0, and 250.0 mg NH_4/L. Ten test organisms were added to each of four replicates of these concentrations. Subsamples were obtained at test initiation and were used to measure actual ammonia concentrations and to calculate unionized ammonia concentrations. The concentrations of total ammonia and unionized ammonia that caused 50% mortality of the organisms (the median lethal concentration, or LC_{50}) were calculated from the data. The LC_{50} values were then compared to historical laboratory data for the test species with ammonium chloride. The results of this test were used in combination with the control mortality to assess the health of the test organisms.

Sediment-Water Interface (SWI) testing

Sediment-water interface bioassays were performed to estimate the potential toxicity of contaminants fluxed from test sediments to the overlying water. The sediments were tested in a 48-hour SWI test using the bivalve *Mytilus galloprovincialis*. SWI bioassays were conducted in accordance with procedures outlined in USEPA 1995 and Anderson et al 1996. On the day before test initiation, 5-cm aliquots of sample sediment were placed in each of five replicate glass chambers followed by approximately 300 mL of prepared seawater. Five replicate controls were also set up to verify that the test system was not causing toxicity; this was done by exposing the bivalve larvae to test chambers with screen tubes but no sediment. The test chambers were left overnight to allow establishment of equilibrium between the sediment and overlying water. On day zero of the test, polycarbonate screen tubes were lowered into each chamber so that larvae settled inside the screen tube were in close proximity to the sediment surface. Approximately 250 bivalve larvae were placed inside the screen tube in each of the test chambers. Water quality, including dissolved oxygen, temperature, salinity and pH, was monitored daily. Overlying and interstitial ammonia were also measured at test initiation and test termination. At the end of the test, organisms were retrieved from the test chambers by removing the screen tubes and gently rinsing the larvae into glass shell vials with clean filtered seawater. The vials were preserved with formalin to be analyzed by microscope. After microscope counts were performed, the percent normal-alive was calculated for the control and test sediments. The acceptability of the test was determined by evaluating the response of the control organisms. The test was considered acceptable if there was 70% mean control normal-alive.

A 48-hour reference toxicity test was conducted concurrently with the sediment test to establish sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The reference toxicant test was performed using the reference substance ammonium chloride with target concentrations of 1.0, 2.0, 5.0, 7.0, 10, and 20 mg NH_4/L. Approximately 250 larvae were added to each of five replicates of these concentrations. Subsamples were obtained at test initiation and were used to measure actual ammonia concentrations and to calculate unionized ammonia concentrations. The concentrations of total ammonia and unionized ammonia that caused 50% mortality and 50% reduction normality of the organisms (the median lethal concentration, or LC_{50}) were calculated from the data. The LC_{50} values were then compared to historical laboratory data for the test species with ammonium chloride. The results of this test were used in combination with the percent control normal-alive to assess the health of the test organisms.

***Leptocheirus plumulosus* test**

Since several San Diego estuaries have high percentages of fine-grained sediment that may contribute to higher toxicity in *E. estuarius* based solely on the physical size of the grains rather than chemical influences (small grains can clog the gills of *E. estuarius*), a second species of marine/estuarine amphipod, *L. plumulosus*, was tested. The side by side testing of *E. estuarius* and *L. plumulosus* was done to assess the effect of grain size on toxicity.

The *L. plumulosus* SP bioassays were conducted in accordance with procedures outlined in the amphipod testing manual (USEPA 1994), the Inland Testing Manual (USEPA/USACE 1998) and the American Society for Testing and Materials (ASTM) method E1367-03 (ASTM 2006b). Test procedures, conditions, and acceptability criteria used for *L. plumulosus* were identical to those previously described for *E. estuarius* with two exceptions: *L. plumulosus* testing was run using slightly different temperature and salinity ranges.

A 96-hour reference toxicity test was conducted concurrently with the sediment test to establish sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The reference toxicant test was performed using the reference substance ammonium chloride with target concentrations of 15.62, 31.25, 62.50, 125.0, and 250.0 mg NH_4/L. Ten test organisms were added to each of four replicates of these concentrations. Subsamples were obtained at test initiation and were used to measure actual ammonia concentrations and to calculate unionized ammonia concentrations. The concentrations of total ammonia and unionized ammonia that caused 50% mortality of the organisms (the median lethal concentration, or LC_{50}) were calculated from the data. The LC_{50} values were then compared to historical laboratory data for the test species with ammonium chloride. The results of this test were used in combination with the control mortality to assess the health of the test organisms.

Sediment Toxicity Identification Evaluations (TIEs)

Targeted TIEs were conducted on sediment that was re-collected at Bight ’08 stations 6252 (Batiquitos Lagoon), 6009 (Tijuana River), and 6189 (San Diego River) to evaluate whether naturally occurring ammonia in sediment was the causative agent of toxicity to mussel (*M. galloprovincialis*) larvae. TIE test procedures were conducted in accordance with the USEPA guidance manual (USEPA, 2007) and the Bight ’08 Coastal Ecology Workplan. TIE treatments included using *Ulva lactuca*, an alga known to absorb ammonia from the water column, and the use of a resin (SIR-600), known to bind ammonia in pore water.

A detailed description of the methods used to perform the TIE analyses is provided in the TIE report in Appendix E.

Infauna

The benthic infaunal samples were transported from the field to the laboratory and stored in a formalin solution for a minimum of 6 days. The samples were then transferred from formalin to 70% ethanol for laboratory processing. In accordance with Bight ’08 protocols (SCCWRP 2008a), the organisms were initially sorted using a dissecting microscope into five groups: polychaetes, crustaceans, molluscs, echinoderms, and miscellaneous minor phyla. While sorting, technicians kept a rough count for quality assurance/quality control (QA/QC) purposes, as described in the following paragraph. After initial sorting, qualified taxonomists identified each organism to the lowest possible taxon, and species counts were tabulated. The Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) Edition 5 was used for nomenclature and orthography.

A QA/QC procedure was performed on each of the sorted samples to ensure a 95% sorting efficiency. A 10% aliquot of a sample was re-sorted by a senior technician trained in the QA/QC procedure. The number of organisms found in the aliquot was divided by 10% and added to the total number found in the sample. The original total was divided by the new total to calculate the percent sorting efficiency. When the sorting efficiency of the sample was below 95%, the remainder of the sample (90%) was re-sorted.

Microbiology

Water samples were analyzed for total and fecal coliforms using SM 9221B and E. Enterococci were analyzed using SM 9230B. All results were reported to a most probable number (MPN) value with a minimum reporting limit of <2 MPN/100mL and a maximum reporting limit of

1,600,000 MPN/100mL for total and fecal coliforms. Samples analyzed for enterococci, had a minimum reporting limit of <2 MPN/100mL and a maximum of 160,000 MPN/100mL. All samples were delivered to the analytical laboratory within the 6-hour holding time requirement. Sample analysis was initiated immediately upon receipt.

Quality Assurance

Quality assurance and quality control for sampling processes included proper collection of the samples in order to minimize the possibility of contamination. All samples were collected in laboratory supplied, laboratory-certified, contaminant-free sample bottles. Field blanks were used to assess the sample collection, container, and transport of the samples to the analytical laboratory. The chemistry analysis of the samples was performed under the guidelines of the quality assurance and quality control programs established by the respective state-certified analytical laboratory.

All sample results were reviewed for adherence to the quality guidelines provided by the individual technical laboratories and workgroups. Results underwent a through quality control review and were entered into a data sharing template and submitted to SCCWRP in accordance with the Bight ’08 Workplan.

Sediment Quality Objectives

Sediment quality from the four harbors was assessed using California’s SQOs as described in the *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality* (State Water Resources Control Board [SWRCB] – California Environmental Protection Agency [Cal EPA], 2009). The goals of the SQOs are to determine if pollutants in sediments are present in quantities that are toxic to benthic organisms and/or will bioaccumulate in marine organisms to levels that may be harmful to humans.

The SQOs are based on a multiple-lines-of-evidence (MLOE) approach in which sediment toxicity, sediment chemistry, and benthic community condition are the lines of evidence (LOE). The MLOE approach evaluates the severity of biological effects and the potential for chemically-mediated effects to provide a final station level assessment. The specific methods associated with each LOE and the integration of the MLOE is described below.

Sediment Chemistry

Concentrations of chemicals detected in sediments are compared to the California Logistic Regression Model (CA LRM) and the Chemical Score Index (CSI). The CA LRM is a maximum probability model (P_{MAX}) that uses logistic regression to predict the probability of sediment toxicity. The CSI is a predictive index that relates sediment chemical concentration to benthic community disturbance to southern California benthic infauna. Sediment chemistry results according to CA LRM and CSI are categorized as having minimal, low, moderate, and high exposure to pollutants (Table 3). The final sediment LOE category is the average of the two chemistry exposure categories. If the average falls midway in between the two categories it is rounded up to the higher of the two.

Table 3. Sediment Chemistry Guideline Categorization

Sediment Chemistry Guideline		Sediment LOE Category
CA LRM	CSI	
<0.33	<1.69	**Minimal Exposure**
0.33 - 0.49	1.69 - 2.33	**Low Exposure**
0.50 - 0.66	2.34 - 2.99	**Moderate Exposure**
>0.66	>2.99	**High Exposure**

Sediment Toxicity

Sediment toxicity is assessed using two tests: a 10-day *E. estuarius* short term survival test and a sublethal sediment test using the mussel *M. galloprovincialis*. Sediment toxicity test results from each station are statistically compared to control test results to determine if they are significantly different, normalized to the control survival, and categorized as nontoxic, low, moderate, and high toxicity (Table 4 and Table 5). The average of the two test responses is then calculated to determine the final toxicity LOE category. When the average falls midway between two categories than the value is rounded up to the next higher response category.

Table 4. Sediment toxicity categorization values for Eohaustorius estuarius

% Survival of *E. estuarius* in Project Sediment		Toxicity LOE Category
If Significantly Different than Control Survival	If Not Significantly Different from Control	
90 – 100	82 – 100	**Nontoxic**
82 – 89	59 – 81	**Low Toxicity**
59 – 81		**Moderate Toxicity**
< 59	< 59	**High Toxicity**

Table 5. Sediment toxicity categorization values for Mytilus galloprovincialis

% Development of *M. galloprovincialis* in Project Sediment		Toxicity LOE Category
If Significantly Different than Control Development	If Not Significantly Different from Control	
80 – 100	77-79	**Nontoxic**
77-79	42-76	**Low Toxicity**
42-76		**Moderate Toxicity**
< 42	< 42	**High Toxicity**

Benthic Community Condition

Benthic community condition is assessed using a combination of four benthic indices: the Benthic Response Index (BRI), Relative Benthic Index (RBI), Index of Biotic Integrity (IBI), and a predictive model based on the River Invertebrate Prediction and Classification System (RIVPACS), following the January 21, 2008 guidance provided by the SCCWRP entitled *Determining Benthic Invertebrate Community Condition in Embayments* for southern California marine bays. All benthic invertebrates were identified to the lowest possible taxon using the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) Edition 5 for nomenclature. It is important to note that current SQO guidelines are utilizing the SCAMIT Edition 4 for species identification; however, the guidelines will be updated to Edition 5 when SCCWRP completes the analysis of the Bight '08 benthic data. Each benthic index result is categorized according to four levels of disturbance, including reference, low, moderate, and high disturbance.

- Reference: Equivalent to a least affected or unaffected site

- Low Disturbance: Some indication of stress is present, but is within measurement error of unaffected condition

- Moderate Disturbance: Clear evidence of physical, chemical, natural, or anthropogenic stress

- High Disturbance: High magnitude of stress

Specific categorization values, which were specifically tailored to southern California marine bays, were assigned for each index (Table 6). The final step in determining the benthic community condition was the integration of the four indices into a single category. In doing so, the median of the four benthic index response categories was computed to determine the benthic condition. If the median fell between two categories, the value was rounded to the next higher category to provide the most conservative estimate of benthic community condition.

Table 6. Benthic Index Categorization Values for Southern California Marine Bays

<table>
<tr><th colspan="4">Benthic Community Guideline</th><th rowspan="2">Benthic Index Category</th></tr>
<tr><th>BRI</th><th>IBI</th><th>RBI</th><th>RIVPACS</th></tr>
<tr><td>< 39.96</td><td>0</td><td>> 0.27</td><td>> 0.90 to < 1.10</td><td>Reference</td></tr>
<tr><td>≥39.96 to <49.14</td><td>1</td><td>> 0.16 to ≤ 0.27</td><td>> 0.75 to ≤ 0.90 or ≥1.10 to < 1.26</td><td>Low Disturbance</td></tr>
<tr><td>≥49.15 to <73.27</td><td>2</td><td>> 0.08 to ≤ 0.16</td><td>> 0.32 to ≤ 0.74 or > 1.26</td><td>Moderate Disturbance</td></tr>
<tr><td>≥ 73.27</td><td>3 or 4</td><td>≤ 0.08</td><td>≤ 0.32</td><td>High Disturbance</td></tr>
</table>

Integration of Multiple Lines of Evidence

The station level assessment provides an indication of whether the aquatic life SQOs is being met at each station of interest. The station level assessment is based on the severity of biological effects (i.e., integration of toxicity LOE and benthic condition LOE categories) and the potential for chemically-mediated effects (i.e., integration of toxicity LOE and chemistry LOE categories), using decision matrices presented in Table 7 and Table 8, respectively.

Table 7. Severity of Biological Effects Category

Benthic Condition LOE Category	Toxicity LOE Category	Severity of Biological Effects Category
Reference	Nontoxic	**Unaffected**
Reference	Low Toxicity	**Unaffected**
Reference	Moderate Toxicity	**Unaffected**
Reference	High Toxicity	**Low Effect**
Low Disturbance	Nontoxic	**Unaffected**
Low Disturbance	Low Toxicity	**Low Effect**
Low Disturbance	Moderate Toxicity	**Low Effect**
Low Disturbance	High Toxicity	**Low Effect**
Moderate Disturbance	Nontoxic	**Moderate Effect**
Moderate Disturbance	Low Toxicity	**Moderate Effect**
Moderate Disturbance	Moderate Toxicity	**Moderate Effect**
Moderate Disturbance	High Toxicity	**Moderate Effect**
High Disturbance	Nontoxic	**Moderate Effect**
High Disturbance	Low Toxicity	**High Effect**
High Disturbance	Moderate Toxicity	**High Effect**
High Disturbance	High Toxicity	**High Effect**

Table 8. Potential for Chemically Mediated Effects Category

Sediment Chemistry Category	Toxicity LOE Category	Potential for Chemically Mediated Effects Category
Minimal Exposure	Nontoxic	**Minimal Potential**
Minimal Exposure	Low Toxicity	**Minimal Potential**
Minimal Exposure	Moderate Toxicity	**Low Potential**
Minimal Exposure	High Toxicity	**Moderate Potential**
Low Exposure	Nontoxic	**Minimal Potential**
Low Exposure	Low Toxicity	**Low Potential**
Low Exposure	Moderate Toxicity	**Moderate Potential**
Low Exposure	High Toxicity	**Moderate Potential**
Moderate Exposure	Nontoxic	**Low Potential**
Moderate Exposure	Low Toxicity	**Moderate Potential**
Moderate Exposure	Moderate Toxicity	**Moderate Potential**
Moderate Exposure	High Toxicity	**Moderate Potential**
High Exposure	Nontoxic	**Moderate Potential**
High Exposure	Low Toxicity	**Moderate Potential**
High Exposure	Moderate Toxicity	**High Potential**
High Exposure	High Toxicity	**High Potential**

Station Level Assessment

The station level assessment can be determined by combining the severity of biological effects category as shown in Table 9 with the potential for chemically-mediated effect category which results in one of six possible station level assessments including unimpacted, likely unimpacted, possibly impacted, likely impacted, clearly impacted, and inconclusive.

Table 9. Station Level Assessment Matrix

Severity of Biological Effects Category	Potential for Chemically Mediated Effects Category	Station Level Assessment
Unaffected	Minimal Potential	**Unimpacted**
Unaffected	Low Potential	**Unimpacted**
Unaffected	Moderate Potential	**Likely Unimpacted**
Unaffected	High Potential	**Inconclusive**
Low Effect	Minimal Potential	**Likely Unimpacted**
Low Effect	Low Potential	**Likely Unimpacted**
Low Effect	Moderate Potential	**Possibly Impacted or Inconclusive**
Low Effect	High Potential	**Likely Impacted**
Moderate Effect	Minimal Potential	**Likely Unimpacted**
Moderate Effect	Low Potential	**Possibly Impacted**
Moderate Effect	Moderate Potential	**Likely Impacted**
Moderate Effect	High Potential	**Clearly Impacted**
High Effect	Minimal Potential	**Inconclusive**
High Effect	Low Potential	**Possibly Impacted**
High Effect	Moderate Potential	**Likely Impacted**
High Effect	High Potential	**Clearly Impacted**

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ATTACHMENT 5

Coastal Storm Drain Monitoring Methods

ATTACHMENT 5: Coastal Storm Drain Monitoring Methods

Coastal Storm Drain Monitoring

The Receiving Waters and Urban Runoff Monitoring and Reporting Program for the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit Order No. R9-2007-0001 requires the Copermittees to identify coastal storm drains which discharge to coastal waters and to conduct monthly sampling of all flowing coastal storm drains for bacterial indicators. At locations in which flowing coastal storm drains are discharging to coastal waters, paired samples from the storm drain discharge and the coastal receiving water were to be collected. At locations in which the flowing coastal storm drain does not discharge to coastal waters, only the storm drain discharge was to be sampled. The frequency of sample collection could be reduced to every other month if the paired coastal storm drain data meets certain criteria as specified in the San Diego Regional Copermittees 2008-2009 Coastal Storm Drain Monitoring (CSDM) Program. Re-sampling of coastal storm drains was to occur within one business day of receipt of analytical results in which both the storm drain and receiving water exceed AB 411 or Basin Plan standards or the storm drain sample exceeds 95th percentile observations of the previous year's data for any bacterial indicator. Detailed methods of the CSDM Program can be found in the *2008-2009 Coastal Storm Drain Monitorng Program*. The methods are summarized below.

Sample Collection

Samples were collected from all locations that met the site selection criteria. Active monitoring sites for each jurisdiction were selected based on accessibility, safety, and outfalls that convey urban runoff from the Copermittee's MS4. Storm drain samples were collected at all flowing storm drain outlets, regardless of whether the discharge came into direct contact with the receiving water, infiltrated into sand prior to reaching the receiving water, or ponded between the storm drain and the receiving water. Paired samples from both the storm drain and receiving water were collected at locations in which storm drain flows were observed reaching the receiving water. Samples were not collected from locations that would have required the disturbance of sensitive habitat, locations that were deemed unsafe to sample, or locations that did not have observed flow from the storm drain. For paired samples, receiving water samples were collected 25 yards down current from the storm drain outlet (Figure 1), where possible, pending accessibility.

Sample collection was performed by trained field personnel in accordance with procedures described in Standard Operating Procedures for the Collection of Bacteria Samples from Storm Drains and Receiving Waters (Creeks Lagoons, Bays, and Ocean) using the following collection methods: Direct Fall Collection, Syringe Collection, and Plunge Collection. Care was taken during sample collection to avoid the disturbance of sediment. All samples were collected in laboratory supplied, laboratory-certified, contaminant-free sample bottles. One field bland and one sample duplicate was collected per every nine samples. Field blanks were used to assess the sample collection, container, and transport of the samples to the analytical laboratory, while duplicate samples were used to assess variability of the samples. Sample bottles were labeled with the following information: Station ID, Source (storm drain or receiving water), sampler's initials, date, time, and any other pertinent information. Immediately following sample collection, samples were placed on ice in a sample cooler with a completed chain of custody form. All samples were delivered to the laboratory within six hours of collection.

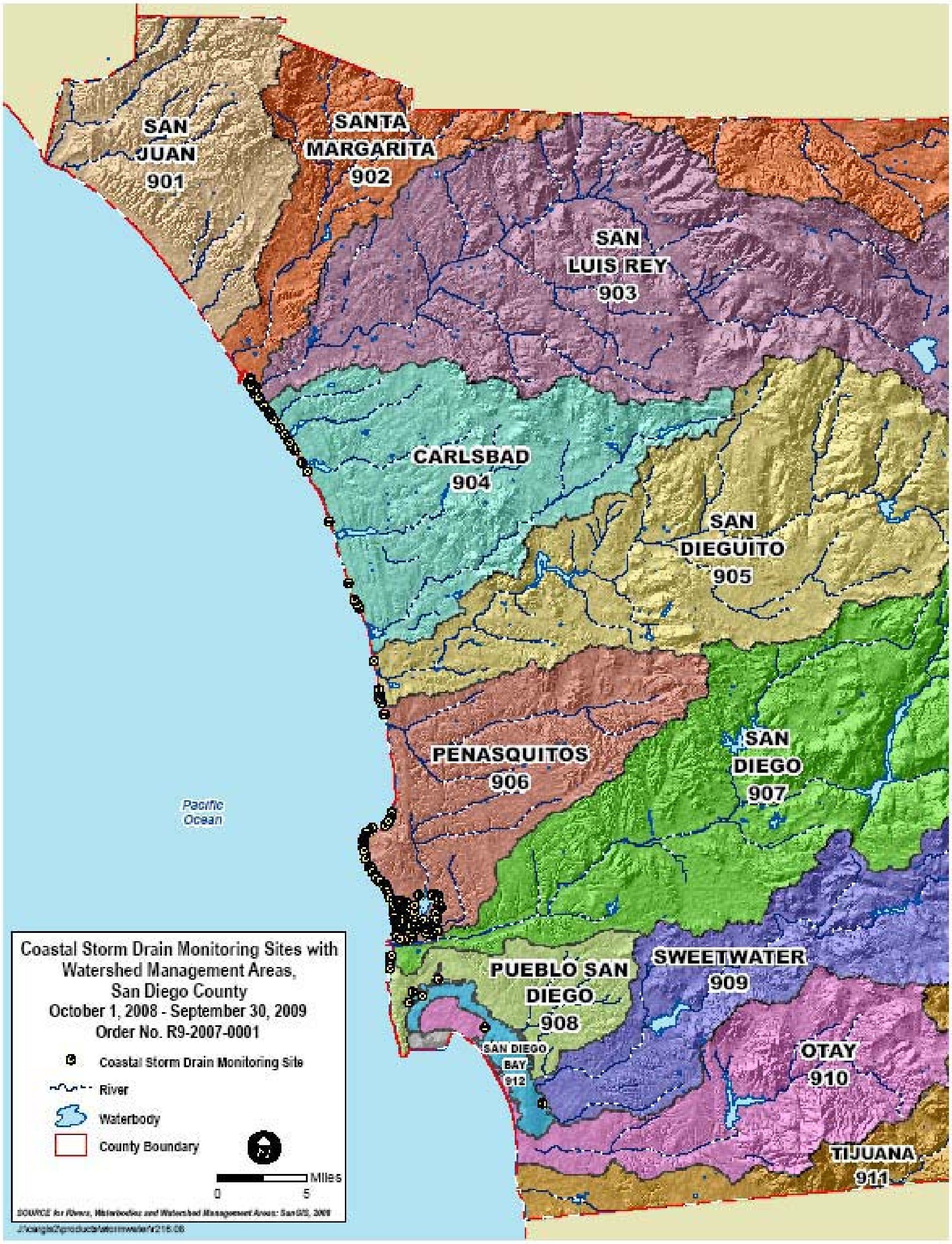

Figure 1. Map of Coastal Storm Drain Monitoring Sites

Sample Frequency

All sites were sampled on a monthly basis with the exception of those sites whose samples met criteria for sample reduction to a bi-monthly basis. Sample reduction criteria for the 2008-2009 season is provided in Table 1.

Table 1. Eligibility Requirements for Bi-monthly Monitoring of Coastal Storm Drains

	Minimum Eligibility Requirements for Sample Reduction
1	Three consecutive storm drain samples with all bacterial indicators below the numeric Sampling Frequency Reduction Criteria developed by the Copermittees under Order 2001-01
2	The three consecutive samples must be paired with receiving water samples that do not exceed AB 411 or Basin Plan standards.
3	Less than 20% of a location's storm drain samples were above any of the Sampling Frequency Reduction Criteria during the previous year.

Sites which met sample frequency reduction criteria for the 2008-2009 monitoring year are listed in Table 2. The complete list of sample locations is provided in the San Diego Regional Copermittees 2008-2009 Coastal Storm Drain Monitoring Program document.

Table 2. Coastal Storm Drain Sites that Met Eligibility Requirements for Bi-Monthly Monitoring

Jurisdiction	Station ID
Oceanside	Coast 1
	Coast 2
	Coast 3
	Coast 4
	Coast 5
	Coast 6
	Coast 7
	Coast 9
	Coast 10
	Coast 11
	Coast 12
	Coast 13
	Coast 14
	Coast 15
	Coast 16
	Coast 18
	Coast 19
	Coast 21
Encinitas	EH-403
	EH-405

Field Observations

A standard field observation sheet was completed during all sampling events to document the conditions observed. In addition to Site ID, date, time, latitude and longitude, field sheets noted the land use, conveyance type, atmospheric conditions, beach appearance, runoff characteristics, vegetation, trash, and other relevant information. Based on site observations, Copermittees had the discretion to initiate follow-up source investigations prior to obtaining analytical results.

Sample Analysis

Collected samples were analyzed for total coliform, fecal coliform, and enterococcus indicators by ELAP certified laboratories. Bacterial analysis methods approved by ELAP include multi-tube fermentation, membrane filtration and IDEXX (for enterococcus analyses only). Laboratory results were to meet both the upper and lower acceptable ranges provided in Table 3 to ensure data compatibility regardless of the methods used. A regional standardized data transfer template was used by all copermittees to submit analytical data.

Table 3. Acceptable Ranges for Bacteria Results

Analytes	Receiving Water Limit	Storm Drain Limit	Units
Total Coliform	20 – 1.6 million	20 – 1.6 million	MPN/CFU per 100ml
Fecal Coliform	20 – 160, 000	20 – 1.6 million	MPN/CFU per 100ml
Enterococci	20 – 160, 000	10 – 1.6 million	MPN/CFU per 100ml

Follow-up Sampling

Re-sampling of storm drains and receiving waters was performed within one day of receipt of analytical results that exceeded either an action level, the REC-1 water quality objective, or the storm drain 95^{th} percentile criteria shown in Table 4. Follow-up actions for all possible bacteria result outcomes are shown in Table 5.

Table 4. Action Level Criteria for Receiving Water and Storm Drains

Analytes	REC-1 Receiving Water Criteria	95^{th} Percentile Storm Drain Criteria based on FY 07-08 data	95^{th} Percentile Storm Drain Criteria for 2008-09
Total Coliform	10,000 MPN/100 mls	1.6 million MPN/100 ml	160,000 MPN/100 ml
Fecal Coliform	400 MPN/100 mls	66,500 MPN/100 ml	18,755 MPN/100 ml
Enterococci	104 MPN/ 100 mls	23,427 MPN/100 ml	17,820 MPN/100 ml

*95^{th} percentile action levels are recalculated annually.

Table 5. Re-sampling Criteria for Receiving Water and Storm Drains

Initial Result			Follow-up Action
Paired Sample	1	SD<AB411 RW<AB411	No re-sampling required.
	2	SD<AB411 RW>=AB411	No re-sampling required.
	3	AB411<=SD<95^{th} percentile RW<AB411	No re-sampling required.
	4	SD>=95^{th} percentile RW<AB411	Re-sample storm drain within one business day of receipt of results.
	5	SD>= AB411 RW>=AB411	Re-sample storm drain and receiving water within one business day of receipt of results.
Single Sample	1	SD<95^{th} percentile	No re-sampling required.
	2	SD>=95^{th} percentile	Re-sample storm drain.

Investigations of sources of bacterial contamination were performed within one business day of receipt of re-sampling analytical results if the results exhibited continued exceedances of AB411 or Basin Plan standards for either a storm drain or receiving water. Investigations were also conducted if, during sampling, abnormally high flow, sewage releases, or restaurant discharges were observed.

ATTACHMENT 6

MS4 Outfall Monitoring Methods

ATTACHMENT 6: MS4 Outfall Monitoring Methods

Municipal Separate Storm Sewer System Outfall Monitoring

The Receiving Waters and Urban Runoff Monitoring and Reporting Program for the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit Order No. R9-2007-0001 requires the Copermittees to assess discharges of urban runoff from the municipal separate stormwater sewage systems (MS4s) in San Diego County Watersheds. The monitoring program seeks to characterize pollutant discharges from MS4 outfalls and assess whether the discharges contribute to water quality problems in the receiving waters within each defined watershed management area. Detailed methods of the MS4 outfall monitoring program can be found in the *Municipal Separate Storm Sewer System (MS4) Outfall monitoring Program in San Diego County Watershed Management Areas Final Workplan* (SDCRC, 2008b). The methods are summarized below.

The MS4 Outfall Monitoring Program was designed to answer core management question #3:

- What is the relative urban runoff contribution to the receiving water problems?

To address this question, discharge samples from random and targeted MS4 outfalls are to be collected during dry and wet weather periods in accordance with the sampling design shown in Table 1. Random sampling was designed to answer the following two subquestions:

1. What are the characteristics of the discharges from MS4 outfalls in regard to high priority pollutants?
2. Are constituent loadings changing over time?

Targeted sampling was designed to address:

1. Which of the targeted MS4 outfalls have the greatest pollutant loading?
2. Are the pollutant loadings decreasing over time from these MS4 outfalls?

Table 1. Summary of MS4 Outfall Monitoring Program Design

Season	Design Type	Outfall Diameter	Number of Samples
Dry	Random	$\geq$ 36 inches	54 per year
	Targeted	Any size	200 per year
Wet	Random	$\geq$ 36 inches	54 per year
	Targeted	Any size	9 per Permit cycle

Dry Weather Sampling

Random Design

Six randomly selected outfalls (36" or greater in size) were monitored within each of the nine watershed management areas between May 1, 2009 and August 1, 2009 based on the stratified random study design described in the Copermittee MS4 Outfall Monitoring Workplan

(Workplan). Samples were collected from those sites at the top of a randomized list of all MS4 outfalls 36" in diameter or greater. Only MS4 outfalls that were deemed accessible and safe were sampled. If an outfall was not accessible or was not considered safe, the next nearest outfall was sampled. Outfalls that did not have dry weather flows were noted on the field sheet and the next outfall on the randomized list was visited until six samples were collected from each watershed management area. No sampling was conducted within 72 hours following measureable rainfall (greater than 0.1 inches). Random samples of the MS4 outfall discharges were analyzed for TSS, total phosphorus, total nitrogen, and bacterial indicators.

Targeted Design
A list of targeted MS4 outfall monitoring locations was generated by the Dry Weather Monitoring Workgroup based on the primary criteria of: any size outfall, likelihood of the outfall to have dry weather flow, and whether the outfall discharges to receiving water. Secondary criteria such as surrounding land use, flow rate, past exceedances, and other factors were also considered. A target number of approximately 200 MS4 Outfall Monitoring sites, along with a list of alternative sites, was set by the Workgroup. Sampling was performed between May 1 and August 1, 2009 on days preceded by at least 72 hours of no measureable rainfall. Targeted samples of the MS4 outfall discharges were analyzed for a customized constituent list based upon individual watershed priorities. The following factors were used by the Dry Weather Monitoring Workgroup to determine the analytical constituent list for each outfall:

- WMA high priority pollutants
- Baseline long-term effectiveness assessment and the potential identified threats to water quality
- 2006 Clean Water Act 303(d) list of impaired waterbodies
- Total maximum daily loads
- Historical water quality data

A complete list of constituents for each targeted outfall is provided in the Workplan.

Wet Weather Sampling
Random Design
The random sampling approach for wet weather was analogous with the random sampling approach for dry weather. Six sample locations were selected randomly from within each watershed management area. Random samples were collected by grab sample throughout the wet weather season during storm events predicted to have 0.1" or greater rainfall. Site selection procedures and laboratory analyses for wet weather samples were identical to that used for random dry weather samples.

Targeted Design
Only outfalls that discharge directly to a receiving water will be targeted for sampling. Targeted wet weather sampling is currently under development and will be implemented during Year 2 of the Permit cycle following a consensus process by Copermittee workgroups.

Sampling Methods
Dry weather

Both random and targeted dry weather samples were collected as grab samples in accordance with sample handling and labeling procedures described in the Workplan. Dry weather flows in the MS4 outfalls were measured using standard USGS protocols or were estimated using accepted indirect methods, such as the leaf method. Samples were collected in appropriate laboratory-certified clean sample containers using proper sampling techniques. Sample containers were labeled with the project name, location, date, time, and sample preservation, and were placed into coolers on ice with completed chain of custody forms. Samples were delivered to analytical laboratories within specified holding times.

Wet weather
Wet weather random samples were collected as grab samples during any point in the hydrograph that is still influenced by urban runoff. No sampling was performed once flow returned to within 10% of antecedent flow conditions. Samples were collected in appropriate laboratory-certified clean sample containers using proper sampling techniques. Sample containers were labeled with the project name, location, date, time, and sample preservation, and were placed into coolers on ice with completed chain of custody forms. Samples were delivered to analytical laboratories within specified holding times. Targeted wet weather sampling is currently being developed and will be performed during year 2 of the Permit through a consensus process in the Copermitteess' workgroups.

Quality Assurance/ Quality Control
Quality assurance and quality control for sampling processes included proper collection of the samples in order to minimize the possibility of contamination. All samples were collected in laboratory supplied, laboratory-certified, contaminant-free sample bottles. Field blanks were used to assess the sample collection, container, and transport of the samples to the analytical laboratory. The chemistry analysis of the samples was performed under the guidelines of the quality assurance and quality control programs established by the respective state-certified analytical laboratory. The dry weather targeted samples complied with the quality assurance/ quality control requirements of the dry weather program in the Jurisdictional Urban Runoff Management Plan for the jurisdiction that collected the sample.

ATTACHMENT 7

Urban Runoff Source ID Methods

ATTACHMENT 7: Urban Runoff Source ID Methods

Urban Runoff Source Identification Program

The Receiving Waters and Urban Runoff Monitoring and Reporting Program for the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit Order No. R9-2007-0001 (Permit) requires the Copermittees to develop and implement a monitoring program to identify constituent discharge sources that are causing water quality problems in San Diego County Watersheds. The monitoring program proposed by the Copermittees seeks to help to answer core management question #4: "What are the sources of urban runoff that contribute to receiving water problems?" by assessing specific activities that may be expected to contribute pollutants to receiving waters and by targeting specific drainage areas where monitoring information suggests urban runoff is a major contributor to receiving water problems. Because the source identification program is mostly new, the Copermittees are provided leeway in its development and implementation by the Permit.

The overall monitoring design for the Copermittees' source identification program was based on a combination of specific activity sampling and sampling within MS4 conveyances upstream of identified water quality problem(s) in the receiving water. Detailed methods of the urban runoff source identification program can be found in the *Urban Runoff Source Identification Program in San Diego County Watersheds*, *Final Workplan* (SDCRC, 2008c). The methods are summarized below.

Monitoring Design

The specific activity monitoring approach identified in the Urban Runoff Source Identification Program in San Diego County Watersheds Workplan (Source ID Workplan) consisted of the following steps:

1. Identifying activities that could potentially release the constituent that may cause exceedances of water quality benchmarks or action levels in the receiving waters (e.g., Threats to Water Quality from the Baseline Long-term Effectiveness Assessment).
2. Identifying locations for monitoring in MS4 outfalls or conveyance sites that drain from areas containing concentrations of these activities.
3. Collecting water samples and/or flow data from the outlet(s) downstream from each activity of cluster of activities.
4. Initiating additional investigations of potential sources of constituents in those drainage upstream of the outfall where exceedances of water quality benchmarks or action levels are identified if previous steps did not isolate the source.

Specific activity monitoring locations were selected for sampling based on a survey of the sources and/or activities that could potentially release the constituent of concern. The survey identified clusters of activities that were, to the extent practical, hydrologically isolated and accessible to sampling personnel.

The “MS4 upstream monitoring of water quality problems in the receiving water” approach consisted of the following four steps to resolve water quality problems:

1. Identify a high priority pollutant in a receiving water of a watershed.
2. Conduct a review of MS4 maps and/or field reconnaissance to identify potential subwatersheds (hydraulically separate) in the MS4 conveyances.
3. Conduct additional sampling and/or flow monitoring upstream of the receiving water. This sampling is performed at outfalls from drainages with observed flows.
4. Initiate an investigation of activities that could potentially release the pollutant in those drainage areas upstream of the outfall where exceedances of water quality benchmarks or action levels are identified.

Using this approach, sampling typically begins at the location of the observed water quality problem in the receiving water before moving upstream. Sampling activities will continue to move upstream to target the ultimate source(s) of the constituent of concern as chemistry and/or flow results are received. Decision trees provided in the Source ID Workplan detail starting and stopping rules for source investigations. Starting rules ensure that available resources are focused on the highest priority problems while stopping rules ensure that source identification studies to not continue indefinitely, but end when reasonable expectations have been met.

Work Plan Development

High priority water quality problems are detailed in the Source ID Workplan for each Watershed Management Area, broken out according to hydrologic area. During the 2008-2009 monitoring year, the Copermittees from the Regional Monitoring and Watershed Urban Runoff Management Program (WURMP) Workgroups supported two dry weather source identification studies in the cities of La Mesa and Del Mar (Figure 1) Both studies focused on single-family residential neighborhoods, with the key study questions including:

1. When are the dry weather or nuisance flows detected from single-family residences (during what part of the day/week)?
2. What is the water quality and load of constituents of dry weather or nuisance flows form single-family residences?
3. What are the potential sources of dry weather flows from single family residences?

Results from these studies has provided information on the sources of dry weather/nuisance flows from single family residences and will be used by Copermittees to develop effective BMP strategies for this common San Diego County land use.

The Copermittees intend to leverage results of the Proposition 50 Nonpoint Source Pollution Control Program Grant entitled “Evaluating Best Management Practices Effectiveness to Reduce Volumes of Runoff and Improve the Quality of Runoff from Urban Environments” being conducted by the University of California, Davis (assuming work is completed and results are available at the time of report writing for the Copermittees’ study). Work for the UC Davis study is currently suspended at the request of the State of California, pending additional funding. In the UC Davis study, wet and dry weather samples from four residential communities in Sacramento and Orange County will be collected before and after an intensive outreach program to encourage reduced water runoff. This program will evaluate the effectiveness of BMPs. A similar model was implemented by the Copermittees in the City of La Mesa to assess if the UC

Davis results apply to the San Diego Region. Based on the results of the verification study, The UC Davis study may be applied to all watersheds within San Diego.

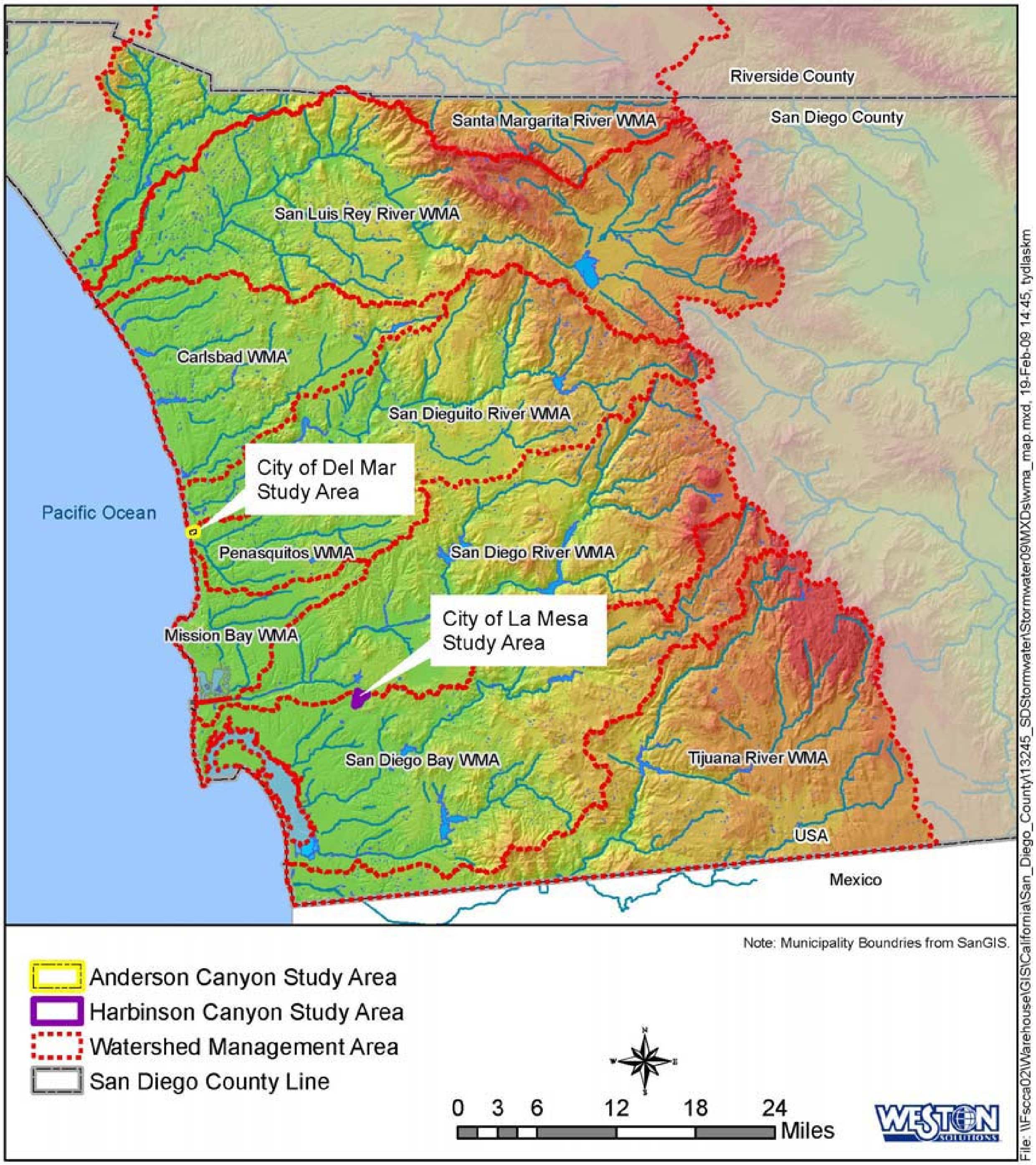

Figure 1. San Diego County Regional Watersheds and 2008-2009 Source Identification Study Areas

Field Equipment and Flow Monitoring

In the monitoring plans for the City of La Mesa and the City of Del Mar, site locations that provided representative flow from defined land uses, rather than mixed land uses, were selected.

Continuous flow monitoring was conducted over a period of three months. Flow in MS4 outlets or conveyance sites was measured quantitatively using standard USGS protocols (Rantz 1982). If the flows were too small to measure with instrumentation, indirect methods, such as the float method or Manning's formula, were used. Specific control elements were used to properly assess the stream flow, including: cross-sectional stream rating surveys, determination of the slope of the water flow, longitudinal axis, roughness, water velocity, and water level. Automated field sampling equipment (Sigma 910s with pressure transducers) was used to collect long-term flow monitoring data. All water quality instruments were calibrated per the manufacturer's specifications during their installation. Equipment quality checks of the calibration were performed on a monthly basis.

Water quality sampling

Only dry weather sampling was conducted during the 2008-2009 monitoring season. Samples were collected during times of increased flows based upon the pattern observed during the first week of flow monitoring. Samples were collected three times at three locations in the City of La Mesa and at one location in the City of Del Mar. Sampling events occurred during May, June, and August 2009 and samples were analyzed for bacteria, chemistry and field parameters listed in Table 1.

Table 1. List of Analytes, Methods, and Detection Limits

Analyte	Method	Units	Method Detection Limit	Reporting Limit
Total Coliform	SM 9221B, E	MPN/100mL	2	20
Fecal Coliform	SM 9221B, E	MPN/100mL	2	20
Enterococci	SM 9230	MPN/100mL	2	20
E. coli	IDEXX	MPN/100mL	1	10
Cadmium (dissolved)	EPA 200.8	µg/L	0.2	0.4
Copper (dissolved)	EPA 200.8	µg/L	0.4	0.8
Lead (dissolved)	EPA 200.8	µg/L	0.05	0.1
Zinc (dissolved)	EPA 200.8	µg/L	0.1	0.5
Hardness	SM 2340 B	mg/L	1	5
Organophosphate Pesticides	EPA 625 (m)	ng/L	Varies by analyte	
Synthetic Pyrethroids	NCI-GCMS	ng/L	Varies by analyte	
Nitrate as N	EPA 300.0	mg/L	0.01	0.05
Nitrite as N	EPA 300.0	mg/L	0.01	0.05
TKN	SM 4500 N Org B	mg/L	0.455	0.5
Total Nitrogen	Calculation	mg/L	0.455	0.5
Total Phosphorus	SM 4500 P E	mg/L	0.016	0.05
Orthophosphate	EPA 300.0	mg/L	0.0075	0.01
Total Organic Carbon	SM 5310 B	mg/L	0.1	0.2
Dissolved Organic Carbon	SM 5310 B	mg/L	0.1	0.2
Bromide	EPA 300.0	mg/L	0.001	0.005
Chloride	EPA 300.0	mg/L	0.01	0.05
Total Dissolved Solids	SM 2540 C	mg/L	0.1	5
Total Suspended Solids	SM 3540 D	mg/L	0.5	5
Turbidity	EPA 180.1	mg/L	1	2
pH	Meter	pH Units	0.5	0.5
Conductivity	Meter	ms/cm	0.1	0.1
Temperature	Meter	Deg. C	0.1	0.1

Quality Assurance/ Quality Control

Samples were collected using proper sample techniques in order to minimize the possibility of contamination. All samples were collected in laboratory-certified, contaminant-free containers and were appropriately labeled with the sample collection date and time, sampler's initials, sample location, and analysis to be performed. Temperature blanks, field blanks, and duplicates samples were collected and analyzed to assess temperature, contamination from field-related techniques, and sample variability. Once collected, samples were stored in coolers on ice with completed chain of custody forms. All samples were analyzed by ELAP certified laboratories.

Reporting

Data results will be compared with UC Davis study results, if available, along with the variability in each data set. The Copermittees will consider the results of the studies in the implementation of their Jurisdictional Urban Runoff Management Programs and Watershed Urban Runoff Management Programs.