C-11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

C-11.1 Introduction

This chapter reviews results and findings from the 2008-09 reporting period of water quality monitoring conducted by the Orange County Stormwater Program (Program) under the Third Term Permit, Order No. R9-2002-0001, from the San Diego Regional Water Quality Control Board. The wet and dry weather monitoring program designs are summarized below and described in much greater detail in two reports previously submitted to the Regional Board and available on the Program's website (http://www.ocwatersheds.com/StormWater/swp_documents_intro.asp). These are:

- Past Monitoring, Future Recommendations, and Receiving Waters Monitoring Program, which summarizes cumulative findings from the First and Second Term Permit monitoring programs, and presents the design of the Third Term Permit wet weather monitoring program; and

- San Diego Region Dry Weather Monitoring Program, which details a dry weather reconnaissance program targeted at identifying potential sources of pollution to the stormwater system.

In addition, cumulative results of the past several years of monitoring are presented in the 2006 Report of Waste Discharge (ROWD) available on the Program's website.

This annual report continues the initiatives begun in the 2004-05 report including new analysis approaches for estimating annual loads, evaluating recreational impacts in the coastal zone and prioritizing stormdrain outfalls, estimating the degree of unexplained toxicity, and displaying the results of bioassessment monitoring. As in last year's report, this report aggregates key indicators (i.e., toxicity, CTR exceedances) from multiple Program elements and uses maps to summarize regional patterns. Finally, the report takes advantage of the six years of bioassessment monitoring to conduct an in-depth analysis investigating the relationship between the components of the bioassessment IBI scores and individual aspects of the physical habitat.

The Third Term Permit monitoring program also represents an important evolution from previous monitoring in terms of its increased focus on ecological conditions in receiving waters, and on potential stormwater impacts in the nearshore coastal zone. Regional efforts are underway, through both the Stormwater Monitoring Coalition (SMC) and the Southern California Coastal Water Research Project (SCCWRP) to develop improved methods for the analysis and interpretation of such data. Future reports will incorporate these methods as they become available.

The following sections review the historical development of the water quality monitoring program (**Section 11.2**), describe the overall monitoring approach **(Section 11.3)**, summarize monitoring procedures (**Section 11.4**) and methods of data analysis (**Section 11.5**), and present the monitoring findings (**Section 11.6**). The data presented in

Section 11.6 are the result of the water quality monitoring conducted from July 1, 2008 to June 30, 2009. While some data from prior years are presented in the discussion of trends more detailed information specific to past monitoring years can be found in each of the prior annual reports and the 2006 Report of Waste Discharge.

C-11.2 Background

C-11.2.1 Program Development

Passage of an amendment to the Clean Water Act in 1987, the Water Quality Act, brought stormwater discharges into the NPDES Program and subsequent EPA regulations required municipal NPDES Permit applicants to develop a management program to effectively address the requirements of the Act.

In response to these regulations, the County of Orange (the Principal Permittee), the Orange County Flood Control District and incorporated cities (all three collectively referred to as Permittees) obtained NPDES Stormwater Permits No. CA 8000180 and No. CA 0108740 (subsequently referred to as the First Term Permits) from the Santa Ana and San Diego Regional Water Quality Control Boards. In 1996, the First Term Permits were replaced by Permits Nos. CAS0108740 and CAS618030 (subsequently referred to as the Second Term Permits). These have recently been replaced by the Third Term Permits.

The overall evolution of the Program's monitoring efforts during this period are illustrated in **Figure C-11.1**. The Program's evolution is characterized by:

- Continued development of a longer-term perspective for tracking trends in key pollutants and at high-priority locations
- A specific focus on problem areas and issues
- Attention to an expanding set of concerns related to stormwater, e.g., bioassessment, ambient coastal receiving water quality.

11.2.1.2 Pre-NPDES Water Quality Monitoring

From 1973 to 1990, the Principal Permittee conducted routine water quality monitoring in drainage facilities that are tributary to water bodies identified as waters of the State by the Regional Boards. The receiving waters were also monitored routinely to assess the chronic effects on established beneficial uses.

When the monitoring program was initiated in 1973, monthly nutrient and trace element sampling was performed at several locations. Sediment samples were collected semiannually to assess the impact of contaminant deposition and adsorption. Additional constituents such as mercury, selenium, DDT, PCBs and radioactivity were also evaluated on a semiannual basis to address public concerns regarding the pollution threat from these constituents.

C-11.2.1.3 First Term Permit Monitoring under Order 90-38

In order to bring the pre-NPDES water quality monitoring program into conformance with the 1990 federal NPDES regulations and the First Term Permit objectives (Section 11.2), field screening was added to the monitoring program to detect gross contamination and the number of sampling sites in the channels and receiving waters was increased in order to better assess the amount and type of contamination in the storm drain system.

The First Term Permit water quality monitoring program consisted of field screening for illegal discharges and illicit connections to the County-wide drainage system; dry-weather and stormwater monitoring of pollutant loads and a receiving water program.

C-11.2.1.4 Second Term Permit Monitoring under Order 96-03

While the First Term Permit monitoring program produced useful information, the Permittees recognized (as have monitoring programs across the nation) the high degree of uncertainty regarding the link between urban stormwater runoff and actual impairment of beneficial uses within the aquatic resources of Orange County.

Therefore, in response to the Second Term Permit objectives, the Permittees conducted a systematic re-evaluation of the water quality monitoring program which led to a re-statement of the monitoring program's primary goals. The primary and parallel goals of the monitoring program were re-stated as:

- To determine the role, if any, of urban stormwater discharges in the impairment of beneficial uses; and

- To provide technical information to support effective urban stormwater management program actions to reduce the beneficial use impairment determined to be associated with urban stormwater.

In order to organize the vast array of monitoring activities needed to carry out the objectives and goals, the Permittees identified three separate key elements within the Final Monitoring Program (May 1999).

These three key elements were:

- A focus on known sites (or Warm Spots) where constituents are substantially above system-wide averages;

- A parallel (and somewhat overlapping) focus on areas of critical aquatic resources (CARs); and

- A countywide reconnaissance program to identify specific sources of contamination from sub-watershed areas as well as specific land use investigations in order to evaluate the effectiveness of a variety of BMPs

The monitoring program included an underlying rationale for each monitoring element, a discussion of how monitoring data will be used in decision-making, identification of potential links to other relevant monitoring programs being carried out by other agencies, a description of the basic monitoring design, identification of additional study design steps, and a description of anticipated monitoring activities.

These monitoring elements included many locations from the pre-NPDES and First Term Permit water quality monitoring programs that were of value because of the length of their historical record. Each key element of the Second Term Monitoring Program contained a description of the monitoring activities proposed to accomplish the objectives described above, as well as a description of the process for making decisions about how the monitoring program would respond to incoming data over time. This process was intended to be used at any time throughout the life of the monitoring program to reevaluate the direction of the program, or to reassess the appropriate allocation of resources within the program.

The second term monitoring program and subsequent elements utilized a five-year timeline (1998-99 – 2002-03) for addressing the goals/objectives associated with each task.

C-11.2.1.5 Third Term Permit Monitoring under Order R9-2002-0001

In 2002-03, the Program completed development of the Third Term Permit monitoring programs for wet and dry weather, respectively. This program extends stormwater monitoring to a broader range of locations and to a wider array of methods for measuring impacts. For example, the Third Term monitoring plan more completely examines storm drains that discharge directly to the coast and pose a potential health risk to swimmers and bathers. In addition, the new plan for the first time investigates the effects of urban runoff on the nearshore marine environment. Inland, the new monitoring plan includes bioassessment studies of creeks, along with the more consistent use of toxicity testing. Combined with the existing measurement of chemical parameters, this “triad” approach is intended to describe impacts more fully; more accurately identify their sources, and target follow-up studies and BMPs more effectively.

The overall monitoring approach and methods are summarized in the following sections.

C-11.2.2 Monitoring Approach

The objectives of the Receiving Waters Monitoring Program, as stated in Attachment B.1 of the Third Term Permit, are to:

- Assess compliance
- Measure the effectiveness of Urban Runoff Management Plans
- Assess the chemical, physical, and biological impacts to receiving waters resulting from urban runoff
- Assess the overall health and evaluate long-term trends in receiving water quality.

The Third Term Permit monitoring program meets these objectives (with the proviso that measuring the effectiveness of Urban Runoff Management Plans also requires the implementation of focused evaluations of best management practices (BMPs)) by continuing and expanding the Second Term Permit monitoring emphasis on assessing impacts on aquatic resources, documenting long-term trends in water quality, targeting problematic discharge sites for more focused monitoring, and adding additional monitoring elements. The objectives for each program element are as follows:

Urban stream bioassessment monitoring	Using a "triad" of indicators (bioassessment, chemistry, toxicity), describe impacts on stream communities and the relationship of any impacts to runoff, based on comparisons with reference locations on a year-to-year time frame.
Long-term mass loading monitoring	Using measurements of key urban pollutants, monitor trend in loads over time.
Coastal storm drains outfall monitoring	Using a suite of pathogen indicator bacteria at high priority drain outfalls, track compliance with regulatory standards and any improvements due to BMP implementation.
Coastal receiving water monitoring	Using measure of runoff plume characteristics and extent, as well as measures of a suite of physical, chemical, and biological indicators, improve understanding of the impacts of runoff plumes on nearshore ecosystems.
Dry weather reconnaissance monitoring	Using data from both random and targeted sites, define background dry weather conditions as a basis for identifying candidate sites for further focused source identification work.

The monitoring program reflects the Program's increased focus on watershed management. As discussed in the following sections, monitoring sites in the various program elements have been located in specific watersheds, with the goal of improving the ability to understand stormwater processes and manage their impacts.

C-11.2.3 Description of Monitoring Procedures

C-11.2.3.1 Urban Stream Bioassessment

The Permittees with assistance of Regional Board staff have selected twelve channels and three reference sites to conduct urban stream bioassessments using California Stream Bioassessment Procedure (CSBP) established by the California Department of Fish and Game (DF&G). A contract laboratory conducts the bioassessment sampling and taxonomic analyses on behalf of the Permittees. A description of the CSBP can be found at http://www.dfg.ca.gov/cabw/Field/csbpwforms.html.

In order to conduct the triad analysis, at the time of bioassessment sampling the Permittees collect grab samples for chemical and toxicity analysis. The suite of analytes includes pH, specific conductance, turbidity, nitrate, ammonia, total Kjehldahl Nitrogen (TKN), total phosphate, orthophosphate, dissolved and total organic carbon, total suspended and settleable solids, volatile suspended solids, organophosphate pesticides, and total recoverable and dissolved cadmium, copper, chromium, lead, nickel, selenium, silver, and zinc. An aliquot of each sample submitted for total recoverable metals analyses is filtered with a 0.45 micron groundwater filtering capsule, preserved with ultra pure grade nitric acid, and submitted for analyses of dissolved metals. The aqueous toxicity is evaluated using three freshwater organisms, *Ceriodaphnia dubia*, *Selanastrum capricornutum*, and *Hyalella azteca*.

C-11.2.3.2 Long-term Mass Loading

The Permittees selected six channels in the San Diego Region to conduct stormwater mass emissions monitoring to evaluate trends in mass loading. The selection criteria included the following:

- Classification of the waterbody as a "Water of the State" in the Water Quality Control Plan for the San Diego Region;
- Suitability of the site drainage area to monitor area-wide contributions of storm water pollutant loading;
- Suitability of the site's hydrological characteristics to enable practical measurement of flow and collection of representative storm water samples;

- Maintenance of long-term data collection at appropriate existing monitoring stations (Laguna Canyon Wash, Aliso Creek, San Juan Creek, Trabuco Creek, Prima Deshecha Channel, and Segunda Deshecha Channel);

- Safety from traffic and other hazards;

- Suitable siting for sampling equipment; and

- Crew access for safely retrieving samples and maintaining equipment during storm conditions.

The Permittees use time-composite sampling and continuously recording streamgauges as the primary method of monitoring the concentration and load of constituents at Mass Emissions sites. This type of sampling is conducted with automatic samplers that consist of programmable pumps (peristaltic) which transport water from the channel to a collection reservoir in the autosampler base. The collection reservoir can be a single large composite bottle or a series of up to 24 bottles. The autosampler program can be modified to vary sample volumes and frequency of collection. Two automatic samplers are used at each Mass Emissions site. One autosampler is for monitoring water chemistry and the other is used for monitoring toxicity.

To collect samples for the analysis of water chemistry, 8, 1.8-liter glass bottles are used in the autosampler base. The water chemistry autosampler is programmed to collect three discrete samples per 1.8-liter bottle. To collect samples for toxicity testing, a single 5-gallon glass bottle is used in the autosampler base. The two samplers are programmed to collect at the same frequency to maintain the consistency between the composite samples produced by each.

The Permittees attempt to monitor three storms per year at each Mass Emissions site. For each storm the water chemistry is characterized with a series of 3 to 5 composite samples collectively spanning approximately 96-hours. The sampling for toxicity testing is coincident with just one of these composite samples. The Permittees selected the following temporal segments of storms to monitor toxicity.

- Storm 1 – first flush (first hour of storm);

- Storms 2 and 3 – 24-hour period beginning three hours after the initiation of the first flush sampling by the water chemistry autosampler.

During each storm the automatic sampling programs are initiated when the water level in the channel rises above a triggering device (level actuator or flowmeter) hardwired to the respective autosampler. When possible, a single triggering device is used to trigger both samplers simultaneously. For the water chemistry sampler (and the toxicity sampler during the first storm) the frequency of collection during the first hour of a storm is set at 1 sample/12 minutes. After the sixth sample is collected at the one-hour mark, the collection frequency is decreased to once every 2 hours. Sampling of water chemistry spans approximately 96 hours to allow comparison of the time-weighted concentrations to guidance criteria for chronic aquatic toxicity from the California Toxics Rule (CTR). The concentrations of dissolved heavy metals in each of the composite samples can be compared to acute toxicity criteria from the CTR. Concentrations of organophosphate pesticides can be compared to literature values of LC_{50}s for toxicity testing organisms.

Autosampler maintenance is performed periodically during the 96-hour period to change sample bottles, icepacks, and power supplies.

The first six samples collected during the first hour of each storm are composited and represent the "first flush". The remaining bi-hourly storm samples are used to prepare composite samples that are representative of the subsequent parts of the storm. Unless a 24-hour composite sample is prepared for comparison to toxicity testing results, the samples beyond the first flush are composited using the stage hydrograph for the channel, or by evaluating the specific conductance of the samples in each bottle. Using hydrographs from the Principal Permittee's Automated Local Evaluation in Real Time (ALERT) system, samples collected beyond the first flush and representing the storm peak and recession are composited into a single sample. The samples collected from storms spanning multiple days are split into two or more composite samples.

Each composite sample is analyzed for the same constituents as are measured in the Bioassessment Program (see previous section). For the first flush sample of the first storm of the year, the analyses also include priority pollutants (except asbestos and dioxin). Synthetic pyrethroid pesticides were also analyzed in some samples. Toxicity of stormwater runoff samples is evaluated using multiple dilution toxicity tests with marine organisms. The toxicity due to pesticides is measured using the mysid (*Mysidopsis bahia* aka *Americamysis bahia*) survival/growth test. The toxicity due to dissolved metals is measured using the sea urchin (*Stronglyocentrotus purpuratus*) fertilization and embryo development tests.

Time composite monitoring is supported by the Principal Permittee's precipitation and streamgaging network which consists of recording and/or transmitting ALERT gages. The recording, non-transmitting and the transmitting ALERT precipitation gages are tipping bucket type with dataloggers. Data are recorded and transmitted in digital format; the sensitivity of the non-transmitting gauges is 0.01 inches while the sensitivity of the ALERT transmitting gauges is 1 mm (0.04 inches) of accumulated rainfall.

The Principal Permittee uses several types of streamgauges to monitor changes in water level. The oldest design is the stilling well with water level float; the newer types are manometer gages or pressure transducers. Analog data (water level versus time) are recorded on stripcharts. The ALERT interface to these gages consists of a connection from the recorder chart drive to an ALERT shaft encoder. ALERT information is recorded on a datalogger and transmitted to the Principal Permittee's Orange base station in digital format. Sensitivity of the transmitted and recorded ALERT record is user-variable with the greatest sensitivity being a change in water level of 0.01 feet.

C-11.2.3.3 Coastal Stormdrain Outfall and Aliso Creek Monitoring

The Permittees have selected twenty-six coastal stormdrain outfalls to monitor the effects of urban runoff on the coastal zone. The following selection criteria were used:

- Outlet of the stormdrain is posted with a warning sign by the Orange County Health Care Agency;
- The stormdrain has an equivalent circular diameter greater than 39-inches or a daily dry-weather, discharge volume exceeding 100,000 gallons; and
- The stormdrain and the surfzone are accessible by monitoring staff.

Monitoring is conducted on both the discharge from the stormdrain and the surfzone 25 yards up-coast (north) and 25 yards down-coast (south) of the stormdrain-ocean interface. Grab samples are collected weekly for the analysis of total coliform, fecal coliform, and *Enterococcus* bacteria. An estimate of the flowrate from the stormdrain is made and the temperatures of the stormdrain discharge and the surfzone down-coast is measured.

The following criteria were established for monitoring:

- Samples are not collected on the day of rainfall;
- Samples are not collected from a stormdrain outfall during the period when its discharge is diverted to a sanitation district; and during such a diversion on a sample from the surfzone (down-coast of the stormdrain-ocean interface) is collected.

Monitoring of bacterial indicators under the Aliso Creek directive has been incorporated into the NPDES permit monitoring program. This monitoring takes place at 11 sites within the watershed and parallels the methods used for coastal stormdrains. Samples are collected from the drain discharge itself, as well as in the receiving water 25 feet upstream and downstream of the discharge. A detailed description of the CSDO monitoring procedures can be found in **Attachment C-II-V**.

C-11.2.3.4 Ambient Coastal Receiving Water Monitoring

The objective of the Ambient Coastal Receiving Waters monitoring program element is to evaluate the effect of urban runoff on the ecologically sensitive areas along the Southern Orange County coastline. During the last five years the monitoring has consisted of sampling the discharges to these coastal areas. In the 2008-09 reporting period samples were collected in the surfzone at some sites during dry weather and stormwater runoff conditions. Grab samples were collected using similar methods described in the Appendix C-11-V of the Coastal Stormdrain Section. These grab-samples were analyzed for water chemistry and aqueous toxicity. The suite of water quality constituents measured and the types of toxicity tests conducted were identical to those used in the Long Term Mass Loading Program (see above).

Dana Point Harbor and Dana Cove are included in the Ambient Coastal Receiving Waters Program. Prior to this reporting period, monitoring in these areas has included assessments of sediment chemistry, sediment toxicity, and benthic infauna. On a semiannual schedule, benthic sediment was collected to evaluate concentrations of copper, chromium, cadmium, lead, zinc, silver, nickel, chlorinated hydrocarbon and organophosphate pesticides, Triazine herbicides, PCBs (arochlors and congeners), and Polynuclear Aromatic Hydrocarbons (PAHs). Sediment toxicity was evaluated using the 10-day amphipod (*Eohaustorius estuarius*) survival test. Benthic infaunal analyses were conducted using the methods developed by the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT). Benthic sediment samples were collected using a petite ponar dredge. Samples for benthic infaunal analyses required five dredge samples per site to approximate the same sampling area used to establish the Regional Benthic Response Index (BRI).

Since the Permittees are participating in the Regional Harbor Monitoring Program (RHMP) with other marina operators in the San Diego Region, full scale monitoring of Dana Harbor has been suspended. One site, DAPTEB in the East Basin, was monitored in the fall of 2008 since it had previously shown a seasonal pattern of sediment toxicity.

The 2005-06 RHMP final report can be accessed through the San Diego Board's website at:
http://www.swrcb.ca.gov/rwqcb9/water_issues/programs/303d_list/ref_reports/index.shtml

C-11.2.3.5 Dry Weather Reconnaissance

The objectives of the Dry-Weather Reconnaissance Monitoring Program are to determine the average condition of stormdrain discharges in the San Diego Region of the County, and to identify and eliminate illegal discharges and illicit connections (ID/ICs) to the stormdrain system.

To accomplish the first objective the Permittees established a set of 30 randomly selected stormdrains (random sites) in South Orange County. Each Permittee including the County of Orange has at least one random site within their respective jurisdiction. Each of these 30 sites is sampled three times during the period from May 1 through September 30 of each year. The data from all of the random site samplings are used to establish a statistical database.

Monitoring at each site includes in-situ measurements of turbidity, pH, temperature, specific conductance, and dissolved oxygen. Chemical measurements in the field include nitrate, ammonia, orthophosphate, total chlorine, phenols, MBAS (surfactants), and water hardness. Grab samples are collected for laboratory analyses of total suspended solids; total coliform, fecal coliform, and *Enterococcus* bacteria; oil and grease; dissolved metals; and organophosphate pesticides. Flowrate is estimated using the method described in the Coastal Stormdrain Outfall Program above.

In order to accomplish the second objective, the Permittees established a list of 26 "targeted" stormdrains in which ID/ICs were suspected. A statistical analysis of the data from the sampling of the random stormdrains is used to establish the triggers for initiating reconnaissance for source identification in the watersheds of the targeted drains. The targeted drains are sampled five times (once per month) during the period between May 1 and September 30 of each year. A request for a Permittee to conduct a follow-up watershed reconnaissance is triggered if the results from two successive samplings at a random or targeted site exceed the upper bound of the tolerance interval for the 90^{th} percentile of the random site data. For dissolved oxygen, two successive values below the lower bound of the tolerance interval for the 10^{th} percentile would trigger a source investigation.

C-11.2.4 Methods of Data Analysis

C-11.2.4.1 Comparison to Water Quality Criteria

California Water Code Section 13170 authorizes the State Water Resources Control Board (SWRCB) to adopt water quality control plans for waters where standards are required by the Federal Clean Water Act (CWA). According to Section 303(c)(2)(B) of the CWA, these plans must contain water quality objectives for priority pollutants that could be reasonably expected to affect the beneficial uses of the waters of the State.

On March 2, 2000, the State adopted the United States Environmental Protection Agency's (USEPA) Rules establishing numeric water quality criteria for priority toxic pollutants (commonly referred to as the CTR) for the State of California. The CTR sets criteria for dissolved heavy metals in freshwater that are based on water hardness and separate criteria for saltwater. The dissolved metals data collected in each program element are compared to the applicable acute and chronic criteria from the CTR.

Acute (CMC-Criteria Maximum Concentration) and chronic (CCC-Criteria Continuous Concentration) aquatic toxicity criteria from the CTR are used as guidance to evaluate dissolved metals data collected from storm channels and harbors. Water quality criteria from the CTR for both freshwater and saltwater are found in **Table C-11.1** and sediment quality guidelines from other sources are presented in **Table C-11.2**.

According to the CTR, for waters with a hardness of 400 mg/l or less as calcium carbonate, the actual ambient hardness of the surface water shall be used in those equations. For waters with a hardness of over 400 mg/l as calcium carbonate, a hardness of 400 mg/l as calcium carbonate shall be used with a default Water-Effect Ratio (WER) of 1, or the actual hardness of the ambient surface water shall be used with a WER. For this program element the former method is used.

In applying the CTR as guidance in evaluating the freshwater monitoring program elements, if the time period to which the criteria applies is less than the length of the sampled period, a measured concentration greater than that guidance value will constitute an exceedance. For example, if the 1-hour criterion for lead (at a hardness of 100 mg/L as $CaCO_3$) is 65 μg/L, a concentration of 68 μg/L during a 24-hour period will be considered an exceedance of the criterion.

When computing the time-weighted mean concentration during a sampled period with multiple composite samples, values below the detection limit were assumed to be zero. This assumption allows for a more consistent evaluation from year to year as laboratory detection limits are lowered with alternative methods of analysis or new technology. The assumption also gives greater confidence to a designation of an exceedance of a criterion as it reduces the likelihood that the exceedance was caused by an erroneous estimation of a non-detected value.

In applying the CTR as guidance in evaluating the saltwater monitoring program elements, the average concentrations of dissolved metals in depth-integrated samplings from each 4-day storm monitoring of Dana Point Harbor were compared to the 4-day guidance criteria. The dissolved metals concentrations in each grab sample were compared to the 1-hr acute toxicity guidance criteria. There is no chronic guidance criterion for silver so only the acute criterion was used. Since total chromium was analyzed only the criteria for trivalent chromium (Chromium III) were used.

C-11.2.4.2 Toxicity Testing Data

Toxicity tests span varying time periods depending on the type of organism function (survival, growth, reproduction, etc.) being evaluated. Endpoint data are used to compute statistics that can be compared against regulatory criteria. These statistics include Acute Toxicity Units (TUa) and Chronic Toxicity Units (TUc).

Each sample is analyzed by monitoring organism responses in a series of sample dilutions (e.g. 100, 50, 25, 12.5, and 6.25% sample concentration). Due to analytical cost constraints the dilution series for dry weather samples and some surfzone samples were limited to two concentrations (100 and 50%). The responses measured in each dilution are validated by a number of replicates. Responses are also monitored in laboratory control water.

The concentration that causes 50% mortality of the organisms (the median lethal concentration, or LC_{50}) is determined using a statistical calculation with the endpoint data from an acute toxicity test. The acute toxicity test spans 48 hours for *Ceriodaphnia bahia, Americamyis bahia*, and *Promelas pimephales* , and 96 hours for *Hyalella azteca*. The

LC_{50} values are expressed as "percent sample;" the lower the LC_{50} percentage the more toxic the sample. For acute regulatory standards, the LC_{50} acute value is used.

For chronic regulatory standards, the chronic effects are estimated using the No Observable Effects Concentration (NOEC), for both survival and reproduction. For the *Ceriodaphnia* reproduction, *Americamysis* growth, and fathead minnow growth tests the endpoint is at seven days. For the *Selenastrum* growth test the endpoint is at 96 hours. The NOEC is the highest concentration tested in which there was no statistically significant effect in the organism response relative to the control sample response. The lower the NOEC, the more toxic the sample.

For purposes of assessment between sites or between samplings, the endpoints described above are transformed into toxic units (TU). Toxic units are further divided into toxic units acute (TUa) and toxic units chronic (TUc) for acute and chronic endpoints, respectively. As toxicity increases, the toxic units increase.

TUa and TUc values are calculated very differently and are not interchangeable or related. The TUa equals 100/ acute LC_{50}. If the LC_{50} is greater than 100% (i.e. more than 50% survival in the undiluted sample), then the TUa is calculated by the following formula:

$$TUa = \log(100-S)/1.7$$

Where S = percentage of survival in 100% sample. If S > 99%, the TUa is reported as zero, which is the lowest TUa value possible. The percent survival in the 100% concentration used in this formula is expressed as a percentage of the control survival. The TUc equals 100/NOEC. The lowest TUc possible, which indicates no toxicity, is 1. TUc values were calculated separately for survival and reproduction endpoints.

For some tests, if the test data meet acceptability criteria, inhibition concentrations, an IC_{25} and an IC_{50}, are calculated. These are the concentrations that cause a 25 percent or 50 percent inhibition of an organism's function such as growth, or cell density, in the *Selanastrum* growth test.

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 animals 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.

A description of the methods used in each toxicity test can be found by consulting the references cited in **Attachment C-11-I**.

For toxicity tests conducted as part of the long term mass loading and ambient coastal receiving water monitoring program elements, available LC_{50} and EC_{50} data on key contaminants can be used to compare the observed toxicity (measured as toxic units) to the expected toxicity. The toxicity testing organisms used in this Program tend to be more sensitive to some categories of toxicants than others. For example, the mysid survival/growth (MSG) test tends to be very sensitive to OP pesticides and unionized ammonia but less sensitive to metals. The Sea Urchin Fertilization (SUF) test is sensitive to dissolved metals and unionized ammonia but not very sensitive to OP pesticides.

LC_{50} data from the *Americamysis bahia* 96-hour survival test with ammonia, Chlorpyrifos, Diazinon, Dimethoate and Malathion were obtained from the PAN Exotoxicity database http://www.pesticideinfo.org/Search_Ecotoxicity.jsp which contains the results of over 220,000 toxicity tests. Results can be sorted by species, chemical or effect. Additional data were obtained from SCCWRP research studies. EC_{50} data for the sea urchin 40-minute fertilization test for unionized ammonia, copper, and zinc were obtained from the same sources. The observed concentration of each chemical constituent (from the aquatic chemistry samples collected at the same time) was divided by the appropriate LC_{50} or EC_{50} value to produce an estimated TU_a from each constituent. These estimated TU_as are then summed and compared to the observed TU_a from the toxicity test, as in the following equations:

$$\frac{\text{Concentration of toxicant}}{\text{Average literature value of } LC_{50} \text{ or } IC_{50} \text{ of toxicant}}$$

The total predicted toxicity from n toxicants is $\sum_{i}^{n} \frac{[toxicant_i]}{[LC_{50} or IC_{50}]_i}$

The calculated TUa from the toxicity test can be compared to this predicted toxicity.

This approach to comparing observed and predicted toxicity has potential shortcomings, including:

- The lack of availability of relevant LC_{50} and EC_{50} data for the full range of chemical constituents of concern,
- Lack of available data for the same life stages (e.g. larval vs. juvenile, or adult) of the organisms evaluated in our monitoring program,
- Lack of available data for the same test evaluation periods used in our monitoring program (e.g. 48-hr LC_{50} for mysids and *Ceriodaphnia* and 96-hr LC_{50}s for *Hyalella azteca*),
- Ranges of responses from multiple studies in the literature,
- The implicit assumption of simple additivity of toxic effects. While probably not true, there is no clear guidance on how to accurately represent synergistic effects, which could very well vary from site to site and over time.

- The fact that the predicted toxicity in several instances is larger than the observed toxicity, which serves to weaken confidence in the reliability of the LC_{50} and EC_{50} data.

Despite these shortcomings, this approach is useful for:

- Assessing the overall accuracy or reliability of the toxicity results
- Identifying specific chemicals that appear to contribute most to toxicity and that are therefore targets for further study and/or source identification and reduction efforts, and
- Identifying monitoring locations that may have consistently high levels of unexplained toxicity. In these cases, more sophisticated studies may be called for.

C-11.2.4.3 Bioassessment and Index of Biotic Integrity (IBI)

Each site is evaluated in terms of a series of metrics (**Table C-11.3**), which are then scored (**Table C-11.4**) to provide a basis for determining the overall IBI scores for each site. These scoring ranges are based on data from the southern California region, from southern Monterey County to the Mexican border. This southern California IBI is more representative of reference conditions throughout the whole of the southern California area than was the original IBI, which was based only on data from streams in the San Diego region. The use of the more broadly applicable IBI follows the California Department of Fish and Game protocol. In addition, the Stormwater Monitoring Coalition is planning a number of efforts to improve the IBI's ability to monitor conditions in the urbanized coastal zone. These include developing an IBI for low-gradient urban streams, a perennial stream succession survey, and developing a regional bioassessment monitoring program for southern California. The Permittees participated in the regional monitoring program during the spring of 2009,

C-11.2.4.4 Evaluation of Triad Data

Evaluation of triad data (i.e., bioassessment, water chemistry, toxicity) is based on the framework developed by the Stormwater Monitoring Coalition's Model Stormwater Monitoring Committee. This approach, which is described in detail in the SMC's report to the State Water Resources Control Board ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/419_smc_mm.pdf, is based on a weight of evidence approach that compares each of the three legs of the triad against each other. **Table C-11.5**, drawn from the SMC's report, summarizes the types of conclusions that can be drawn from various combinations of triad results. There is no routine or standard method for evaluating triad data. However, the triad data from the bioassessment stations for the most part has resulted in relatively clear interpretations of causal factors for observed conditions.

Three additional analyses are included in this year's report to more thoroughly examine the relationships among the three legs of the triad. (In actuality, there are four legs if the physical habitat data collected as part of the bioassessment protocol are considered separately from the biological community data.)

1. Thresholds were established for each of the four data types (IBI, physical habitat, aquatic chemistry, and toxicity) in order to divide the range of values for each data type into four categories representing conditions from excellent to poor. IBI categories were based on the Fish and Game interpretation framework for these data types. The following thresholds for total physical habitat scores were used as the color scheme for the PHAB symbols on the maps showing the triad evaluation:

Color	CSBP (0-200)	SWAMP (0-60)
• Green:	160-200	48-60
• Blue:	120-159	36-47
• Yellow:	80-119	24-36
• Red:	<80	<24

Aquatic chemistry thresholds focus on dissolved metals. At each station, the total number of CTR exceedances at each sampling time is divided by the total number of constituents (Cd, Cr, Cu, Pb, Ni, Ag, Zn) with relevant CTR acute criteria, resulting in a proportion for each station between 0 and 1.0. The exceedance proportion for each station is then indicated on a map of the sampling sites, according to the following color scheme:

- Green: 0 - < 0.14
- Blue: 0.14 - < 0.40
- Yellow: 0.40 - < 0.75
- Red: 0.75 – 1.0

Toxicity categories are based on the number of toxicity tests that showed toxicity above 25% mortality in the undiluted sample of a multiple dilution test with invertebrates or fish (*Ceriodaphnia* or *Promelas Pimephales* chronic survival or *Hyalella azteca* acute survival) or, if the value for TUc was greater than 1 in the *Selenastrum* growth test. For each site, icons on a map of the monitoring sites representing the four data types are then colored green, blue, yellow, or red to summarize the overall range of conditions at each site.

2. All data from the bioassessment sampling program were analyzed for spatial and temporal patterns in the benthic invertebrate community. Two methods were used to describe spatial and temporal patterns in the benthic invertebrate community: cluster analysis and two-way coincidence tables.

   a. Cluster analysis defines groups of stations with similar community composition. The results are displayed in a hierarchical tree-like structure called a dendrogram. On the dendrogram, two groups are first defined, and within these groups subgroups are defined. Subsequently, subgroups within the subgroups are defined. This process is continued until all stations are a separate subgroup. The hierarchical nature of the dendrogram allows the analyst to choose groups of stations that represent a scale of community differences relevant to the present project. Cluster analysis is also used to define groups of species that tend to have similar distributional patterns among the stations.

b. A two-way coincidence table is the station-species abundance data matrix displayed as a table of symbols indicating the relative abundances of the species at the stations. The rows and columns of the table are arranged to correspond to the order of stations and species along the respective station and species dendrograms. Since similar entities (stations or species) will tend to be closer together along a dendrogram, the row and column orders will efficiently show the pattern of species over the stations and station groups.

   Since the rows and columns of the two-way coincidence table are ordered according to the dendrograms, the two-way coincidence table is also used to help delimit the station and species groups defined by the cluster analyses. At each potential separation of subgroups defined by the dendrogram, the two way coincidence table is examined to see the corresponding group differences in terms of species presences and abundances. This allows the analyst to choose groups with a level of community differences consistent with the goals of the project.

The specific steps are as follows:

- Preliminary biotic data transformation, using a square root transformation and standardization by species mean of values >0 (Smith, 1976; Smith et al., 1988) [1]
- Calculation of a Dissimilarity Index for cluster analysis of stations, using the Bray-Curtis Index, step-across procedure for dissimilarity >0.8 (Bradfield and Kenkel, 1987; Clifford and Stephenson, 1975; Smith, 1984; Williamson, 1978)[2]

[1] Smith, R.W. 1976. Numerical Analysis of Ecological Survey Data. PhD thesis, Univ. of S. Calif., Los Angeles. 401 pp.
Smith, R.W., B.B. Bernstein, and R.L. Cimberg. 1988. Community-Environmental Relationships in the Benthos: Applications of Multivariate Analytical Techniques. Chapter 11 In: Marine Organisms as Indicators. Springer-Verlag. New York: 247-326.

[2] Bradfield, G.E. and N.C. Kenkel. 1987. Nonlinear ordination using shortest path adjustment of ecological distances. Ecology 68(3): 750-753.
Clifford, H.T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York: 229 pp.
Smith, R.W. 1984. The re-estimation of ecological distance values using the step-across procedure. EAP Technical Report No. 2.
Williamson, M.H. 1978. The ordination of incidence data. J. Ecol. 66: 911-920.

- Calculation of similarities for cluster analysis of species, using flexible clustering (β=-0.25) (Clifford and Stephenson, 1975; Lance and Williams, 1967; Smith, 1982)[3]
- Creation of the two-way coincidence table (Kiddawa, 1968; Smith, 1976)[4].

3. These patterns were then compared to potential explanatory variables (physical habitat, aquatic chemistry, toxicity) to identify potentially causative relationships among the different data types.Potential explanatory relationships between IBI scores and physical habitat, aquatic chemistry, and aquatic toxicity data were examined in more depth with the use of scatterplots, the development of a RIVPACs model, and correlations of the components of the physical habitat score with both IBI and the RIVPACs scores.

C-11.2.4.5 Mass Load Calculations

Mass loads are calculated using chemical and hydrographic data. Water level records from permanent streamgauging stations at or near the sampling site are processed using Hydstra software. Water levels from the station's continuous stripchart recorder are digitized and converted to discharge rates using stage-discharge relationships (channel ratings). At sites that have ISCO water level recorders, the dataloggers are downloaded periodically and the information is stored in Hydstra. Using the respective rating tables for each site, the water level data are converted to flow rates. The total discharge in acre-feet during each sampled period is computed. By multiplying the total water discharge per sampled period by the pollutant concentration in the composite sample from the period and applying the proper conversion factors (acre-feet to lbs. of water), a mass load in pounds of contaminant is calculated. For data reported as Non-detected (ND), one-half of the laboratory reporting limits are used in the calculations.

An EMC is the flow-weighted average concentration during a storm. It is calculated from composite sample concentrations and measured stormwater volumes represented by those composite samples. The annual mean EMC represents the flow-weighted mean of all storms sampled at a site during the monitoring year.

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[3] Clifford, H.T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York: 229 pp.
Lance, G.N., and W.T. Williams. 1967. A general theory of classificatory sorting strategies. I. Hierarchical systems. Computer J. 9: 373-380.
Smith, R.W. 1982. Analysis of ecological survey data with SAS and EAP. Proc. 7th Annual SAS Users' Group International (SUGI). SAS Institute Inc. P.O. Box 8000, Cary NC 27511: 610-615.

[4] Kikkawa J. 1968. Ecological association of bird species and habitats in Eastern Australia; similarity analysis. J. Anim. Ecol. 37: 143-165.
Smith, R.W. 1976. Numerical Analysis of Ecological Survey Data. PhD thesis, Univ. of S. Calif., Los Angeles. 401 pp.

$$MeanEMC = \frac{\sum_{i=1}^{n} V_i EMC_i}{\sum_{i=1}^{n} V_i}$$

where n storms are monitored and V_i is the stormwater volume of the *i*th storm. The EMC for a storm *i* is defined as

$$EMC_i = \frac{\sum_{j=1}^{m} SWL_j}{k\sum_{j=1}^{m} SWV_j}$$

where SWL*j* is the stormwater load from composite sample *j* , SWV*j* is the stormwater volume used to calculate SWL*j*, *m* is the total number of composite samples collected during storm *i* and k is a conversion factor to produce the appropriate concentration units.

Annual site-mean EMCs are used to estimate mass loads from un-sampled storms during the monitoring year for two purposes:

- To estimate total annual loads on a site-by-site basis and
- To estimate the loads on a watershed basis.

The annual site-mean EMCs are used to estimate mass loads from un-sampled storms at that site. To estimate these unsampled loads in pounds, the site-mean EMC (in mg/L) for each stormwater contaminant is multiplied by the total annual volume of water (in acre-ft) discharged during un-sampled storms, and the unit conversion factors [2.718 liter • lbs/mg • ac-ft]. If the units of the EMC are ug/L the conversion factor is 2.718 X 10^{-3}. The watershed load is calculated by simply summing the total estimated annual loads from each monitoring site in the watershed. Only EMCs in which the 75-120% of the total runoff volume of a storm is sampled are used to calculate the annual site-mean EMCs.

C-11.2.4.6 Evaluation of Coastal Stormdrain Outfall Data

Coastal stormdrain Outfall data include water temperature and concentrations of bacterial indicators in the discharge and in the surfzone upcoast (north) and downcoast (south) of these stormdrains. Five types of analysis are conducted:

1. Comparing indicator levels at each drain to the state's AB411 single sample standards for ocean water sports contact

2. Ranking drains in terms of the proportion of total possible exceedances of the AB411 standards. The actual number of microbiological analyses or tests conducted on receiving water samples collected at each drain throughout the year is summed. This does not always equal 312 (i.e., 52 weeks x 3 indicators per sample x 2 locations) because it was not always possible to collect the full suite of samples at each site throughout the entire year. The total number of AB411 exceedances is then divided by the total number of sample tests, resulting in a proportion for each drain between 0 and 1.0. The exceedance proportion for each site is then indicated on a map of the sampling sites, according to the following color scheme:

Green:	0 - < 0.14
Blue:	0.14 - < 0.40
Yellow:	0.40 - < 0.75
Red:	0.75 – 1.0

   It should be noted that this color scheme was developed to provide a relative ranking of the surfzone water quality at the outfalls of south Orange County stormdrains. The Heal the Bay Report card scoring methodology uses a different evaluation process which also includes analyses of total to fecal coliform ratios and 30-day geometric mean concentrations of all three indicators.

3. Plotting indicator levels in the receiving water vs. those in the drain. The surfzone concentrations for each indicator are plotted vs. the indicator concentrations in the drain during the same sampling event, with receiving water values on the y-axis and drain values on the x-axis. Separate plots are presented for each indicator at each drain, with upcoast and downcoast data displayed with distinct symbols. The plots are divided into sectors suggesting the conclusions and possible management actions that would be appropriate when a preponderance of the data points fall into one sector or another.

4. Ranking drains in terms of the slope of the linear regression of receiving water indicator levels vs. those in the drain. The concentration data are log transformed and then a standard least squares linear regression calculated for relationship between receiving water indicator concentrations and stormdrain concentrations. A separate regression is calculated for each indicator / drain combination. Sites are then ranked in terms of the "p" value for the regression for each indicator. The "p" value reflects the strength of the drain – receiving water relationship. In combination with the other analyses, this can be used to help assess each drain's likely effect on receiving water conditions.

5. Plotting percentages of sampled days in which at least one indicator bacteria concentration exceeded the AB411 concentration in the surfzone. Each day of surfzone sampling is evaluated with respect to the AB411 standards for the three

indicators. For each drain, the percentage of sampled days in which at least one standard was exceeded in the surfzone (upcoast or downcoast) is calculated. These percentages are calculated for the entire year and the AB411 season. The results are plotted, with the drains grouped by City jurisdiction on the x-axis. This method of analysis provides a better assessment of the health risk (compared to analysis #2) associated with water contact in the surfzone near the discharges from the drains.

These analyses are performed for the entire year and for the AB411 season alone. Analyses also focus on only those instances where field notes indicate that the outflow of a drain is flowing to the surfzone.

Analysis results are then evaluated to identify consistent spatial and temporal patterns. Drains with exceedances and/or regression ranks are evaluated more carefully to identify potential explanatory factors in their drainage areas.

C-11.2.4.7 Evaluation of Ambient Coastal Receiving Water Data

The ambient coastal receiving water data are compared to CTR criteria for saltwater and each sampled area is ranked in terms of its relative degree of impact. In addition, toxicity test results are compared to chemistry samples to identify potential explanations for any observed toxicity. These analyses have contributed to an assessment of the receiving water environment around each stormdrain outfall in terms of its ability to assimilate runoff, the presence of other sources of contamination, and the presence of sensitive marine resources. This information is used to arrive at relative rankings of the degree of runoff risk to each site, which will then provides a basis for prioritizing further studies of stormwater plume extent and impact.

C-11.2.4.8 Prioritization of Dry Weather Sites for Source Identification

Concentrations of monitored constituents at dry weather reconnaissance sites are compared to the upper bounds (lower bound for dissolved oxygen) of tolerance intervals around the 90^{th} percentile calculated from the set of random urban background sites. The concentrations are also compared to the limits from the site-specific control charts. These control charts are time series plots of each measurement at a site. The upper control limit for each measurement is set at 3.9 standard deviations above the mean of all measurements at the site. Instances in which data values for a specific contaminant exceeds either of these two qualifiers for two consecutive monitoring events are flagged for further source identification efforts to identify upstream sources of pollution.

C-11.3 Analysis of Data

The following sections present data summaries and interpretations for each of the major monitoring program elements.

C-11.3.1 Urban Stream Bioassessment Monitoring

IBI ratings

Figure C-11.2 and Table C-11.6 display and describe the bioassessment monitoring sites, which are sampled twice each year, in fall and spring. During the spring of 2009 three additional sites were sampled as part of the SMC Regional Monitoring Program. The location of these sites was based on the random selection of 300-meter stream reaches from throughout the San Diego Region. This sample draw represented a subset of sites selected from a larger draw for watersheds from the entire southern California region. By randomly selecting sampling locations, comparisons can be made regarding stream condition within and among watersheds.

Figures C-11.3 and **C-11.4** present the IBI scores for each bioassessment monitoring site during the fall of 2008 and spring of 2009. Both urbanized and upper watershed reference sites had IBI ratings of Poor to Very Poor, except reference station REF-TCAS, which scored in the Fair range during the spring and represented the best score of either survey. The IBI at reference site REF-CS (San Juan Creek at Cold Spring) scored in the Very Poor range during both seasons. This site was moved slightly upstream beginning with the fall 2006 survey because of chronically low seasonal flows and was located nearer to a spring source with better flow, as well as vegetative bank and canopy cover. However, much of the reach was still located in slow moving pool with an associated reduction in instream complexity and velocity depth regimes, which are not ideal for benthic macroinvertebrate (BMI) communities. As a result of continued low IBI scores, the site was once again moved upstream during the fall 2008 survey where physical habitat conditions appeared to be better.

The IBI rating of most sites remained relatively consistent across the two surveys. Of sites that were flowing during both surveys, only LC-133 changed ratings between surveys from Poor in the fall to Very Poor in the spring. In past years IBI ratings have shown some increase from the fall to the spring survey. The absence of this improvement from fall to spring during the past two years might be the result of drought conditions. Rainfall during the period has been extremely low and represented the third year of drought conditions in Southern California. As a result, two of the reference sites (REF-BC and REF-TCAS) were not flowing during the fall 2008 survey.

The influence of rainfall on the IBI scores at reference sites can be seen in the data from Trabuco Creek at Alder Spring. **Figure C-11.5a** shows the IBI scores from the spring and fall surveys with the annual rainfall measured in Laguna Niguel. The highest IBI scores were observed during and just after the 2004-05 near-record rainfall year; when natural flow and more favorable invertebrate habitat could be maintained in the Creek. After the low rainfall total in 2006-07 the IBI score dipped into the poor range.

The Southern California IBI[5] was developed based on streams that were presumed to be perennial (flowed year round). IBI scores generated for streams that are ephemeral (flow for only a portion of each year) should, therefore, be considered with caution especially during drought conditions. The time necessary to establish a representative and stable population of organisms in a stream system following the onset of flow after a long dry period, can be variable and is not well understood in the southern California region. The State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) is currently mapping the proportion of California streams that are truly perennial.

When IBI scores at each site are averaged (± 95% Confidence Interval) for the period from 200209 a clear pattern emerges (**Figure C-11.5**). All of the lower watershed, urbanized stream reaches scored in the poor to very poor range (IBI< 39). Only Christianitos Creek (CC-CR) in the San Mateo Creek watershed scored at the high end of the poor range. Overall, stations further downstream tend to have lower IBI scores than stations further upstream (**Figures C-11.6a-b**), which reflects the pattern of development with denser development closer to the coast. During the same period average IBI scores at reference site REF-TCAS scored in the Good range, REF-BC (Bell Creek in the Starr Ranch Audubon Sanctuary) scored in the Fair range and REF-CS scored at the top end of the Poor range. REF-CS, as discussed above, is subject to low flows and has been moved upstream twice during the past 3 years in the hopes of bringing the IBI score rating there closer to reference.

Spatial pattern analysis

In addition to describing patterns and trends in benthic invertebrates, a further purpose of the bioassessment program element is to determine whether physical habitat, aquatic chemistry, and/or toxicity are correlated with IBI scores. If strong correlations exist, then this would suggest a causal relationship. The most recent ROWD, which analyzed data from 2002 through spring of 2005, showed that there are no apparent correlations between IBI scores and either toxicity or aquatic chemistry. In contrast, there is a broad relationship between higher physical habitat scores and higher IBI scores. In addition, the pattern of several components of the physical habitat score mimicked patterns in the biological community across the region. Three approaches were used to search for such correlations and validate these conclusions:

[5] Ode PR, Rehn AC, May JT. 2005a. A quantitative tool for assessing the ecological condition of streams in southern coastal California. Environmental Management 35:493-504.

1. Spatial Distribution

   Broad patterns for each of the four types of indicator (i.e., IBI, physical habitat, aquatic chemistry, toxicity) were mapped. **Figures C-11.6a** and **C-11.6b** show that there are no clear relationships at this broad scale between IBI scores and any other type of variable, except for perhaps physical habitat. Thus, sites with a poor overall IBI score did not have similar poor scores for either toxicity or aquatic chemistry.

2. Relationship to Aquatic Toxicity and Chemistry

   Detailed monitoring data for bioassessment, aquatic chemistry, and toxicity were examined at a greater level of specificity to determine whether there are any clear relationships among these measurements. Toxicity testing results (**Table C-11.7**) show that toxicity responses in samples were limited to the invertebrate species (*Ceriodaphnia dubia* and *Hyalella azteca*), with no toxicity observed in the *Selenastrum capricornutum* (freshwater algae) growth test and only 1 toxic response seen in 10 samples submitted for the *Pimephales promelas* (fathead minnow) survival test. Toxicity was observed in the chronic *Ceriodaphnia* survival and reproduction tests at several locations in the fall 2008 and spring 2009 surveys. Closer examination of the data for the individual tests reveals that in 7 instances the survival rates in the undiluted samples of the chronic tests (7 days) were below 50%. The survival rates at 48 hours (acute toxicity) for these samples were 100% further indicating the presence of a slow acting toxicant. In two of the samples, the toxicity dissipated with a 2-fold dilution (TUc=2). In the others, toxicity was still present after a 2-fold dilution. Examination of the available chemistry data from the samples shows that the causes of toxicity were not dissolved metals or organophosphate pesticides. For the two samples where a 2-fold dilution eliminated the toxic response (ACJ01 - 10/22/08 and SC-MB – 4/28/09), the toxicity may have been attributable to the naturally occurring high levels of total dissolved solids in the undiluted sample.

   High toxicity (<u><</u>15% survival in undiluted samples) was also found in the *Hyalella azteca* acute survival test for 6 of the 21 samples submitted for analyses. Interestingly, none of these high toxicities coincides with the high values in the *Ceriodaphnia* chronic survival tests.

   This year's data suggest that neither aquatic chemistry nor toxicity is strongly correlated with the IBI scores, a conclusion consistent with past years' results.

3. Biological Cluster Analysis

   A more powerful set of analyses was used to search for relationships between the biological patterns in the benthic community on the one hand and patterns in potential explanatory variables in the toxicity, aquatic chemistry, and physical habitat data.

As a first step, the species data from all surveys are clustered to identify groupings of sites that were similar in terms of their community composition. **Figure C-11.7** shows the cluster analysis of all sites over the seven years of surveys and **Figure C-11.8** the two-way coincidence table of the relative distribution of species in each site at each sampling time. (Data from previous monitoring years are included in this cumulative analysis because there were no readily apparent differences from patterns observed in previous years.) Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and sites, respectively. Relative species abundances are shown as symbols. The abundance of each species is standardized in terms of its maximum at each site's overall surveys. Smaller symbols represent a lower proportion of maximum abundance and larger symbols are a larger proportion.

So many sites are included in this year's historical analysis that for presentation purposes cluster groups are identified by the general characteristics that make up the group. For example, groups 1 and 2 are composed almost exclusively of reference sites for all surveys since 2002. Other groups are labeled with the site(s) that predominated in the group. In addition the IBI scores for each site and survey are averaged to assess the biological integrity of stations within each of the clusters.

The dominant pattern found in the cluster analysis is a separation between upper watershed reference sites and lower watershed sites. This pattern overshadowed any differences between years or seasons. Reference sites are concentrated at the upper end of the dendrogram, which is equivalent to the left side of the two-way coincidence table.

Site group 2 was composed mostly of Sites REF-CS and WC-WCT. Site REF-CS was intended to be a reference for the San Juan Creek drainage; but during the six year period, this site has produced both low and relatively high IBI scores due to variable physical habitat conditions (see prior discussion). Site WC-WCT is located on Wood Creek in the lower watershed, but unlike many of the other lower watershed sites, it has reasonably good physical habitat conditions and is not immediately surrounded by urban development. Groups 3, 4, 5 and 6 are composed of lower watershed sites that have moderately to highly disturbed, physical habitat conditions.

The second step examines species with broader distributions across sites and times that are concentrated in the lower half of the two-way coincidence table. Species with such broad distributions tend to be more pollution and/or disturbance tolerant. In contrast, species in the upper half of the two-way coincidence table have much more restricted distributions and in fact are found primarily at the reference sites. A closer examination of the species groups A and B shows that they are a diverse assemblage of several less tolerant types of organisms. Species groups C and D contain organisms that are prevalent at both reference sites and some lower watershed sites. Species Group E represents a ubiquitous population that spans groups and included both intolerant and tolerant species. Finally, species group F (at the bottom of the two-way table) includes only very tolerant species characteristic of very disturbed sites. Group F includes the New Zealand mudsnail (*Potamopyrgus antipodarum*) an invasive gastropod that has spread from the Midwestern US, across the western stream systems to California during the past ten years. Efforts to control the expansion of this organism's range at a regional scale have been unsuccessful thus far. However, control efforts on the part of the County's sampling teams (sterilization of sampling equipment after each site visit) have, to date, isolated the mudsnail to two locations on Aliso and Trabuco Creeks in the lower watershed.

Correlations with physical habitat parameters

The strong relationship between physical habitat effects and the biological community response (IBI scores) persisted during the 200809 surveys. Physical habitat continues to have a stronger affect than either aquatic chemistry or toxicity.

Figure C-11.9 shows scatterplots of each physical habitat variable against IBI scores for the period from 2002 to 2009. The plot showing the sum of the scoring of physical habitat metrics versus IBI scores shows that the lower watershed and reference sites are almost completely separated from one another, so that sites with good physical habitat conditions have correspondingly healthy biological communities. Taking this a step further, when each of the individual physical habitat variables is plotted against IBI scores, strong relationships were found for channel alteration and in-stream cover (**Figure C-11.9** and **Table C-11.9**). Moderately strong associations are found for sedimentation, embeddedness, riparian vegetation and riffle frequency. These scatter plots display a "hockey-stick" shaped relationship with IBI. In other words, samples from sites with good physical habitat also have good ecological condition, but ecological condition drops rapidly for sites with poor or moderate physical habitat. For most variables, the threshold physical habitat score is generally above 15 (of possible 20). Bank stability shows a different relationship with the IBI in that the highest ecological condition does not co-occur with the highest bank stability score (20); very high bank stability scores may reflect degradation in the form of bank hardening and channelization. Channel flow and velocity depth regimes also display this type of relationship, with peak ecological condition occurring at intermediate and low channel flow scores.

This year's results continue the pattern seen in previous years of persistent spatial differences between sites higher up in the watershed, which tend to be reference sites, and those lower in the watershed, which tend to be much more subject to urban influences. Toxicity and urban pollutants do not appear to be strongly related to either of these patterns, while some aspects of physical habitat and general water chemistry are related. A detailed analysis of the relationship between IBI scores and physical habitat show that a subset of physical habitat parameters is strongly correlated with IBI scores.

C-11.3.2 Long-Term Mass Loading Monitoring

Mass load monitoring of stormwater runoff is conducted for a wide range of constituents at the sites shown in **Figure C-11.10**. The intent is to monitor each site during three periods of stormwater runoff each year. Water chemistry data from mass load stations are used to calculate loads and to assess water quality with respect to applicable acute and chronic toxicity criteria from the CTR. **Figure C-11.11** shows the temporal trends in rainfall during the last four monitoring years. The lower plot shows the points at which stormwater monitoring was performed at mass load and ambient coastal receiving waters sites during the 2008-09 reporting period.

Table C-11.10 contains the measured stormwater mass loads of nutrients and dissolved metals while **Table C-11.11** shows the corresponding flow-weighted event mean concentrations (EMC) of these constituents. The concentrations of dissolved metals in each composite sample collected in the Mass Loading program element were compared to the CTR criteria for acute toxicity for freshwater and saltwater. The time-weighted concentrations of dissolved metals for monitored events spanning at least three and a half days were compared to the chronic CTR criteria. **Table C-11.12** presents all of water chemistry data from mass emissions monitoring and **Table C-11.13** is a summary of the comparisons to the CTR criteria. It should be noted that comparisons to CTR values are for guidance purposes only (see Section C-11.2.4.1).

Exceedances of the freshwater criteria were rare with two exceedances of the dissolved copper criterion for acute toxicity at LCWI02 (Laguna Canyon Wash) and one exceedance of the chronic criterion for cadmium at PDCM01 (Prima Deshecha Channel). Exceedances of the saltwater criteria were relatively frequent, with 35 exceedances of the copper criterion in 58 samples collected throughout the region. Exceedances of the saltwater criterion for dissolved copper were distributed across all of the sites, while the nickel criterion was exceeded at only one station (Prima Dechecha) in 3 of 11 of its samples. A multi-year summary of exceedances of CTR saltwater acute criteria for dissolved copper and nickel is presented below.

Year	n	Cu	Ni
2004-05	56	33	12
2005-06	49	22	8
2006-07	28	19	2
2007-08	52	31	4
2008-09	58	35	3

It appears that there has been a significant reduction in the number exceedances of the nickel criterion since 2005-06. A closer examination of the data shows that in 2004-05, the near-record rain season, that the nickel criterion was exceeded in 4 of 13 samples (all 4 from the storm of 1/27 – 1/31/05) from Segunda Deshecha Channel and 8 of 11 samples from Prima Deshecha Channel. Since 2004-05 only samples from Prima Deshecha Channel show exceedances of the nickel criterion.

The toxicity results (**Table C-11.14**) show substantial toxicity (TUc $\geq$ 16 toxic units) in the sea urchin fertilization tests conducted on grab samples collected at 3 (LCWI02, SDCM02, and TCOL02) of the 5 sites on November 4, 2008. Substantial toxicity ($\leq$20%

survival in undiluted samples) was measured in the mysid chronic survival tests on samples from the 2 sites (ACJ01, PDCM01) that did not show the high toxicity in the sea urchin tests.

The 24-hr composite samples collected during the storm of November 26-27, 2008 showed essentially no toxicity in the sea urchin fertilization tests but very toxic responses in the mysid (*Americamysis bahia*) chronic survival tests. For three of the sites (PDCM01, SDCM02, and SJCL01) there were no surviving organisms in the undiluted samples after 7 days.

The samples from the storm of February 13-14, 2009 showed essentially no toxicity in either the sea urchin fertilization or mysid survival tests. This sampling was preceded by approximately two inches of rainfall from February 6 to 10, 2009. The runoff from the antecedent storm most likely removed all of the usual toxicants from the watershed and drainage system.

The list of chemical analyses was expanded (**Table C-11.14a**) for some of these stormwater samplings in order provide greater insight into the causes of toxic responses from the tests. Unfortunately, due to laboratory processing issues, the reporting limits for semi-volatile organics were several orders of magnitude greater than last year. Reasonable reporting limits were however, obtained for pyrethroid pesticides and detectable amounts of Bifenthrin, Cyfluthrin, Cypermethrin, and Permethrin were found in some of the samples. The first flush sample from PDCM01 collected on 11/26/08 showed very high levels of Bifenthrin (410 ng/L) and L-Cyhalothrin (2500 ng/L). This site also showed high levels of Bifenthrin, Cyfluthrin, and Permethrin in a first flush sample collected in 2007. The following table summarizes the results of the toxicity testing for samples from the first two storms monitored this season.

Site	ACJ01		LCWI02		PDCM01		SDCM02		SJCL01		TCOL02	
Date	11/4	11/26	11/4	11/26	11/4	11/26	11/4	11/26	11/4	11/26	11/4	11/26
Type	grab	24hr	grab	24hr	grab	24hr	grab	24hr	NS	24hr	grab	24hr
SUFTUc	4	1	>16	2	4	1	16	1		2	16	1
MS%48hr	100	90	82	93	74	55	90	50		75	88	100
MS%7day	16	46	71	34	21	0	53	0		0	74	93
Cu ug/L	4.9	2.7	38	6.7	12	8.3	8.5	5.6		5.9	7.9	3.8
Zn ug/L	11.6	4.4	85	7.9	40	18	33	16		7.6	27	5.2
Mal ng/L	<50	140	<50	110	<50	100	<50	120		120	<50	120
Bifen ng/L	<50	<50	<50	<50	<50	<50	<50	<50		<50	<50	<50
Cyflu	72	<50	66	<50	<50	<50	<50	<50		<50	71	<50
Cyper	77	<50	63	<50	<50	<50	<50	<50		<50	67	<50
Perm	<50	<50	<50	<50	<50	<50	<50	<50		<50	<50	<50

SUF=Sea Urchin Fertilization; MS=Mysid Survival; Mal=Malathion; Bifen=Bifenthrin; Cyflu=Cyfluthrin; Cyper=Cypermethrin; Perm=Permethrin; units are ng/L for all pesticides

The greater toxicity to urchin fertilization seen in samples from the November 4, 2008 storm appears to be correlated to the relatively higher concentrations of dissolved metals in samples from that storm. The available water chemistry does not provide any insight into the sources of toxicity to mysids seen in the second storm. TIEs conducted in previous years have suggested that stormwater toxicity to *Americamysis bahia* survival were attributed to a variety of compounds including metals, non-polar organic compounds or surfactants.

C-11.3.3 Coastal Stormdrain Outfall Monitoring

The locations of the coastal stormdrains are shown in **Figure C-11.12**. The weekly concentrations of indicator bacteria in the stormdrains and the surfzone receiving waters are tabulated in **Attachment C-11.II**. Surfzone concentrations exceeding the AB411 single sample standards for ocean water sports contact are in bold font.

Patterns of AB411 Exceedances

Table C-11.15a-b shows the proportion of all samples exceeding AB411 single sample ocean water sports contact standards in the receiving water upcoast and downcoast of coastal drains for the entire year and for the AB411 season (April 1-October 31). Each site was sampled between 45 and 47 times during this reporting year including over 30 times during the AB-411 season. **Table C-11.15a** presents exceedance proportions based on date of collection (entire year or AB-411 season) and **Table C-11.15b** presents the exceedance proportions for the subset of sampling events during which the discharge from the stormdrain was observed to actually commingle with ocean water. **Figures C-11.13a-b** and **Figures C-11.14a-b** allow a regional perspective of these statistics. Note that some of the exceedance proportions calculated in **Table C-11.15.b** are based on small sample sizes. These exceedance statistics are not as meaningful as those generated from locations with larger sample sizes such as San Juan Creek, Aliso Creek, Salt Creek, Prima Deschecha Channel and Segunda Deshecha Channel.

As in prior years, the exceedances of the AB411 standards during the current reporting year are predominantly for *Enterococci* (223 in 2311 samples) and less so for fecal coliforms (53 of 2311) and total coliforms (61 of 2311). The number of exceedances of the *Enterococcus* standard are slightly higher in the wet season, with 53% (118 of 223) occurring between November 1, 2008 and March 31, 2009. Finally, for the 214 samples collected from the surfzone during the AB411 season when the discharges from a stormdrain reached the ocean, there were 55 exceedances of the *Enterococcus* standard, 14 of the fecal coliform standard, and 18 exceedances of the total coliform standard.

Influence of Outfall on Receiving Water

Linear regression is used to evaluate the strength of the relationship between concentrations of indicator bacteria in the discharge from a stormdrain and the concentrations of indicator bacteria in the respective receiving waters. For each sampling, the stormdrain concentration of an indicator is plotted against its corresponding receiving water concentration. For each site a plot is created for each indicator (total, coliform, fecal coliform, and *Enterococcus*) for each of four conditions:

- Data from the entire year (All Year)
- AB411 Season Only
- All Year-Flows to Ocean Only, and
- AB411 Season-Flows to Ocean Only

These plots are found in **Attachment C-11.III**. The purpose of this analysis is to identify those outfalls that had the most consistent relationship, both for the entire year and during the AB411 season, between the outfall discharge and the receiving water. The assumption underlying this analysis is that the strength of the regression reflected the strength of each drain's influence on its nearby receiving water. **Figures C-11.15a** and **C-11.15b** show examples of data where the discharge from the stormdrain is imparting a significant effect on the receiving water. **Tables C-11.18 (a-d)** ranks the drains in terms of the strength of this relationship, as measured by the statistical significance, or "p" value, of the regression slope for the four conditions. It is important to note that a highly significant regression is not, by itself, indicative of a potentially problem drain. A statistically significant regression must be combined with a relatively high proportion of exceedances, particularly in the AB411 season and when the drain is flowing to the ocean.

Each receiving water site is also evaluated by determining the proportion of sampled days on which at least one single sample standard was exceeded in the surfzone. The results are shown graphically in **Figure C-11.16a**. This method of ranking provides a better assessment of the possible health risks from water contact recreation in the surfzone near the outlets of each drain. As can be seen by **Figure C-11.16a** the areas that show the highest (≥20% of samples) exceedances of single sample ocean water sports contact during the AB411 season are near the outlets of Salt Creek mouth (SCM-1), North Beach Creek (DSB-5), San Juan Creek mouth (SJC-1), Prima Deshecha Channel (POCHE), Segunda Deschecha Channel (PICO), and the stormdrain beneath San Clemente Pier (PIER).

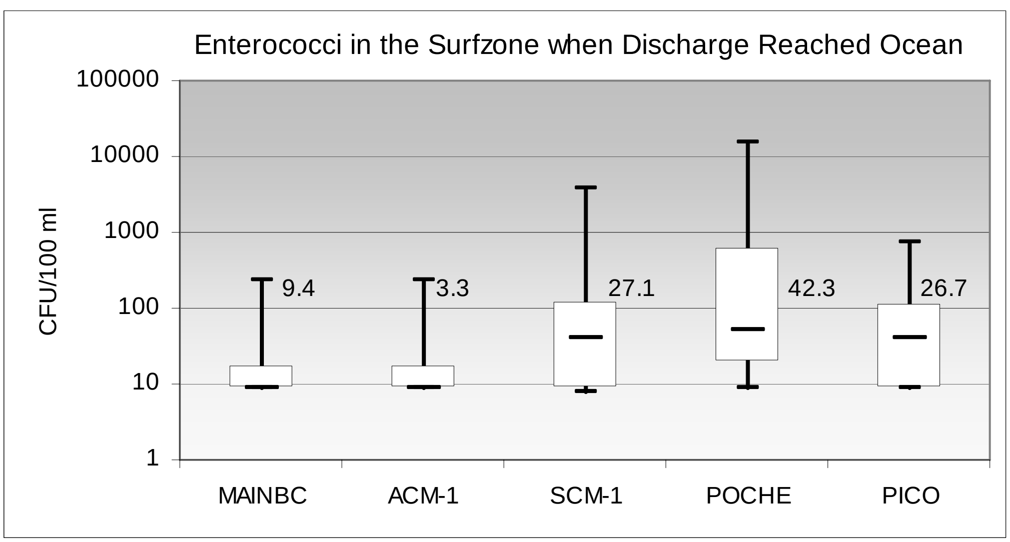
Figures **C-11.16b** and **C-11.16c** graphically show the data presented in **Table C-11.15b** and provide more information for interpreting the rankings presented on the maps in **Figures C-11.13b** and **C-11.14b. Figure C-11.16b** shows that the sites at which the stormdrain discharge reached the ocean most often in 2008-09 were ACM-1, SCM-1, POCHE, and PICO. Of these drains, SCM-1, POCHE, and PICO show an exceedance of a standard more than 37% of the time on those days. On more than 60% (24 of 39) of the days sampled at POCHE in which the discharge from the reached the ocean, at least one of the standards was exceeded. The lower half of **Figure C-11.16b** shows that many of the samplings in the Doheny State Beach and Capistrano Beach area showed an exceedance of a standard even when the discharge did not reach the ocean at the time of sampling. These findings suggest a bacterial source other than urban runoff. The permittees are currently conducting a study of the influence of waterfowl on the bacteriological quality of the surfzone in the Doheny Beach.

Summary

Compared to the previous two years, there was a smaller proportion this year of surfzone samplings in which at least one ocean water sports contact standard was exceeded.

	% of Sampled Days with a Surfzone Exceedance	
Year	All Year	AB-411 Season
2005-06	12.7	8.0
2006-07	16.2	11.2
2007-08	18.7	13.2
2008-09	12.5	8.0

During this reporting period three stormdrains show the most consistent relationships between the concentrations of bacteria in the stormdrains and concentrations of bacteria in the surfzone (as measured by p values). From **Tables C-11-18a-d** Salt Creek**,** Prima Deshecha, and Segunda Deshecha Channels show the most consistent strong relationships between the stormdrains and surfzone for all three indicators during all four conditions. The following figure shows the statistics on *Enterococci* in the surfzone near the outlets of five channels when the flow from those channels entered the surfzone at the time of sampling. The boxplots show the maximum, minimum, 25th percentile, median, and 75th percentile values for each site. The percentage of samples exceeding the 104 CFU/100 ml standard are noted for each site. The figure suggests that the POCHE drain imparts the biggest impact on the surfzone when its discharge reaches the ocean.



The results from all analyses were combined to identify a set of sites of particular interest. Sites were selected based on a relatively high proportion of exceedances combined with highly significant regressions across all three indicators. Additional subjective weight was given to those drains that ranked highly on these criteria at times when the drain was flowing to the ocean, on the assumption that this condition best represents the times when the drain is impacting the surfzone. Each drain's average discharge rate was considered in assessing its potential to affect the surfzone. Finally one site (PIER) was selected solely because of the relatively high percentage of sampled days in which a standard was exceeded.

These priority drains are:

- SCM-1 (Salt Creek mouth)
- POCHE (Prima Deshecha Channel mouth)
- PICO (Segunda Deshecha Channel mouth)
- SJC-1 (San Juan Creek mouth)
- ACM-1 (Aliso Creek mouth)
- PIER (San Clemente Pier)

These sites are the same as those identified as high priorities last year. The San Clemente Pier drain makes the list for the second consecutive year due to the high proportion (7 of 35 - 20%) of sampled days during the AB411 season for which at least one AB411 single sample standard was exceeded in the surfzone (**Figure C-11.16a**). The high percentage of exceedances in the surfzone however does not appear to be attributable to the stormdrain discharge. **Figure C-11.16b** shows that the stormdrain discharge was observed to reach the surfzone in only 6 of the 45 samplings conducted throughout the year. On only 1 of those 6 days were the standards exceeded. It also shows that exceedances of standards were seen in 8 of the 39 samplings that were conducted when no discharge to the ocean was observed.

Of the regional channels that discharge to the ocean (Laguna Canyon Wash, Aliso Creek, Salt Creek, San Juan Creek, Prima Deshecha, and Segunda Deshecha) Aliso Creek (ACM-1) shows the least effect on the surfzone when the Creek flowed to the ocean. During the 2008-09 monitoring year the Creek flowed to the ocean on 30 of the 45 sampling days. On only 3 of those 30 days did concentrations of any of the three indicator bacteria in the surfzone exceed an AB-411 single sample standard.

The receiving waters of the Segunda Deshecha channel (PICO) in San Clemente continue to show a high proportion of AB411 single sample standard exceedances and strong statistical relationships between the concentration of all three indicators in the stormdrain relative to those in its the receiving waters. The system for dry-weather diversion to the sanitary sewer was operational for a portion of the last year. Once it is fully operational conditions in the surfzone should improve during the AB411 season.

At Poche Beach (POCHE) and Salt Creek (SCM-1) the receiving waters near the respective stormdrain–surfzone interfaces also continue to show high exceedance rates and strong regression relationships for all three indictors. Operational testing of the ultraviolet treatment system in lower Prima Deshecha Channel is on-going.

At the outlet of Salt Creek, the City of Dana Point's ozone treatment system has reduced the level of bacteria in dry-weather discharges significantly and the bacteriological quality in the surfzone at Monarch Beach (just north of the Creek) shows improvement.

Table C-11.19 summarizes conditions at these five drains. All except Aliso Creek and the San Clemente Pier Drain typically have stagnant sections or scour ponds at or very near their mouths. Two (Salt Creek mouth and San Juan Creek mouth) also have large bird populations that may be significant contributors to the bacterial concentrations in the creek discharges and the surfzone. With the exception of the San Clemente Pier drain, each of high priority drains is also ranked at the top with respect to discharge rate.

As previously stated, the concentration of bacteria in the receiving water is not necessarily a function of its respective stormdrain discharge despite a strong statistical relationship. For example, the BLULGN site in Laguna Beach showed strongly significant regressions for each indicator but relatively low exceedance rates, while the mouth of San Juan Creek (SJC-1) displayed the opposite pattern of high exceedances but a weaker relationship between creek and receiving water. SJC-1 discharges to the ocean in an area where there are several other coastal stormdrains including North Beach Creek (DSB-5). The shoreline area is also habitat for many waterfowl which excrete significant amounts of fecal material that can impact the surfzone during rising tides. The high concentrations of bacteria in the surfzone in this area may be function of variety of factors.

SCCWRP's study of bacterial indicator levels at reference beaches (SCCWRP Tech. Rpt. #448) showed that exceedance levels at reference beaches were very low during dry weather but reached levels as high as 33% during wet weather. The exceedance levels documented in **Table C-11.15b** (exceedance rates when drain flows to ocean) are in some instances higher than 33% year-round. The SCCWRP study will thus provide a basis in subsequent analyses for estimating the degree of anthropogenic contribution to these exceedance levels.

C-11.3.4 Ambient Coastal Receiving Water Monitoring

The ambient coastal receiving water (ACRW) program component (**Figure C-11.17)** includes both toxicity testing (with marine test organisms) and analyses of water chemistry. Up to the 2006-07 monitoring year, toxicity testing and water chemistry analyses (aside from Dana Point Harbor) had been performed only on samples from the stormdrain discharges. The 2007-08 reporting year includes analyses of dry-weather samples from the receiving waters for five of the stormdrains during both dry-weather and stormwater runoff conditions. **Table C-11.20a** presents the standard aqueous chemistry results, with exceedances of the acute saltwater CTR criteria for metals in bold font. **Table C-11.20b** presents the expanded suite of analytes monitored during storm on December 15, 2008. **Table C-11.21** is a summary of the numbers of acute CTR exceedances at each sampling station and **Table C-11.22** presents the aqueous toxicity testing results.

Table C-11.21 shows that there were no exceedances of CTR saltwater criteria in the surfzone receiving waters during stormwater runoff conditions. Exceedances of CTR saltwater criteria in dry-weather samples were only seen in the samples from the drains and not the surfzone. The dry-weather sample from North Beach Creek (DSB-5) showed exceedances of the criteria for dissolved copper and nickel.

Contrary to last year, Malathion was found in many of the dry weather discharges from the stormdrains. The discharge from the Niguel Marine Life Refuge drain (NI-1) on September 30, 2008 contained significant concentrations of Diazinon (110 ng/L) and Malalation (730 ng/L). Of the samples collected from the receiving waters during the December 15, 2008 storm, a few had detectable amounts of Malathion with the greatest concentration (100 ng/L) seen in the receiving waters of Salt Creek. The expanded chemical analyses (**Table C-11.20b**) conducted on the stormwater runoff samples does not provide any information useful in determining potential toxicants because the laboratory reporting limits for the semi-volatile organic compounds were 3 orders of magnitude higher than last year.

The only toxic response observed in any sea urchin fertilization or embryo development tests conducted in the ACRW program during this reporting year is seen in the dry weather sample from the North Beach Creek drain (DSB-5) on October 2, 2008. This sample coincidently contained dissolved copper and nickel above CTR acute criteria for saltwater.

Several dry-weather samples from the stormdrains show toxic responses in the mysid survival tests. One of the two dry-weather samples from the surfzone near the outlet of Salt Creek shows very high toxicity in the mysid survival tests.

Figure C-11.18 graphically presents the results of the mysid survival tests and the organophosphate pesticide analyses on the dry-weather samples from the ACRW drains. **Figure C-11.19a** shows the data from the dry-weather sampling of the surfzone near the outlets of 4 drains during two different time periods and **Figure C-11.19b** shows the data from the surfzone during the December 15, 2008 storm.

Figure C-11.18 shows that acutely toxic substances were present in the samples from the LB-4 and NI-1 stormdrains. The absence of toxicity at 48 hours and the significant toxic responses noted at 7 days in the samples from LB-2 and DSB-1 suggest that slow acting toxicants were present. The chemistry of the sample from LB-2 suggests that Chlorpyrifos may have been contributory to the toxic effects since it was present at a level twice the 96-hr LC_{50} for mysids. Despite the presence of detectable amounts of other organophosphate pesticides in all but two of the other six samples, the amounts were well below levels that could account for the observed toxicity.

Figure C-11.19a shows that an unusual amount of toxicity was present in the surfzone near the outlet of Salt Creek during a dry-weather sampling on April 28, 2009. From the available water chemistry data neither ammonia, dissolved metals, nor organophosphate pesticides were the cause.

Figure C-11.19b shows that significant amounts of acutely toxic substances were present in the samples collected from the surfzone near the outlets of ACRW drains ACM-1, DSB-5, LB-4, and SCM-1. The sample from the surfzone near Salt Creek mouth caused 100% mortality to mysids after 48 hours. Although Malathion was present in the sample from this site, it was not at a concentration that would have caused the observed toxic response. TIEs conducted in prior years on stormwater samples from mass emissions sites and ACRW drains indicated that causes of toxicity to mysid survival included dissolved metals, non-polar organic compounds, or surfactants.

C-11.3.5 Dry Weather Reconnaissance

Although the dry weather period (May 1 – September 30) does not precisely match the Program's reporting period (July 1 – June 30), the data through the end of the current dry weather period are included in this report.

For reference, the dry weather program monitoring results from both regions for the reporting period are presented in **Attachment C-11-IV**.

This report section summarizes basic monitoring results. Additional information on the permittees' activities to follow up on these data with source identification and other efforts are presented in Chapter 10.

The dry weather monitoring program design includes both random (sampled three times each dry weather period) and targeted sites (sampled five times each dry weather period). **Figure C-11.20** is a map showing the location of the monitoring sites. The purpose of the random sites is to define an average background condition in urban stormdrains. The purpose of the targeted sites is to focus specifically on stormdrains and/or locations known or thought to be sources of urban pollutants. A site (either random or targeted) was classified as problematic only when a pollutant was outside a tolerance interval bound (calculated from the entire set of random sites) or a control chart bound (calculated from the history of data at each site) on two consecutive sampling periods.

Each year, sites are evaluated and may be eliminated from the monitoring program if they meet the following criteria:

- Chronically dry (no dry weather flows);
- Data does not indicate a pollution source in the drainage area (very few tolerance interval exceedances, and none consecutively for the same constituent in the last year);
- A source investigation has been completed that identifies and eliminates the source of the pollutant(s) causing the consecutive tolerance interval exceedances.

This methodology allows jurisdictions to move on from drains that are dry or no longer represent dry runoff problems and focus resources on parts of their MS4 that have not previously been monitored for dry weather flows.

During the 2009 monitoring year, the San Diego Region DWMP observed consecutive exceedances of a tolerance interval bound at six random sites and fourteen targeted sites (**Table C-11.24**). There were no instances in which data points exceeded either the Shewart or CUSUM control chart bounds on consecutive sampling events. **Table C-11.24** shows that a wide range of constituents exceeded the tolerance interval bounds, including metals, pesticides, nutrients, surfactants, total chlorine, and pathogen indicator bacteria. **Table C-11.24** also shows that some issues are chronic such as the nitrate concentrations at AVJ01P26, AVJ01P28, LFJ01P01, and DPL01S03; and the dissolved cadmium, nickel, and zinc concentrations at DPL0102.

C-11.3.6 Dana Point Harbor Monitoring

Monitoring at Dana Point Harbor (**Figure C-11.21**) was limited to a fall 2008 sampling of the sediment at DAPTEB in the East Basin. During the last three years the sediment collected at DAPTEB has shown seasonal toxicity with the spring samples showing non-toxic responses and the fall samples showing highly toxic responses. **Table C-11.25** shows the sediment chemistry and sediment toxicity testing results.

Table C-11.25 shows that, as in last three years of data, the sediment from DAPTEB, near the outlet of the Golden Lantern stormdrain, contained substances that exceeded the NOAA Effects Range Median (ERM) concentrations. The fall 2008 sampling shows copper and zinc above ERM values.

In the 10-day *Eohaustorius* survival sediment toxicity test, 100% mortality was observed. A significant amount of synthetic pyrethroid pesticides were found in the sediment but the TIE analysis, conducted on the sediment concluded that the toxicant was most likely ammonia. The source of ammonia was most likely anaerobic decomposition of organic matter in the sediment. **Figure C-11.23** shows the results of the sediment toxicity analyses for DAPTEB conducted during the last five years. Initially both spring and fall samplings each year showed highly toxic conditions. During the last three years however the toxicity ranged from highly toxic in the fall samplings to non-toxic in the spring samplings. This pattern would suggest that toxicity at that sampling builds up during the dry season and is possibly scoured away from the sampling site during the storm season.

The State Water Quality Control Board's current effort to develop sediment quality objectives (SQO) for bays and estuaries has shown, using a large dataset from across the state, that the relationship between sediment chemistry and toxicity is very noisy at best. This is due to the fact that the bioavailability of contaminants in the sediment is highly variable and is affected by a number of poorly understood factors, making it extremely difficult to draw firm conclusions about the relationship between sediment chemistry and toxicity on a site-specific basis. Part 1 of the SQOs was released in August of 2009 and will be used in next years analysis to provide a rigorous assessment framework for combining sediment chemistry, sediment toxicity, and benthic infauna data for site and waterbody assessment.

Figure C-11.22 and **Table C-11.28** provide a larger regional context for assessing the sediment toxicity of Dana Point Harbor. It is important to note that the data from the Bight Program are not strictly comparable to the monitoring data from Dana Point Harbor because they were collected on the random Bight Program sampling grid, while the NPDES monitoring program has deliberately sited stations in locations (i.e., at the mouths of stormdrains) more likely to be contaminated by urban runoff. Despite this, a subjective comparison shows that sediment toxicity at Dana Point Harbor is below average for bays and harbors in the Southern California Bight (**Figure C-11.22**, **Table C-11.28**), as documented in the Bight '03 report on sediment toxicity.

The Bight '03 survey documented an increase in the average sediment toxicity in Dana Point Harbor relative to the Bight '98 survey. Although the sites from the Bight '03 survey were not near the outlets of stormdrains, the two sites in the harbor (4 total sites) which showed the greatest toxicity were in areas of limited circulation where finer sediments would deposit. While temporal variability in sediment toxicity may result from changes in the physical and chemical characteristics of the sediment, the Bight '03 sediment toxicity report illustrates that these relationships are too variable to provide a basis for site-by-site explanations of shifts in toxicity levels.

C-11.3.7 <u>Aliso Creek Bacterial Indicator Monitoring</u>

Trends in fecal coliform concentrations, relative to the relevant REC1 water quality standard, are shown in **Figures C-11.26** and **C-11.27** for the BMP evaluation and trend tracking sites in the Aliso Creek watershed, respectively. The purpose of the BMP evaluation sites is to determine whether focused efforts in specific sub-drainages result in downward trends in fecal coliform concentrations, both in the drain and the receiving waters of the Creek. The purpose of the trend tracking sites in the lower portion of the watershed is to assess whether the cumulative efforts at bacterial source identification and source control in the watershed result in lower concentrations of fecal coliform in those areas where human use, and therefore the potential for human health impacts, is the highest.

Figures C-11.26 and **C-11.27** show the monthly geomeans for the late summer / early fall period that is the current focus of the monitoring effort, extending back to the beginning of the 13225 Directive Monitoring Program. A comprehensive analysis of these data can be found in **Exhibit 13-Section 2: The Aliso Creek Watershed Action Plan Annual Report**.

C-11.3.8 Additional Comparisons to CTR

Aquatic chemistry samples from several components of the water quality monitoring program (urban stream bioassessment, long-term mass loading, ambient coastal receiving water monitoring) are evaluated in comparison to thresholds established in the CTR. While such CTR thresholds are available for only a portion of the constituents measured in the program's samples, the combination of CTR exceedances from all available program components provides an overview of contamination patterns across the region.

Table C-11.29 summarizes exceedances of acute CTR criteria for all water quality monitoring stations in the San Diego region. For purposes of this assessment, all program components (bioassessment, mass loading, ambient coastal) are combined into one dataset, in order to better represent the spatial pattern of exceedances across the region.

Exceedances overall are predominantly due to copper, with a much smaller percentage due to nickel and zinc. Exceedances of the CTR for cadmium, lead, and silver were extremely rare and thus not included in **Table C-11.29**. Most of the copper exceedances were of the saltwater criterion and these generally occurred during storms. **Figures C-11.30** and **C-11.31** visually summarize these regional patterns, using the data presented in **Table C-11.29**.

Within these larger patterns, the CTR exceedance data help identify locations where targeted special studies to identify upstream sources should be considered. Exceedances of CTR criteria during a single year alone should not be the only factor influencing the initiation of source identification studies. Other factors include:

- Temporal variability (are the exceedances seen every year?);
- Sensitivity of the receiving waters (ACRWs should receive higher priority);
- Volume of discharge (channels with large watersheds will generate greater volumes of stormwater runoff and cause greater spatial impact in the receiving waters); and
- Magnitude of the concentration (the sources of concentrations slightly exceeding the saltwater criterion for copper would be difficult to track).

C-11.4 Summary

The seventh year of monitoring under the Third Term Permit expands the information available for regional and watershed assessment of receiving water conditions and potential impacts on these from urban runoff. The expanded scope of the monitoring program encompasses not only inland creeks and streams but coastal receiving waters as well.

The monitoring data reviewed above expand our understanding of year-to-year variability in conditions, as well as highlighting those patterns that tend to persist over time. These results enable the Program to identify specific locations of potential concern and to document how these respond to changes in yearly rainfall and to management actions. An expanded emphasis on displaying data in a regional context has supports the identification of locations of concern by showing how indicators such as toxicity change across the region and between dry and wet weather conditions.

The **Urban Stream Bioassessment** results confirmed the broad patterns identified in last year's analysis. These included:

- Greater impact to the biological community in the lower portions of watersheds
- Low levels of pollutant concentrations
- The absence of a strong relationship between biological patterns and either aquatic chemistry or aquatic toxicity
- A relationship between biological patterns and some physical habitat parameters.

A more in-depth analysis of the relationship between IBI and physical habitat components continue to validate the Program's prior conclusion that changes in physical habitat condition are correlated with, and possibly responsible for, impacts on the instream biological community. As a result of the findings listed above, the Program is considering focusing bioassessment monitoring on the spring season and reprogramming effort now allocated to the fall sampling to further studies of the relationships between physical habitat and IBI scores. A similar option was offered by the Regional Board in monitoring program section of the tentative order for the 4^{th} Term Permit. While there are consistent differences (during average rainfall seasons) between fall and spring biological communities, both tell the same story about spatial pattern and the relationship to potential explanatory variables. Other programs, such as SWAMP, the San Gabriel River Regional Watershed Monitoring Program, and the Los Angeles County Stormwater Program, focus on the spring index period. Additional studies of the effects of physical habitat modification would include further analyses of available data, comparison of results with those obtained by other bioassessment monitoring programs, and potentially field experiments to assess whether remediation of specific habitat features would improve biological condition.

The **Long-Term Mass Loadings** program continues to add to the database from which a long-term record of stormwater loads will be generated. Experience in the Santa Ana

Region has demonstrated that a long time period is necessary in order to separate trends from background variability.

Although criteria from the California Toxics Rule (CTR) do not apply to stormwater comparisons to these criteria were made to provide insight into the results of toxicity testing of stormwater runoff samples. Exceedances of the CTR freshwater criteria were rare in stormwater from the mass loading sites with two exceedances of the dissolved copper criterion for acute toxicity at LCWI02 (Laguna Canyon Wash) and one exceedance of the chronic criterion for dissolved cadmium at PDCM01 (Prima Deshecha Channel). Since the fate of stormwater discharges are the coastal receiving waters, the quality of the discharges were also compared to the CTR saltwater criteria. It should be noted that direct comparison of the concentrations of dissolved metals in stormwater runoff to CTR criteria for saltwater only provides insight into the potential impacts at the freshwater-saltwater interface. With that being said, exceedances of the saltwater criteria were relatively frequent, with 35 exceedances of the copper criterion in 58 samples collected. Exceedances of the saltwater criterion for dissolved copper were distributed across all of the sites, while the nickel criterion was exceeded at only one station (Prima Deschecha) in 3 of its 11 samples.

Synthetic Pyrethroid pesticides were found in some of the samples collected from the mass emissions sites. The analyses of the first flush sample from Prima Deschecha Channel (PDCM01) collected on 11/26/08 shows very high levels of Bifenthrin (410 ng/L) and L-Cyhalothrin (2500 ng/L). This site also showed high levels of Bifenthrin, Cyfluthrin, and Permethrin in a first flush sample collected last year.

Toxicity testing results show substantial toxicity ($\geq$ 16 chronic toxicity units) in the sea urchin fertilization tests conducted on grab samples collected at 3 of the 5 sites during the storm of November 4, 2008. The amounts of dissolved copper and zinc detected in those samples are most likely the cause of the toxicity. At the two sites that showed lower toxicity in the urchin fertilization tests, substantial toxicity (<22% survival in undiluted samples) was measured in the mysid chronic survival tests.

The 24-hr composite samples collected during the storm of November 26-27, 2008 shows essentially no toxicity in the sea urchin fertilization tests but very toxic responses in the mysid chronic survival tests. For three of the sites (PDCM01, SDCM02, and SJCL01) there were no surviving mysids in the undiluted samples after 7 days. In these three samples no pyrethroid pesticides were detected (<50 ng/L) and only small amounts of Malathion were detected (100-120 ng/L). TIEs conducted on stormwater samples from Mass Loading and Ambient Coastal Receiving Waters sites in 2006-07 showed that metals, surfactants, and non-polar organic compounds were responsible for toxicity seen in some of the mysid tests.

The 24-hr composite samples from the storm of February 13-14, 2009 show essentially no toxicity in either the sea urchin fertilization or mysid survival tests. This absence of toxicity may be related to the 2 inches of antecedent rainfall that occurred within a week of the sampling.

Compared to the previous two years, there was a smaller proportion this year of surfzone samplings in the **Coastal Stormdrain Outfall** monitoring program for which at least one ocean-water-sports-contact standard was exceeded.

	% of Sampled Days with a Surfzone Exceedance	
Year	All Year	AB-411 Season
2005-06	12.7	8.0
2006-07	16.2	11.2
2007-08	18.7	13.2
2008-09	12.5	8.0

Analysis of monitoring data was used to prioritize sites of particular interest which had a high proportion of samples that exceeded the AB-411 ocean water sports contact standards and had statistically significant correlations between the concentrations of bacterial indicators in the stormdrain and in the surfzone. The four groupings of data that were evaluated at each site were:

- the entire year,
- AB411 season only,
- entire year with discharge flowing to the ocean at the time of sampling, and
- AB411 season with discharge flowing to the ocean at the time of sampling.

During this reporting year, Salt Creek**,** Prima Deshecha, and Segunda Deshecha Channels stormdrains show the most consistent relationships between the concentrations of bacteria in the stormdrains and concentrations of bacteria in the surfzone (as measured by p values) for all three indicators during all four conditions. Additional subjective weight was given to those drains that ranked highly on these criteria at times when the drain was flowing to the ocean, on the assumption that this condition best represents the times when the drain is impacting the surfzone. Finally, each drain's discharge rate was considered in assessing its potential to affect the surfzone. The drains selected using this year's data are:

- SCM-1 (Salt Creek mouth)
- POCHE (Prima Deshecha Channel mouth)
- PICO (Segunda Deshecha Channel mouth)
- SJC-1 (San Juan Creek mouth)
- ACM-1 (Aliso Creek mouth)
- PIER (San Clemente Pier)

The San Clemente Pier drain makes the list for the second consecutive year due to the high proportion (7 of 35 - 20%) of sampled days during the AB411 season for which at least one AB411 single sample standard was exceeded in the surfzone. The high percentage of exceedances in the surfzone however does not appear to be attributable to the stormdrain discharge. The stormdrain discharge was observed to reach the surfzone in only 6 of the 45 samplings conducted throughout the year and on only 1 of those 6 days were the standards exceeded. Furthermore, exceedances of standards were seen in 8 of the 39 samplings that were conducted when no discharge to the ocean was observed.

Of the regional channels that discharge to the ocean (Laguna Canyon Wash, Aliso Creek, Salt Creek, San Juan Creek, Prima Deshecha, and Segunda Deshecha), Aliso Creek (ACM-1) showed least effect on the surfzone when the Creek flowed to the ocean. During the 2008-09 reporting year, Aliso Creek flowed to the ocean on 30 of the 45 sampling days. On only 3 of those 30 days did concentrations of any of the three indicator bacteria in the surfzone exceed AB-411 single sample standards.

The receiving waters of the Segunda Deshecha channel (PICO) in San Clemente continue to show a high proportion of AB411 single sample standard exceedances and strong statistical relationships between the concentration of all three indicators in the stormdrain relative to those in its the receiving waters. The system for dry-weather diversion to the sanitary sewer was operational for a portion of the last year. Once it is fully operational conditions in the surfzone should improve during the AB411 season.

At Poche Beach (POCHE) and Salt Creek (SCM-1) the receiving waters near the respective stormdrain–surfzone interfaces also continue to show high exceedance rates and strong regression relationships for all three indictors. Operational testing of the ultraviolet treatment system in lower Prima Deshecha Channel is on-going.

At the outlet of Salt Creek, the City of Dana Point's ozone treatment system has reduced the level of bacteria in dry-weather discharges significantly and the water quality in the surfzone at Monarch Beach (just north of the Creek) shows improvement.

The seven years of monitoring data from the **Ambient Coastal Receiving Waters (ACRW)** Program demonstrate a large degree of variability in conditions at the ambient coastal sites. The 2008-09 reporting year includes collection of toxicity and aqueous chemistry samples from the surfzone during dry-weather and stormwater runoff conditions. Dry-weather samples were also collected from the stormdrains.

With respect to water chemistry, there were no exceedances of CTR saltwater criteria for dissolved metals in the surfzone receiving waters during dry-weather or stormwater runoff conditions. In 5 of the 7 samples collected from the stormdrains during dry weather, dissolved copper and/or nickel were found in concentration exceeding CTR criteria. The chemistry of the dry-weather sample from North Beach Creek (DSB-5) shows exceedances of the criteria for both dissolved copper and nickel.

Contrary to last year, Malathion was detected in many of the dry-weather discharges from the stormdrains. It was frequently found in the stormwater discharges from the drains last year. The dry-weather discharge from the Niguel Marine Life Refuge drain (NI-1) on September 30, 2008 contained significant concentrations of Diazinon (110 ng/L) and Malalation (730 ng/L). Of the samples collected from the receiving waters during the December 15, 2008 storm, a few had detectable amounts of Malathion with the greatest concentration (100 ng/L) seen in the receiving waters of Salt Creek (SCM-1).

The only toxic response observed in any sea urchin fertilization or embryo development tests conducted in the ACRW program this year is seen in the dry-weather sample from the North Beach Creek drain (DSB-5) on October 2, 2008. This sample coincidently contained dissolved copper and nickel above CTR acute criteria for saltwater.

Several dry-weather samples from the stormdrains show toxic responses in the mysid survival tests. One of the two dry-weather samples from the surfzone near the outlet of Salt Creek shows extremely high toxicity (0% survival in undiluted sample) in the acute mysid survival test. The available water chemistry data from this sample however does not provide any insight as to the cause of the toxicity.

Since the Permittees are part of the Regional Harbor Monitoring Program (RHMP) the Board has suspended the requirement for routine monitoring at **Dana Point Harbor.** Despite the suspension the Permittees continue to investigate the seasonal sediment toxicity near the outlet of the Golden Lantern Stormdrain. During the last three years the sediment collected at DAPTEB has shown seasonal toxicity with the spring samples showing non-toxic responses and the fall samples showing highly toxic responses. Sediment chemistry and toxicity was monitored at station DAPTEB in the East Basin during the fall of 2008.

The last three years of sediment chemistry data from DAPTEB has shown that some metals have exceeded the NOAA Effects Range Median (ERM) concentrations. The fall 2008 sampling data shows copper and zinc above ERM values.

The 10-day *Eohaustorius estuarius* survival test conducted on the fall 2008 sediment sample caused 100% mortality to the test organisms. A Toxicity Identification Evaluation analysis was conducted on the sediment and concluded that the toxicant was most likely ammonia. Sources of ammonia is sediment are anaerobic decomposition of organic matter. This organic matter may have been vegetative debris deposited by stormwater runoff from the Golden Lantern Stormdrain.

The **Dry Weather Reconnaissance** monitoring effort continued to identify specific locations that meet the criteria for targeted source identification efforts. A number of instances (described in more detail in Chapter 10) were forwarded to the responsible for investigation and resolution.

C-11.5 Quality Assurance / Quality Control Evaluation

During the middle of the reporting period the Principal Permittee relocated to a new facility in Orange, California. With that move was the construction of a larger and more modern laboratory. The additional space will allow more efficient sample processing and analysis as well as better quality assurance of Program data.

Overall the proportion of quality assurance samples grew from last year's 13%of sample submittals to 18% this year. The Annual QA/ QC Summary which describes the quality assurance (QA) sample type and percent breakdown are presented in **Attachment C-11-X**.

The Monitoring programs QA officer oversaw preparation and submittals of quality assurance (QA) samples to evaluate the quality of data produced by each of the three contractor laboratories and the Public Health Laboratory. The preparation included synthetic samples for accuracy which are comprised of aliquots of prepared standard solutions in ultra-pure (Nanopure) water matrices where the level of total dissolved solids (TDS) was adjusted with Ultrex grade sodium chloride to simulate comparable levels of TDS in environmental samples. Additionally, replicates of the environmental samples were also submitted to evaluate analytical precision.

Along with the previously described QA regime, the Dry-weather Reconnaissance monitoring staff routinely analyzed synthetically prepared standards to assess the quality of mobile laboratory measurements. Moreover, contractor laboratories supplied QA data relating to their respective internal quality control programs utilizing certified reference materials (CRMs), spiked and replicate samples analyzed along with county environmental sample batches.

The results of the quality assurance program are summarized in tabular and graphic form in **Attachment C-11-X**. Control charts were created to show the performance of the laboratories over the course of the monitoring year. The upper (UCL) and lower (UCL) control limits are shown on each of the control charts.

The results of the QA program show that:

- The precision of analyses for pathogen indicator bacteria were generally within the bounds of the control limits.
- The analyses for nutrients and trace metals in freshwater were generally good for precision.
- The precision of some analyses of samples with salt water matrices collected during storms was outside of the control limits especially lead, thallium,zincammonia, TSS and turbidity.
- Many of the recoveries in the analyses of Oil and Grease were consistently outside control limits. The Program will work with the lab to resolve this issue.
- Although the precision of organophosphate pesticides analyses was goodthe accuracy of analyses was inconsistent toward the end of the reporting year (June). This dip in performance coincided with a change in analytical services providers. The Program will work with the new contract laboratory to improve the quality of these analyses. If acceptable quality cannot be achieved an alternative vendor which can meet the requirements will be used.

- Some trip blank and equipment blank results showed slight contamination with trace metals possibly due to the use of de-inionized water rather than nanopure water when the Principal Permittee's ultrapure water system failed.

The accuracy of field chemical analyses in the Dry-weather reconnaissance programs was generally acceptable with the exception of the analyses for total chlorine and surfactants (MBAS). For San Diego region, the percent recovery for total chlorine analyses was consistently low (mid 60%) and there were 5 of 7 samples for which the recoveries for MBAS were below 75%. For MBAS, the Santa Ana region also had 6 of 8 samples below acceptable ranges.