# C-11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

## C-11.1 Introduction

In response to the monitoring and reporting requirements of the Fourth Term Municipal Stormwater Permit (R8-2009-0030, NPDES CAS618030) from the Santa Ana Regional Board, the Permittees developed and implemented a water quality monitoring program. This monitoring and reporting program is an extension of the Third Term Permit program developed and submitted by the Permittees to the Regional Board in 2003 and approved by the Executive Officer in August 2005. The program is based on "The Model Monitoring Program for Municipal Separate Storm Sewer Systems (MS4) in Southern California" developed by the Stormwater Monitoring Coalition (SMC). The SMC is an organization of municipal stormwater agencies, Regional Boards, USEPA Region 9, NGOs, and the Southern California Coastal Water Research Project (SCCWRP).

This report presents the results of water quality monitoring, conducted between July 1, 2011 and June 30, 2012, in the portion of Orange County under the jurisdiction of the Santa Ana Regional Board. The report includes a number of attachments that provide supporting and supplemental information, as follows:

**Attachment C-11-I** – Includes maps of monitoring sites
**Attachment C-11-II –** Includes monitoring data from the major monitoring program components.
**Attachment C-11-III** – Includes a history of the monitoring program and descriptions of monitoring and data analysis methods used to evaluate the water, sediment, and benthic infaunal taxonomy data collected in this monitoring program.
**Attachment C-11-IV –** Includes a summary of the quality assurance program for 2011-12.

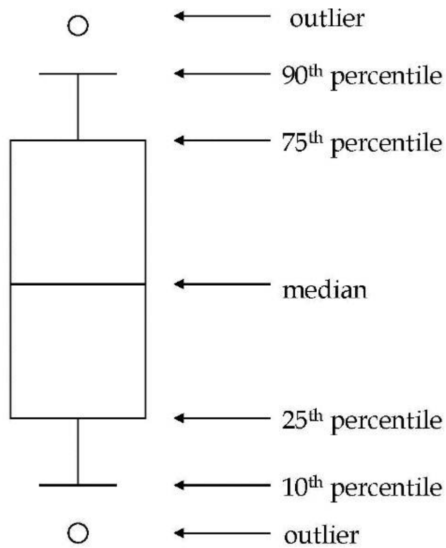
## C-11.2 Analysis of 2011-12 Data

The following sections present data summaries and interpretations for each of the major monitoring program components. The approach for evaluating water quality monitoring data includes comparisons to benchmarks, as described in the Monitoring and Reporting Program and **Attachment C-11-III**, including as appropriate:

- Basin Plan Objectives for Inland Waters and Enclosed Bays
- California Toxics Rules criteria for toxics and priority pollutants
- Shoreline recreational water contact objectives established by Assembly Bill 411 (AB411)
- Water Quality Control Policy thresholds for aquatic and sediment toxicity
- US Environmental Protection Agency aquatic life benchmarks
- Southern California Index of Biotic Integrity for freshwater streams
- Reference stream thresholds from the Stormwater Monitoring Coalition's Regional Watershed Monitoring Program

Data in this report are commonly presented using the box and whisker diagram to convey the distribution of data with respect to the specific analysis presented. An explanation of the various components of the box and whisker plot are provided in the following diagram

Explanation of the Box and Whisker diagram




C-11.2.1 Long Term Mass Emissions Monitoring

C-11.2.1.1 Core Monitoring Program

Mass emissions monitoring is conducted primarily to estimate the total annual masses of a wide range of constituents which are transported by flood control drainage channels to receiving waters during both dry-weather and stormwater runoff conditions. Water chemistry and channel discharge rates are measured to compute loads for specific dry weather and wet weather events each year. Ideally, the total annual load of a selected constituent from a channel would be determined from a continuous monitoring of the water chemistry and discharge rate throughout the year. The cost for analytical services and monitoring labor requirements however, make the continuous analysis of aquatic chemistry cost prohibitive. Consequently, monitoring of aquatic chemistry is conducted during representative runoff conditions (dry-weather or stormwater runoff) and the information gathered is used to estimate the conditions throughout the year. The monitoring locations are shown in **Attachment C-11-I – Map 1.** The intent is to monitor each site during three periods influenced by stormwater runoff and a representative number of dry weather periods. The annual rainfall summary for Santa Ana, shown in **Figure C-11.1,** shows that this year's total of 8.27 inches was the fifth lowest total in the last 15 years.

Water quality data from mass emissions stations were used to assess stormwater mass loads, toxicity effects associated with runoff, and compliance with respect to acute and chronic criteria from the California Toxics Rule (CTR). **Attachment C-11-II - Table 1** contains the measured flow-weighted event mean concentrations (EMC) of these constituents and stormwater mass loads of nutrients and trace elements, respectively. The concentrations of dissolved metals and total recoverable selenium in each composite sample collected in the mass emissions program element are compared to the acute toxicity criteria from the CTR. The time-weighted mean concentrations for periods spanning 3.5 days or more are compared to the chronic criteria. Freshwater criteria are used to evaluate channel discharges. **Attachment C-11-II – Table 3** presents all of these data and **Attachment C-11-II – Table 7** summarizes the comparisons to the CTR criteria. Regional patterns of CTR exceedances during dry weather and wet weather conditions are presented in **Attachment C-11-1 - Table 2** and **Attachment C-11-1 - Table 3**

Of the 125 composite samples collected during in 2011-12, exceedances of CTR criteria were limited to selenium, copper, and zinc.

*Selenium*

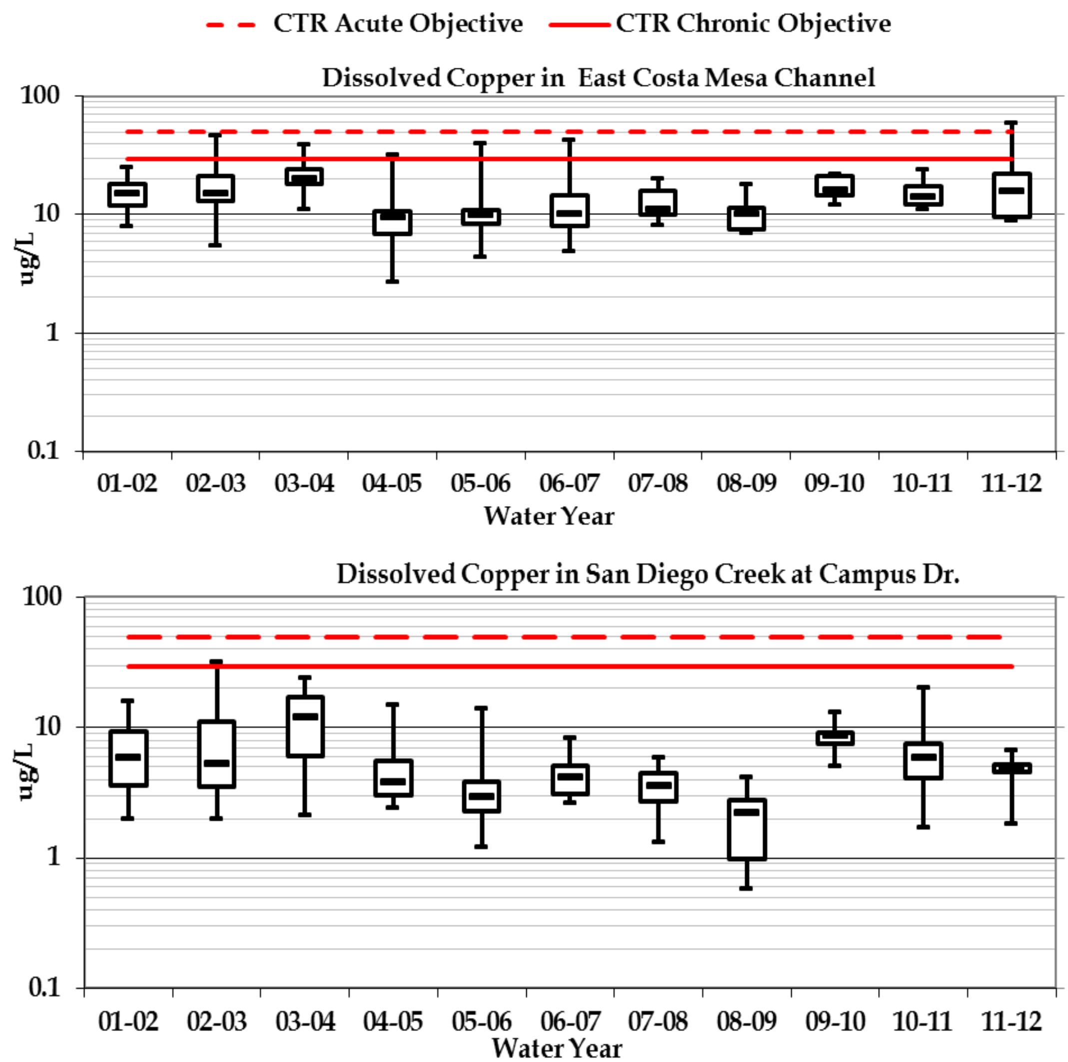
73 composite samples were collected during dry weather, 35 (47.9%) of which showed an exceedance of the chronic CTR criterion for total recoverable selenium. All of the dry weather samples showing exceedances of the selenium criterion were collected from the Upper Newport Bay watershed: San Diego Creek at Campus Drive SDMF05 – 10 of 10 samples), San Diego Creek at Harvard Avenue (WYLSED - 4 of 10 samples), Peters Canyon Wash at Barranca Parkway (BARSED – 10 of 10 samples), and Santa Ana Delhi Channel (SADF01 – 11 of 11 samples). The chronic CTR criterion for total recoverable selenium was exceeded in 7 out of 22 of these stormwater samples.

*Copper and Zinc*

3 of the 73 (4.1%) dry weather samples collected across the region showed an exceedance of the acute freshwater criteria (adjusted for water hardness) for dissolved copper. Of the 52 stormwater-influenced composite samples collected, 10 (19%) showed an exceedance of the acute freshwater criteria for dissolved copper and 2 (3.8%) showed an exceedance of the acute freshwater criteria for dissolved zinc. On an annual basis during 2011-12, exceedances of the copper criteria were found in samples collected from Costa Mesa Channel [CMCG02] (5 of 16 samples), Central Irvine Channel [CICF25] (2 of 14), Fullerton Creek Channel [FCVA03] (3 of 7), and Santa Ana Delhi Channel [SADF01] (1 of 17). None of the samples collected from San Diego Creek at Campus Drive exceeded CTR criteria.

2 of the 52 stormwater-influenced composite samples collected across the region showed an exceedance of the acute freshwater criteria for dissolved copper. Zinc exceedances were found in samples collected from found in samples collected Costa Mesa Channel [CMCG02] (1 of 5 samples) and Fullerton Creek Channel [FCVA03] (1 of 5). No other sites had any exceedances of the CTR criteria for dissolved zinc.

The following graphic shows the annual statistics of dissolved copper in stormwater at two sites in the Newport Bay watershed, specifically East Costa Mesa Channel and San Diego Creek at Campus Drive.




*Toxicity*

Toxicity testing is also conducted on selected samples of dry weather and stormwater runoff and streambed sediments at mass emissions monitoring sites. Toxicity testing provides a cumulative perspective of pollutant effects on receiving water aquatic species. Results indicate that toxicity effects in receiving waters across the region were different between dry weather and storm events as shown in **Attachment C-11-I – Map 4** and **Attachment C-11-I – Map 5**. Samples were considered to be toxic if the organism response test results (i.e. survival, reproduction, or growth) were less than 80% effect. Toxicity was found occur in only 9 of 148 tests (6%) of dry weather samples in comparison to 28 of 110 tests (25 %) of stormwater samples collected from inland receiving waters. Sediment toxicity was found in only 2 of 16 (12%) samples collected during dry weather conditions.

The tests on the dry weather runoff samples are conducted with freshwater organisms, while the stormwater runoff samples are evaluated with a combination of freshwater and marine organisms. The tests involve a statistical comparison of the mean organism responses (e.g.

survival, growth, reproduction, or fertilization rates) in a series of sample dilutions to the mean value of responses in laboratory control samples. The toxicity tests results for all samples analyzed during 2011-12 are contained in **Attachment C-11-II – Table 4.**

A summary of toxicity test result statistics for samples collected during dry weather is provided in the table below.

| Dry Weather Tests Statistics | Mean | Min | Max |
|---|---|---|---|
| *Ceriodaphnia dubia* Reproduction | 108% | 35% | 154% |
| *Ceriodaphnia dubia* Survival | 98% | 50% | 111% |
| *Ceriodaphnia dubia* Survival 48 Hour | 98% | 60% | 111% |
| *Hyallela azteca* Survival 96 Hour | 100% | 79% | 105% |
| *Selenastrum capricornutum* Cell Density | 137% | 28% | 191% |

One hour composite stormwater toxicity samples were collected and tested from six sites on October 4, 2011 in the first flush of the first storm at Santa Ana Delhi Channel, East Costa Mesa Channel, Bolsa Chica Channel, East Garden Grove Wintersburg Channel, Coyote Creek, and Fullerton Creek. Toxicity testing was also conducted at six sites in the Newport Bay watershed during the December 13, 2011 storm and six sites in the Anaheim Bay and Coyote Creek watersheds during on March 17, 2012 from 24-hour composite samples. Equipment irregularities and debris in the channels interfered with the sampling effort on December 13, 2011 at San Diego Creek at Campus Drive which greatly limited the test volume and as a result only the *Strongylocentrotus purpuratu*s Fertilization test could be analyzed. All stormwater toxicity test results are presented in **Table C-11-1**.

The toxicity test results for stormwater samples collected during 2011-12 were, as noted, slightly different from the dry weather samples statistics and are summarized in the table below.

| Stormwater Tests Statistics | Mean | Min | Max |
|---|---|---|---|
| *Ceriodaphnia dubia* Reproduction | 79% | 16% | 121% |
| *Ceriodaphnia dubia* Survival | 80% | 50% | 100% |
| *Ceriodaphnia dubia* Survival 48 Hour | 93% | 80% | 100% |
| *Americamysis bahia* Growth | 82% | 0% | 135% |
| *Americamysis bahia* Survival | 74% | 0% | 103% |
| *Americamysis bahia* Survival 48 Hour | 87% | 10% | 103% |
| *Strongylocentrotus purpuratu*s Fertilization | 90% | 9% | 102% |

The results show that the most toxic responses were seen in the chronic *Americamysis bahia* survival and growth tests and the *Ceriodaphnia dubia* survival and reproduction tests. None of the samples collected for the acute 48 hour *Ceriodaphnia dubia* survival samples were toxic and only 2 of 17 samples for the *Strongylocentrotus purpuratu*s Fertilization were toxic.

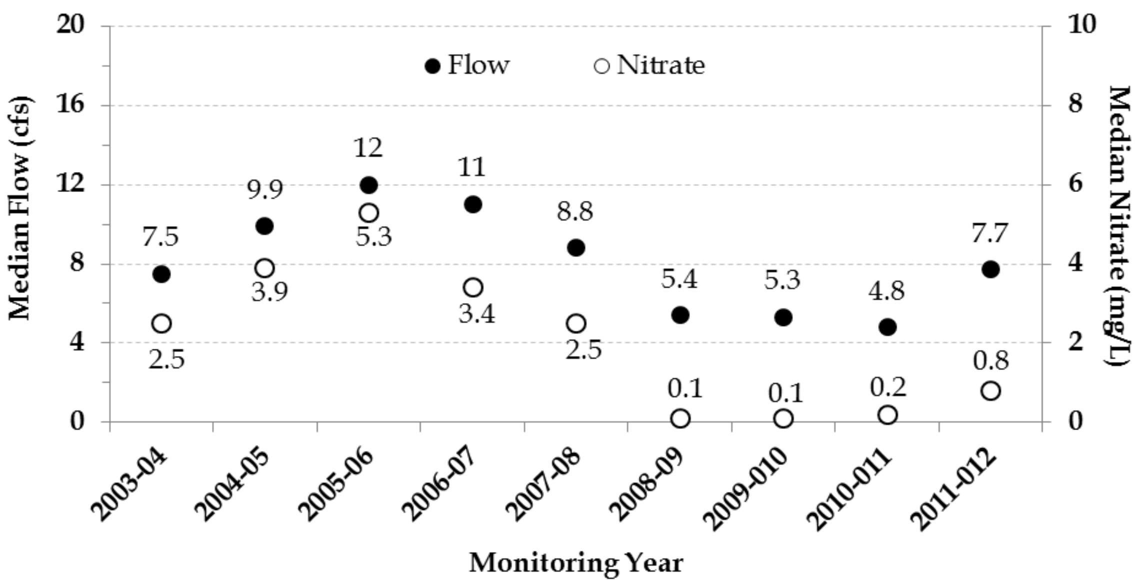
Sediment samples were collected during dry weather and tested using the 10 day *Hyallela azteca* survival test. Sediment toxicity samples ranged from 60% to 100% survival with only two samples collected from Santa Ana Delhi Channel (60% survival) on August, 23 2011 and

Peter's Canyon Wash (86% survival) on April 3, 2012 indicating moderate to low toxicity, respectively.

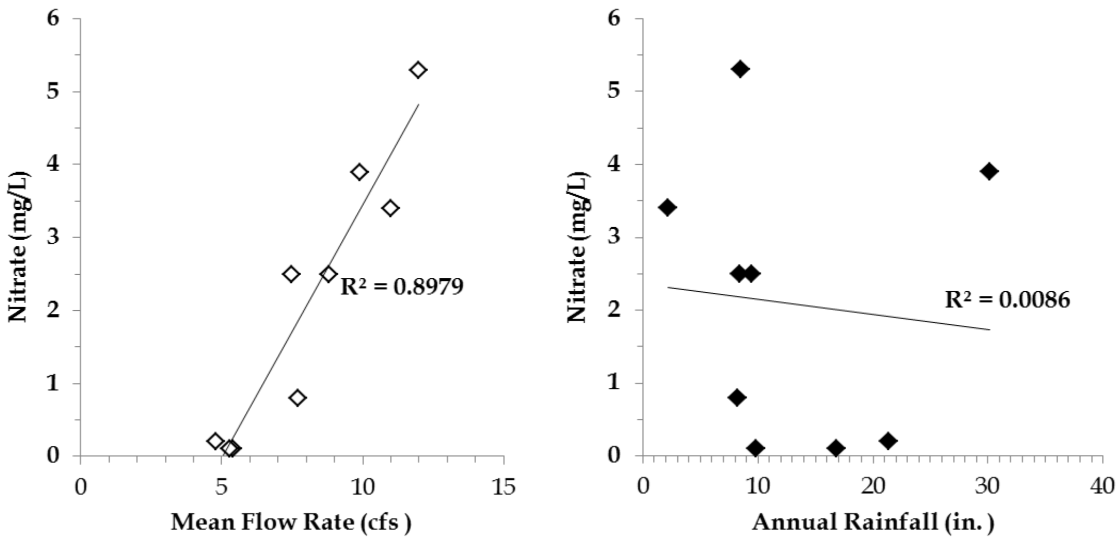
C-11.2.1.2  Regional Monitoring

Dry weather monitoring for nutrients is conducted at the mass emissions sites in the San Diego Creek watershed as part of the Nutrient TMDL program. Nutrient TMDL reports are prepared and submitted to the Regional Board quarterly, see **Section C-11.3.8.**

Since the late spring of 2008, several samples collected from San Diego Creek at Campus Drive have contained very low levels of nitrate during the periods when the IRWD treatment wetlands were operational. The following graphics show the trends in dry-weather nitrate concentrations and flowrates at Campus Drive over the last 8 years.  The median nitrate concentration and flowrate this reporting year have increased from the two prior years.




As can be seen from the figures below, the increased nitrate concentrations do not appear to stem from changes in the annual rainfall. Rather, increases in the mean flow rate above 5 cfs appear directly associated with increases in nitrate concentration.  The maximum diversion rate of water from San Diego Creek to the IRWD wetlands is 2600 gpm or 5.8 cfs. From the flowrate graphic the median flowrate in the Creek during this reporting year was nearly 2 cfs greater suggesting that a significant portion of the water in the Creek bypassed the diversion system and went untreated to the monitoring station, unlike the prior years.




C-11.2.1.3 Special Studies

The standard suite of analyses was expanded to include additional organic compounds in some stormwater samples from the mass emissions sites. Stormwater samples collected from first flush and the first 24 hour intervals were analyzed for synthetic Pyrethroid pesticides. **Attachment C-11.II – Table 6** contains the results of the analyses for these compounds. The synthetic Pyrethroid pesticides were collected in combination with organophosphorus pesticides in order to evaluate the frequency of detection and range of concentrations.

Pesticide monitoring results from 2011-12 show that detection patterns continue to shift towards the use of pyrethroid pesticides as summarized in **Table C-11.2**. Overall, organophosphorus pesticides were detected in only 4.6% of all samples collected and showed significant seasonal differences. Organophosphorus pesticides were detected in 0.4% of dry weather samples and 11% of stormwater samples. Chlorpyrifos and Diazinon were detected in only 3% of stormwater samples collected. Malathion continues to dominate the rate of detection for organophosphorus pesticides with nearly 35% of samples collected during the 2011-12 monitoring year .

The synthetic pyrethroid pesticide group was detected nearly five times more often that the organophosphorus pesticides during storm events. Amongst the pyrethroid pesticides constituents monitored, Bifenthrin was detected in 91% of samples, a ratio of nearly three to one over Malathion. The detection frequencies of the pyrethroid pesticides ranged from 8.8% to 76% with Permethrin representing the second most frequent pesticide detected at a frequency of 76%. Concentrations in Bifenthrin ranged from <2 to 140 ng/L (parts per trillion) with an mean of 26 ng/L.

## C-11.2.2 Harbor /Estuary / Wetlands Monitoring

### C-11.2.2.1 Core Monitoring Program

Harbor, Estuary, and Wetlands monitoring is conducted to assess the impact of MS4 discharges on aquatic habitat in estuarine or brackish waters. Monitoring consists of assessments of water for chemistry, physical characteristics, and toxicity and benthic sediments for chemistry, toxicity, and infaunal assemblage. The evaluation of estuary / wetlands monitoring data includes three distinct elements that will be reported separately below: benthic habitat assessment, conducted in the Fall of 2011; sediment chemistry and toxicity analysis; and, aquatic chemistry and toxicity analysis

*Benthic Habitat Assessment*

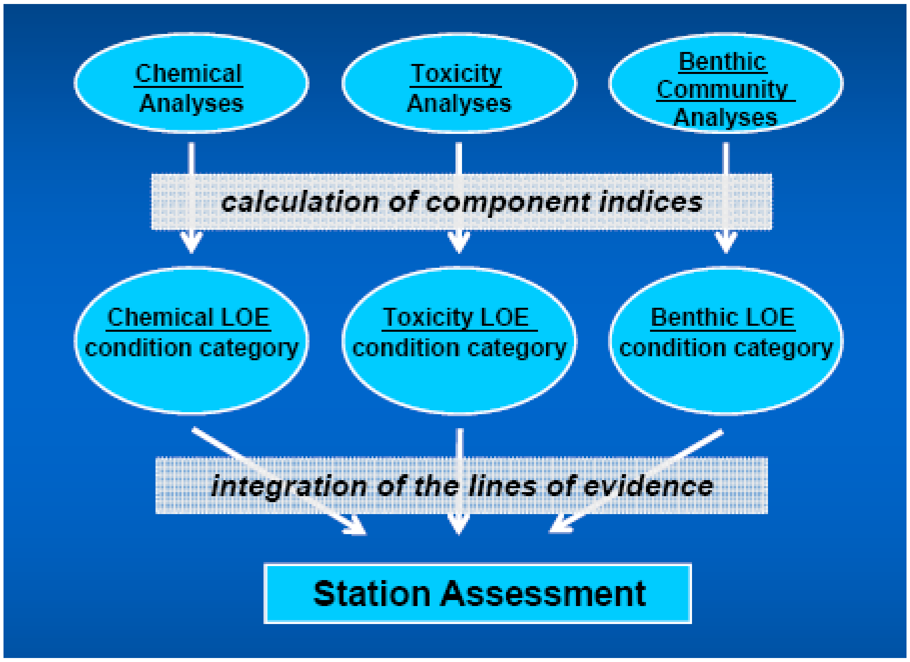
Sediment monitoring at the harbor, estuary, and wetlands stations is based on the multiple lines of evidence (MLOE) approach, and includes benthic infaunal community condition, sediment chemistry, sediment toxicity analyses. **Attachment C-11-II - Table 13** to shows the sediment chemistry results and **Attachment C-11-II – Table 14** the sediment toxicity testing results.

California Water Code section 13393 requires the State Water Board to develop sediment quality objectives (SQOs) for toxic pollutants for California’s enclosed bays and estuaries. On September 16, 2008, the State Water Board conducted a public hearing and adopted the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (Plan), containing narrative sediment quality objectives (SQOs) and a policy of implementation. The Plan became effective on August 25, 2009.

The State Water Resources Control Board and the Southern California Coastal Water Research Project (SCCWRP) have developed a Microsoft Excel based calculation tool which integrates information from each of the three lines of evidence (LOE) to produce an overall assessment of the quality of the sediment habitat at a monitoring location. The following table lists the assessment tools that are used to generate the scores which are integrated to produce the overall benthic habitat assessment.

<table>
<tr><td>LOE</td><td colspan="4">Assessment Tools</td></tr>
<tr><td>Chemistry</td><td>CA LRM Value</td><td colspan="3">CSI value</td></tr>
<tr><td>Toxicity</td><td>10-day Amphipod Survival Test</td><td colspan="3">Sub-lethal Test</td></tr>
<tr><td>Benthos</td><td>RIVPACS Score</td><td>BRI Score</td><td>IBI Score</td><td>RBI Score</td></tr>
</table>

The graphic below outlines the assessment process:



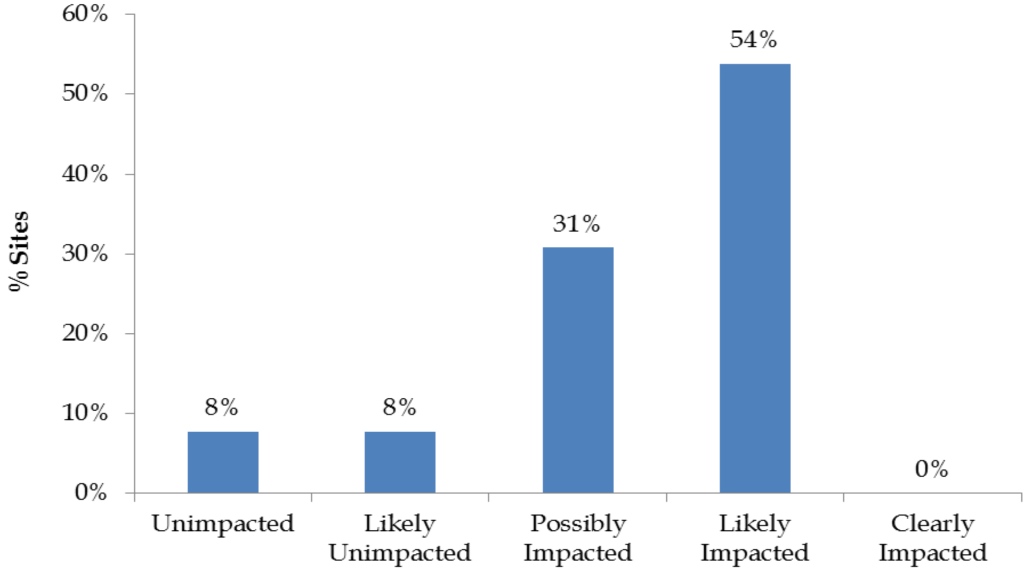

The station assessment categories are:

- Unimpacted
- Likely Unimpacted
- Possibly Impacted
- Likely Impacted
- Clearly Impacted
- Inconclusive

The Benthic Response Index has been used by the Permittees since the Third Permit Term and is one of four assessment tools used by the SQO process to measure the condition of a benthic assemblage with defined thresholds for levels of environmental disturbance (Smith et al. 2001, Ranasinghe et al. 2003, SCCWRP 2008). The pollution tolerance of each species is assigned based upon its distribution of abundance along a pre-established environmental gradient developed using hundreds of benthic samples collected from bays and harbors from the Mexican border to Pt. Conception. To give index values an ecological context and facilitate their interpretation, four thresholds of biological response to pollution are identified. These thresholds are based on changes in biodiversity along a pollution gradient. The reference threshold, below which natural benthic assemblages normally occur, are identified at an index value of <39.96; the point on the pollution vector where pollution effects first result in a net loss of species.

**Table C-11.3** presents the output of the SQO calculation tool showing the LOE component indices, condition categories, and final assessment category of each of the estuary and wetland sites monitored in the fall of 2011. On a region wide basis, as shown in the figure below, the

SQO assessment indicates that 16% of sites are Likely Unimpacted or at a higher level of quality, 31% are Possibly Impacted, and 7 of 13 sites (54%) are Likely Impacted.




Patterns in the SQO assessment category suggest a high degree of spatial variability between sites. SQO assessment of sites in areas that are minimally influenced by tidal exchange, such as Rhine Channel (LNBRIN) and Turning Basin (LNBTUB) in Lower Newport Bay, tended towards the Likely Impacted assessment category. The data additionally show that sites towards the middle of the enclosed bays where tidal exchange is more significant, such as the Upper Newport Bay sites at North Star Beach (UNBNSB) and Coast Highway Bridge (UNBCHB), tended to have an assessment category of Likely Unimpacted and Unimpacted, respectively. **Attachment C-11-II – Table 15** provides the LOE condition categories and the station assessment categories at sites in Newport Bay, shown in **Attachment C-11-I – Map 6,** and the Huntington Harbour / Bolsa Bay complex, shown in **Attachment C-11-I – Map 7**.

Samples collected during the Fall 2011 survey showed low toxicity in the 10-day *Eohaustorius* survival test and nearly a complete absence of toxicity in the *Mytilus* 48-hr embryo development test, **Table C-11.4**. Levels of toxicity in the 10-day *Eohaustorius* survival test ranged from 84% to 99% survival with an overall average of 90%. The SQO category assessment and level of sediment toxicity were not consistent and sites that were Likely Impacted did not consistently have the lowest 10-day *Eohaustorius* survival rates.

*Sediment Chemistry and Toxicity Analysis*

Sediment toxicity testing represents an integrated approach to measuring pollutant effects on aquatic species. As an overall indicator of the presence of toxic pollutants present in sediments, that may or may not be detected as individual chemical constituents, toxicity provides a cumulative perspective of conditions.

Additional sediment chemistry and toxicity samples are collected twice per year from harbors, estuary, and wetland sites. Samples are normally collected in the spring / early summer time period following storm season and in the Fall. The data from the samples is used for evaluating seasonal dry weather effects on toxicity as well as measuring the aggregated effects of toxicants accumulated in sediments over the period of the storm season. A discussion of lessons learned from sediment chemistry and toxicity monitoring (**C-11-II - Table 13** and **Table 14**) efforts during 2011-12 is provided in **Section C-11.4.1**.

*Aquatic chemistry and toxicity analysis*

The estuary / wetlands program component also included both aquatic chemistry sampling and aquatic toxicity testing (with marine test organisms). **Attachment C-11-II – Table 12** presents the aqueous chemistry results and **Attachment C-11-II –Table 13** presents the aqueous toxicity results.

**Table C-11-II - Table 7** is a summary of the exceedances of CTR acute toxicity criteria for dissolved metals samples collected in the marine environment. The comparison of data with the CTR acute criteria shows that 5 of the 36 ( 14%) grab samples collected during dry weather contained dissolved copper at a concentration which exceeds a CTR acute toxicity criterion (4.8 μg/L) for saltwater. Of samples collected during periods influenced by stormwater runoff 5 of 24 (21%) contained copper exceeding CTR acute criteria. Regional patterns of CTR exceedances during dry weather and wet weather conditions are presented in **Attachment C-11-1 – Map 3** and **Attachment C-11-1 – Map 4** from results provided in **Attachment C-11-II – Table 7**.

Amongst the harbors monitored in 2011-12, samples from the Huntington Harbour/Bolsa Bay complex exceeded the dissolved copper CTR criteria 3 of 10 times (30%) during dry weather and 5 of 10 times (50%) during storm events. By contrast, samples from Newport Bay exceeded the dissolved copper CTR criteria 2 of 24 times (8.3%) during dry weather and 0 of 24 times (0%) during storm events.

Aquatic toxicity was evaluated on dry weather and stormwater runoff influenced samples with four toxicity tests with marine organisms: the purple sea urchin (*Stronglyocentrotus purpuratus*) fertilization test, the mysid shrimp (*Americamysis bahia*) 48 hour and 7 day survival and growth tests. Stormwater runoff-influenced samples were collected from Newport Bay on December 13, 2011 and Huntington Harbour, Bolsa Bay, and Talbert Marsh on March 17, 2012. A summary of the toxicity organism responses statistics during dry weather and storm events is summarized in the tables below.

| Dry Weather Toxicity Test Statistics | Mean | Min | Max |
|---|---|---|---|
| *Americamysis bahia* Growth test | 94% | 69% | 100% |
| *Americamysis bahia* Survival test | 97% | 85% | 100% |
| *Americamysis bahia* Survival, 48 Hour test | 98% | 92% | 100% |
| *Strongylocentrotus purpuratus* Fertilization test | 96% | 79% | 100% |

| Stormwater Toxicity Test Statistics | Mean | Min | Max |
|---|---|---|---|
| *Americamysis bahia* Growth test | 94% | 75% | 100% |
| *Americamysis bahia* Survival test | 93% | 75% | 100% |
| *Americamysis bahia* Survival 48 Hour test | 95% | 92% | 100% |
| *Strongylocentrotus purpuratus* Fertilization test | 97% | 79% | 100% |

48 samples were collected resulting in a maximum of 189 tests conducted using the four different tests organisms. The integrated results of toxicity during dry weather are shown in **Attachment C-11-I – Map 4** and during wet weather are shown in **Attachment C-11.I – Map 5.** Overall, aquatic toxicity (<80% survival) occurred in 10 of 189 (5.3%) tests conducted with dry weather toxicity in 6 of 141 (4.3%) tests and stormwater toxicity in 4 of 48 (8.3%) tests. The toxicity testing results were delineated by testing organism as follows:

| Toxicity Samples | Dry Weather | Storm Event |
|---|---|---|
| *Americamysis bahia* Growth | 5 of 36 | 2 of 12 |
| *Americamysis bahia* Survival | 0 of 36 | 1 of 12 |
| *Americamysis bahia* Survival 48 Hour | 0 of 33 | 0 of 12 |
| *Strongylocentrotus purpuratu*s Fertilization | 1 of 36 | 1 of 12 |

The toxicity testing results from harbor, estuary, and wetlands samples during 2011-12 were consistent with samples collected from Long Term Mass Emission monitoring sites. The test organisms that produced the only toxic responses were the *Americamysis bahia* survival and growth tests. It is unclear as to whether the patterns in test responses were coincidental or may have originated from similar or chemically related constituents. A discussion of lessons learned from chemistry and toxicity monitoring efforts during 2011-12 is provided in **Sections C-11.4** and **C-11.5.**

C-11.2.2.2 Regional Monitoring Program

Water quality monitoring efforts for the Harbors, Estuary, and Wetlands Program focused on the core monitoring component during 2011-12 and no regional monitoring has been conducted during the 2011-12 reporting period other than the Regional Harbor Monitoring Program conducted in the San Diego Regional Board part of the County. Regional monitoring efforts during 2012-13 are expected to include participation in the Southern California Bight Regional Monitoring Program.

C-11.2.2.3 Special Studies

Special studies conducted during 2011-12 focused on evaluating synthetic pyrethroid pesticides in sediments as part of an effort to better understand potential sediment toxicity effects. The results of the special study effort are summarized and discussed in Section C-11.4.

C-11.2.3 Bacteriological / Pathogen Monitoring

The concentrations of fecal indicator bacteria are monitored weekly during dry-weather conditions at nine coastal stormdrains and their respective surfzone receiving waters, as well as five regional flood control channels discharging to the Huntington Harbour, Bolsa Bay, Talbert Marsh, and the Upper Newport Bay. The monitoring locations are shown on **Attachment C-11-I – Map 8**. The results of the monitoring are presented in **Attachment C-11-II – Table 8.** Details on the methods of data analysis are provided in **Attachment C-11.III**.

The data display differences between stations in the relative frequency of exceedances of the AB411 single-sample standards, which are:

- Total coliforms: 10,000 CFU / 100 ml
- Fecal coliforms: 400 CFU / 100 ml
- *Enterococcus*: 104 CFU / 100 ml.

**Table C-11.7** is a summary of the monitoring conducted in 2011-12, the number of samples collected throughout the year, the number of samples collected during the AB411 season, and the number of AB411 single sample criteria exceeded, by indicator. Each receiving water site was also evaluated to determine the proportion of sampled days on which at least one single sample standard was exceeded in the surfzone. The results for each site are provided in **Table C-11.8.**

This approach provides a mechanism for ranking sites and establishing priorities for each drainage. The proportion of exceedances for each monitoring site is calculated as:

$$\frac{\text{Number of exceedances of a single sample standard}}{\text{Number of samples X number of analyses per sample}}$$

**Attachment C-11-I – Map 9** and **C-11-I – Map 10** show the spatial distribution of monitoring stations exceeding AB411 standards in the surfzone receiving water upcoast (north) and downcoast (south) of coastal drains, and in the channels, both for the entire year and for the AB411 season (April 1 through October 31). For a typical sampling there are two receiving water samples (upcoast and downcoast) and three laboratory analyses (total coliform, fecal coliform, and *Enterococcui*) included in the analysis. It should be noted that comparison of water quality in the inland channels to AB411 standards is done for comparison purposes only given that AB411 standards apply to ocean water contact.

In general, indicator bacteria conditions in receiving waters experienced moderate to low exceedance frequencies of the three indicator bacteria as listed in **Table C-11.7**. Consistent with previous years, beach water quality exceedances were largely due to Enterococcus which continues to represent the primary fecal indicator bacteria of concern during the entire year and the AB411 period (April 1 to October 30). Fecal Coliform and Total Coliform levels were found to exceed recreational contact standards at beach sites up to a maximum rate of 0.4%. There do not appear to be any major differences in the proportion of exceedances between the entire year and the AB411 season. At some sites the percentages of exceedances are slightly higher in the AB411 season and at other sites the percentages are slightly lower.

The condition of receiving waters did change depending on whether storm drains were flowing to the ocean. The monitoring data show that, on an annual basis, storm drains flowing to the ocean may have contributed to an increase in Enterococcus exceedance frequencies. During the AB411 period, however, Enterococcus levels exceeded 6.9% more often if the drains were observed flowing to the ocean, which occurred during 17% of site visits.

The results provided in **Table C-11.8** show that the proportion of exceedances at each surfzone sites was relatively low at 0% to 4% for the entire year with the greatest percentages observed in the surfzone near the outlet of one of the Huntington City Beach drains (HB5) and Buck Gully Creek (BGC) on the Newport Coast:

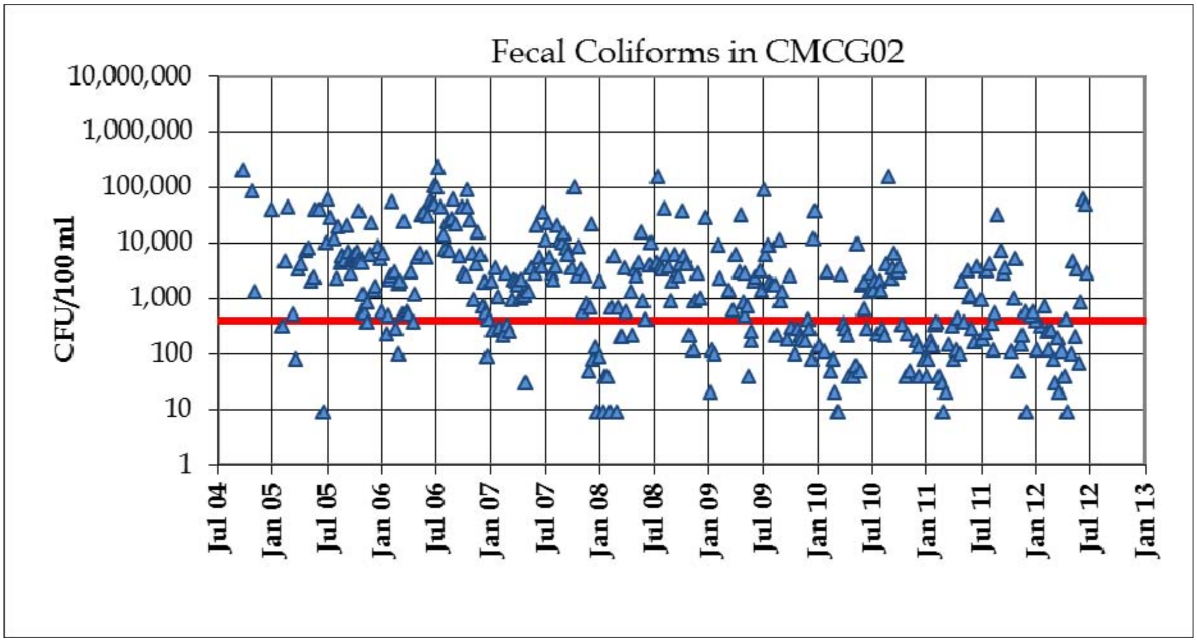
- On 41 of the 45 days that Buck Gully Creek and its surfzone receiving waters were sampled, the discharge from the Creek reached the surfzone at the time of sampling. AB411 standards were exceeded in 3.3% of samples collected.
- The Huntington Beach stormdrains (HB1-HB5) had no observed discharge commingling with the surfzone at any of the times of sampling. The coastal stormdrains discharge at the inland edge of the beach and these discharge points are separated by the width of the beach (average 70 meters) from the surfzone.

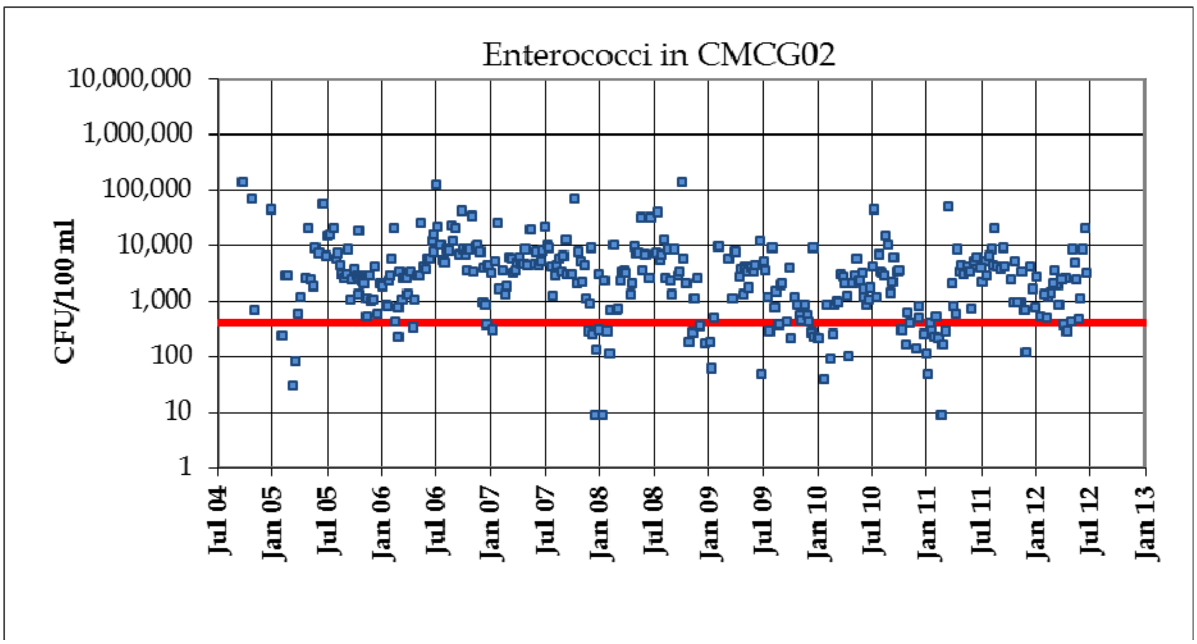
Channels draining to harbors exhibited slightly higher exceedance frequencies of the three indicator bacteria than beach sites. Indicator bacteria exceeded from 7.6 to 18% on an annual basis, which was not significantly different than the AB411 period ranging from 8.5 to 17%. Similar to beach water quality, Enterococcus continues to represent the primary indicator bacteria of concern. There do not appear to be any major differences in the proportion of exceedances between the entire year and the AB411 season. At some sites the percentages of exceedances are slightly higher in the AB411 season and at other sites the percentages are slightly lower.

Data from 2011-12 show concentrations of fecal indicator bacteria in regional flood channels at concentrations above water contact criteria. Despite the greater exceedance rates in the regional channels, there has been an overall declining trend in fecal coliform bacteria at each location. Non-parametric trend analyses of fecal indicator bacteria concentrations in East Costa Mesa Channel, the site with the most exceedances in 2011-12, show a statistically significant reduction in all three indicators as summarized in the table and figures below. The slope of the trend line is provided in the table below as a percent change per year in fecal indicator bacteria levels.

| **Parameter** | **Trend Line Slope** | **p value** |
|---|---|---|
| Total Coliform | -2.05% | 0.031 |
| Fecal Coliform | -7.76% | <0.0001 |
| Enterococci | -4.23% | 0.003 |

The red line in the two trend plots shown below is the AB411 single sample standard.




C-11.2.3.1 Regional Monitoring

Water quality monitoring efforts for the Bacteriological / Pathogen Monitoring Program focused on the core monitoring component during 2011-12 and no regional monitoring has been conducted during the 2011-12 reporting period. Monitoring efforts during 2012-13 are expected to change as the Permittees participate in the Regional Shoreline Monitoring Program and the Southern California Bight Regional Monitoring Program microbiology study. A discussion of the Regional Shoreline Monitoring Program is provided in **Section C-11.4.2**

C-11.2.3.2 Special Studies

No special studies for the Bacteriological / Pathogen Monitoring Program were conducted during 2011-12.

C-11.2.4 Urban Stream Bioassessment Monitoring

C-11.2.4.1 Core Monitoring

The Urban Stream Bioassessment Monitoring Program concluded sampling efforts in 2009 upon adoption of the Fourth Term Municipal Stormwater Permit (R8-2009-0030, NPDES CAS618030). No monitoring for this program has been conducted during the 2011-12 reporting period. The Permittees are currently implementing monitoring requirements for the Stormwater Monitoring Coalition Regional Watershed Monitoring Program.

C-11.2.4.2 Regional Monitoring

The Permittees, with assistance of Regional Board staff, began participation in a Regional Monitoring Program sponsored by the Southern California Stormwater Monitoring Coalition (SMC Program) and managed by the Southern California Coastal Water Research Project (SCCWRP) in 2009. This program was designed to assess stream health using the resident stream benthic macroinvertebrates to determine the water quality conditions within a stream reach. The SMC Program is based on a probabilistic sampling design that will allow for the ambient condition of streams in the southern California to be assessed for the first time allowing comparisons among stream systems, watersheds and by land use. The goal of this multi-agency, five year study is to 1) determine the status of macroinvertebrate conditions across southern California streams, 2) identify key stressors that affect stream macroinvertebrate conditions, and 3) monitor receiving water stressors over time. Stream monitoring sites are stratified by urban, open space, and agricultural land uses to provide a better assessment across stressor gradients from chemical, biological, and physical influences.

During the 2011-12 year, the Permittees continued to participate in the SMC Program. The 2012 sampling effort was the fourth year of the five year study to assess stream macroinvertebrate conditions across southern California. The details of the SMC Program and results of the 2009 sampling effort can be found in:

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/639_SMC_StreamsYear1.pdf

All bioassessment and physical habitat sampling was conducted according to SWAMP protocols which can be found at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/phab_sopr6.pdf

In addition to the SWAMP in-stream physical habitat condition measurements, the SMC Program also specifies that the California Rapid Assessment Method (CRAM) be conducted at each site. This protocol provides an assessment of not only the instream habitat condition, but also of the buffer zone surrounding the site as well as the condition of the hydrology and biotic structure of the riparian zone. Details of the CRAM assessments can be found at:

http://www.cramwetlands.org/

In order to conduct a triad analysis, at the time of bioassessment sampling the Permittees collect grab samples for water chemistry and aqueous toxicity analysis. The suite of chemical constituents is the same as analyzed in the Mass Emissions Program. Aqueous toxicity is evaluated using the freshwater organism, *Ceriodaphnia dubia*,

Each site is evaluated in terms of a series of metrics (**Attachment C-11-III)**, which are then scored to provide a basis for determining the overall IBI score 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 representative of reference conditions throughout the whole of the southern California area. Data were analyzed as follows:

- 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.
- 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.

*IBI and Physical Habitat Scores*

**Attachment C-11-I – Table 11** and **Table C-11.5** provide the bioassessment monitoring sites sampled during the May to July 2012 index period. Samples collected in 2012 represented the fourth year of this survey for the Permittees. A total of seven sites were visited in 2012: six as part of SMC Program, and one site as part of the Permittees participation in the San Gabriel River Regional Monitoring Program (SGRRMP). A contract laboratory conducts the bioassessment sampling and taxonomic analyses on behalf of the Permittees.

Monitoring results from the 2012 regional bioassessment program survey are presented in **Table C-11.6** and **Figure C-11.2** which provide the IBI scores, physical habitat and CRAM conditions. Scores were in the Very Poor range at all sites, except station SMC03438 at Carbon Canyon Creek which scored in the Poor range. The stream macroinvertebrate conditions of receiving waters as determined by the Index of Biotic Integrity (IBI) during the 2012 monitoring period are provided in **Table C-11-I.6.** Index of Biotic Integrity scores for urban sites sampled ranged from 2.9 to 12.9 and the scores are consistent with urban sites sampled during the prior years of the SMC Program.

The open space local reference stream also sampled as part of the 2012 survey had an IBI score of 21.4 which is considerably lower than the IBI reference condition threshold of 39. It is unclear whether the depressed IBI score for the reference stream was a function of localized environmental conditions or if other stressors contributed to its condition. These types of issues are a primary concern for the SMC Program which is developing the assessment tools needed to better understand these types of site-specific issue. Each of the urban sites was located in the urbanized lower watershed, except SMC03438 in Carbon Canyon. This site was located in relatively open space except that Highway 146 runs along its entire length and a commercial construction site is located just upstream.

The physical habitat conditions for each of the SMC Program sites were assessed using three attribute scores (sediment deposition, epifaunal substrate, channel alteration) that, together are summed to a total score ranging from zero (poorest condition) to 60 (best condition). None of the sites scored above 24 on this scale indicating relatively poor habitat conditions. Even the best site (SMC03438 described above) still had poor habitat conditions. CRAM scores for each site also showed poor habitat quality with scores for each site less than 50 on a scale of 100. Of note is that site SMC03438 in Carbon Canyon had the highest CRAM score. CRAM assessment is important in determining stream health since it evaluates not only the condition of the stream bed habitat, but also the condition of the buffer zones surrounding the riparian zone out to 250 meters on either side of the stream. The biotic condition at the site in Carbon Canyon was most likely the result of the open space available in the nearby buffer zone.

*Spatial pattern analysis*

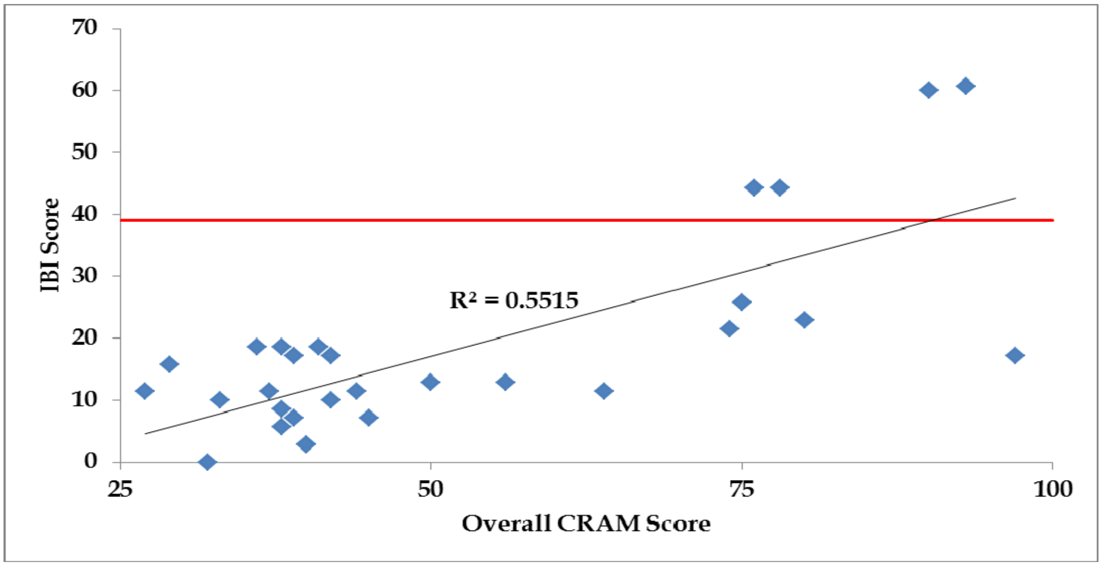
In addition to describing patterns and trends in benthic invertebrates, a further purpose of the SMC Program is to evaluate the monitoring triad to determine whether physical habitat, aquatic chemistry, and/or toxicity are correlated with IBI scores. The spatial patterns of conditions in the 2012 are provided in **Attachment C-11.II - Table 12.** If strong correlations exist, then this would suggest the presence of a causal relationship between the various stressors and biological integrity.

The spatial pattern analysis consisted of three elements:

1. Spatial Distribution

   Broad patterns for each of the four types of indicator (i.e., IBI, physical habitat, aquatic chemistry, toxicity) were mapped. **Figure C-11.3** shows consistently low IBI scores across the urbanized portion of the County (IBI ≤ 39). Sites in the upper watershed, east of Irvine Lake had IBI scores that were ≥ 40 indicating the biological communities found there were similar to those found at reference sites in the southern California region.

   The CRAM scores for these same sites showed a very similar pattern, with the poorest habitat scores associated with sites in the highly urbanized lower watershed and highest scores associated with sites in the upper watershed, especially east of Irvine Lake (**Figure C-11.4**). There was a strong association between IBI and CRAM scores ($R^2 = 0.55$) in these watersheds as shown in the figure below.




Of note were a few sites that bordered the upper watershed where the CRAM scores indicated relatively good habitat conditions, but the IBI scores were slightly elevated and still below the threshold of 39 (SMC03438, SMC1822, SMC2422). This was especially true at site SMC26288, on a tributary to Irvine Lake, where the CRAM score indicated good habitat conditions, but the IBI score was in the 'very poor' range.

2. Relationship to Aquatic Toxicity and Chemistry

Detailed monitoring data for bioassessment, aquatic chemistry, and toxicity were examined to determine whether there are any clear relationships among these at a finer level of detail.

Past reports adopting this method of analysis showed that there were no apparent correlations between IBI scores and either toxicity or aquatic chemistry. In contrast, there was a broad relationship between higher physical habitat scores and higher IBI scores. Additionally, the patterns of several components of the physical habitat score mimicked patterns in the biological community across the region.

3. Biological Cluster Analysis

A more powerful set of analyses was used to discern relationships between the biological patterns in the benthic community 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 were clustered to identify groupings of sites that were similar in terms of their community composition. **Figure C-11.5** shows the cluster analysis of all sites during surveys conducted from 2009 to 2012 and **Figure C-11.6** the two-way coincidence table of the relative distribution of species in each site at each sampling time. Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and sites, respectively. (Sites are identified by their site number and year of sampling. The average IBI score for the station group is provided. Relative species abundances are shown as symbols. The abundance of each species was standardized in terms of its maximum at each site over all surveys. Smaller symbols represent a lower proportion of maximum abundance and larger symbols a larger proportion.)

These two figures clearly show several dominant patterns. First, sites that are at or near reference conditions based on the Southern California IBI are concentrated at the lower end of the dendrogram, which is equivalent to station Group 4, located on the left side of the two-way coincidence table. These sites are almost exclusively located in the upper watershed above Irvine Lake (**Figure C-11.3**). An exception to this was station SMC03438 which was also located in the upper watershed, but in Carbon Canyon. This site had relatively good habitat conditions based on CRAM, but an IBI below 40. Inclusion of this site with Group 4 indicates that while impacted, the basic composition of species at this site is similar to reference sites.

Second, three sites located on the Santa Ana River (SMC05230, SMC24222 and SMC21822) fell into Group 3 which had species composition that was more similar to the upper watershed Group 4 sites than sites in the lower watershed (Groups 1 and 2). Each of these sites is located where the Santa Ana River is a low gradient, natural bottom wash. The IBI scores at each of these sites are slightly better than other lower watershed sites, but still below the impairment threshold. The riparian zones on either side of these reaches are surrounded by residential and industrial land use and, as a result, the habitat quality is not optimal for benthic macroinvertebrate communities.

Third, there is no clear clustering of sites based on sample year. This indicates that annual variability in weather conditions is not driving the composition and abundances of taxa in the watersheds.

Finally, species with broader distributions across sites and times are concentrated in the upper three species groups (Groups A, B and C) on the two-way coincidence table. Species with such broad distributions tend to be more pollution and/or disturbance tolerant. In contrast, species in the lower two species groups (Groups D and E) half of the two-way coincidence table have much more restricted distributions and in fact are found primarily at the upper watershed and Santa Ana River sites. A closer examination of the species groups shown in the two-way table shows that species Groups D and E contain a diverse assemblage of several sensitive types of organisms. Species Groups A, B and C (at the top of the two-way table) include moderately to very tolerant species characteristic of disturbed sites.

*Correlation with parameters*

Variables measured during the surveys conducted from 2009 to 2012 were then grouped into biotic condition (e.g. IBI scores), physical habitat parameters (e.g. channel alteration), water quality parameters (e.g. pH, dissolved oxygen), nutrients, potential pollutant parameters (e.g. dissolved metals) and ions (e.g. chloride). The median values of each parameter were then plotted for each cluster site group using box and whisker plots. “Cluster Group” on the x-axis of the box and whisker plots refers to the site groups from the dendrograms and two-way tables.

The box and whisker plots show the biological condition of each cluster group as determined by the median IBI score (**Figures C-11.7** to **C-11.9**). Median IBI scores were above the threshold of 39 for Group 4 which were the sites located in the upper watershed east of Irvine Lake. Median IBI scores were below the 39 threshold in Groups 1, 2 and 3. These groups included all stations located in the lower watershed. IBI scores were somewhat better in Groups 2 and 3 than Group 1.

Physical habitat parameters differed markedly across the site groups. In general, physical habitat scores for channel alteration, in stream cover, and sediment deposition were better at reference sites and worse at the lower watershed, urban sites (**Figure C-11.7**). This is expected because diverse biological communities, such as those found at the upper watershed reference sites, require undisturbed and relatively complex stream habitat, coupled with good vegetative cover on the banks. Of note is the strong relationship between watershed position and channel alteration. The sites with the greatest median IBI scores (Group 4) had the least amount of alteration, the lower watershed sites, in Group 3 (Santa Ana River), were moderately altered and Groups 1 and 2 were composed of sites where the channel had been completely changed from the original configuration.

Dissolved metal concentrations for arsenic, copper, zinc and, chromium concentrations were elevated at the lower watershed stations compared to the reference sites (**Figure C-11.8**). Increased metals and nutrients in the lower watershed are presumably the result of urban and agricultural runoff from the surrounding watershed.  Nutrients were somewhat elevated in the lower watershed (Groups 1 and 2) compared to the upper watershed sites (**Figure C-11.9**). This was especially true for cluster Group 3 which was greater in ammonia, TKN, orthophosphate, and total phosphorus.

Values for physical chemistry parameters such as water temperature, dissolved oxygen and pH were slightly elevated at the lower watershed site groups which is most likely associated with the reduction in canopy cover in highly urbanized areas. Several parameters were similar across sites and Groups including hardness, conductivity (EC) and total suspended solids (TSS) except at site Group 3 in the Santa River where TSS was much greater than all other groups.

The evaluation of four years of SMC Program monitoring data in the Santa Ana Region shows that there is an apparent relationship between the biological community patterns and physical habitat parameters (e.g., channel alteration and instream cover). This relationship has been observed in a number of other bioassessment programs, including the County's bioassessment monitoring in the San Diego Region and the San Gabriel River Watershed (LASGRWC 2010). On the other hand, strong relationships between biological patterns and water chemistry have not been typically observed in other programs. The relationships observed here may be causal, or it may simply be due to the fact that chemical concentrations and physical habitat alteration are highly correlated in urbanized environments. This issue will be investigated further as more data become available.

C-11.2.4.3 Special Studies

Special studies initiated during 2011-12 focused on evaluating synthetic Pyrethroid pesticides in sediments to better understand the linkages between potential toxicity effects and changes in the biological communities of streams. The special study results have been transferred to SCCWRP and will be included as part of the overall data analysis and future reporting from SMC Program.

C-11.2.5 Reconnaissance Monitoring (dry weather)

The dry weather reconnaissance stations are shown in **Attachment C-11-I.13.** The dry weather period (May 1 – September 30) does not precisely match the reporting period for this Monitoring Report (July 1 – June 30). The data from the entire 2012 monitoring year however are presented as an Attachment to this report.

In the Santa Ana Region, there are 39 targeted sites and 17 random sites. From 2006 to 2008, when Reconnaissance Monitoring began, the tolerance interval statistics from the San Diego Region were used for evaluating data from the Santa Ana program. For the current monitoring year the statistics were derived from the six years of data collected at the random sites in the Santa Ana Region.

The dry weather program monitoring results from 2005 through the end of this reporting period are presented in **Attachment C-11-II Table 16**.

C-11.2.6 Land Use Correlations Monitoring

The Land Use Correlations Monitoring Program concluded sampling efforts in 2009 upon adoption of the Fourth Term Permit. No monitoring was conducted during the 2011-12 reporting period.

C-11.2.7 Nutrient TMDL Monitoring

The Nutrient TMDL reporting process is now quarterly. Electronic copies of the reports from the last four quarters were submitted separately to the Santa Ana Regional Board and can be found on the OC Watersheds website.

http://www.ocwatersheds.com/DocumentDatabaseLibrary.aspx

**C-11.3 Additional Monitoring Efforts**

Multiple efforts to remove trash as well better understand the sources and pathways are currently in progress by the Permittees (see especially Section C-5.0). Targeted studies aimed at understanding problematic locations have been initiated in collaboration with California State University Fullerton and regional surveys are being conducted by the Permittees in concert with the SMC focused on addressing these specific types of problems as part of the Southern California Regional Watershed Trash Assessment Project.

The goal of the Southern California Regional Watershed Trash Assessment Project conducted in 2011 and 2012 was to improve the understanding and ability to manage trash in the environment at both regional and local scales. The regional trash assessment effort collected stream trash data at sites in open space, agricultural areas, and urban streams following the SWAMP Rapid Trash Assessment protocol using a probabilistic monitoring design. The focus of the project was to generate an assessment of regional conditions and provide the SMC member agencies with an opportunity to examine common pathways and sources over a larger geographic scale across a range of stream conditions.

Starting in 2012-13 the County will initiate a grant-funded project focusing on trash in receiving waters. The intent of the project is to develop the technical tools and guidance documents that allow watershed scale trash management plans to be developed in a cost effective and efficient manner. This project, in coordination with the SMC, is also intended to develop the framework for an iterative approach that will allow long term monitoring assessments to provide feedback into ongoing management efforts.

During the 2011-12 monitoring year the Permittees contributed to the 2008 Southern California Bight Regional Monitoring Program Water Quality Study (2008 Bight Study). Additional monitoring data collected in 2009-10, contributed through in-kind services, was provided for the 2008 Bight Study. One of the goals of the Bight Study was to characterize riverine nutrient loads discharged to the coastal ocean based on an empirical and model based approach. The goal of this study was to establish a better understanding about the contributions that riverine discharges can have on supporting harmful algae blooms in the coastal ocean.

### C-11.4 Evaluation of 2011-12 Water Quality Conditions

This was the third complete year of monitoring under the Fourth Term Permit. The Program underwent some modifications to incorporate the SMC Program and added additional sediment analyses in the harbors, marinas, and estuaries to enable enhanced assessments of benthic habitats

#### C-11.4.1 Receiving Water Conditions from Mass Emissions, SMC Program, and Harbor, Estuary / Wetlands Monitoring

Water quality samples from several components of the monitoring programs (mass emissions, harbor /estuary / wetlands, bioassessment) were evaluated in combination to provide an overview of patterns across the region. For purposes of this assessment, all program components are combined into one dataset, in order to better represent the spatial and temporal patterns across the region.

The results of the assessment and a ranking of receiving water priorities based simply on frequency of benchmark exceedances in the 2011-12 monitoring data are provided in **Table C-11.9** and shown in **Figure C-11-10.**

The analysis shows that 81% of samples in the nutrient category exceeded the assessment benchmarks followed by indicator bacteria at 68%. The lowest categories were the metals with 42% of samples exceeding s and pesticides with 28% samples exceeding benchmarks. It should be noted that this analysis does not assess the severity of impact from benchmark exceedances, just the number of exceedances.

The assessment results show the following constituents exceeded the benchmarks most:

- Nutrients - phosphorus (85%) and inorganic nitrogen (40%)
- Indicator bacteria - Enterococcus (80%) and fecal coliform (55%)
- Metals - selenium (44%), copper (17%) and zinc (1%), 0% for cadmium, nickel, or lead.
- Pesticides - pyrethroid pesticides (52% in storm events )and organophosphorus pesticides (11% during storm events, 0.4% in dry weather).

C-11.4.1.1 Nutrients

Nutrient levels in inland receiving waters have a wide range of concentrations. Differences in inorganic nitrogen and total phosphorus levels are significantly different between sites and between seasons as shown in **Table C-11.10** and **Table C-11.11**, respectively. Inorganic nitrogen concentrations in dry weather range from 0.15 to 13 mg/L while storm events tended to be higher and have a smaller range varying from 1.0 to 7.5 mg/L.

Elevated total phosphorus concentrations in receiving waters represented the major reason nutrients were listed as having the most benchmark exceedances. Phosphorus concentrations in dry weather have a wide range of concentrations varying from 0.03 to 0.85 mg/L while storm events typically show higher concentrations and have a smaller concentration range from 0.27 to 0.56 mg/L. The highest and lowest phosphorus concentration were measured on the Santa Ana River near Weir Canyon Road and Carbon Canyon Creek at Bloomfield, respectively.

Inorganic nitrogen concentrations across the region indicate that nitrate levels in the Newport Bay watershed still represent the highest priority based on benchmark exceedance numbers. A comparison of upstream and downstream nitrate concentrations, shown in **Figure C-11.11**, in San Diego Creek and the major tributaries to Upper Newport Bay, shown in **Figure C-11.12,** shows concentrations varying significantly across the watershed and between sites.

Elevated nitrates levels are limited to key locations in the watershed. Upstream nitrate levels in El Modena-Irvine Channel, Peter's Canyon Wash at El Camino Real, and Central Irvine Channel are, on average, 1.0 to 1.7 mg/L and provide an estimate about the magnitude of background concentrations from upstream sources. Nitrate concentrations in Peter's Canyon Wash at Barranca Parkway and San Diego Creek at Harvard Avenue were the highest at an average concentration of 9.0 and 13 mg/L, respectively. Groundwater inflow in the area of these sites continues to represent the dominate source of inorganic nitrogen source in the watershed. Ranges of nitrate and phosphorus during dry weather conditions in receiving waters at long term mass load monitoring sites outside the Newport Bay watershed are provided in **Figure C-11.13** and **Figure C-11.14.**

The inorganic nitrogen concentration in Coyote Creek at Lambert Avenue was elevated in comparison to other sites monitored across the region, with the exception of Newport Bay watershed sites. It is unclear whether the 11 mg/L concentration was a random event given that only one sample was collected at this site as during the 2012 survey for the SMC Program. The high nitrate level in Coyote Creek will be further evaluated to determine if elevated concentrations persist in the future and whether MS4 discharges might be contributing.

*Progress in Assessing Nutrient Issues in Receiving Waters*

The Permittees conducted multiple efforts to assess nutrient issues in receiving waters during the past reporting period. These efforts included targeted studies to formulate an approach aimed at reducing the nitrate loads in Newport Bay watershed and completion of a regional water quality study on the subject of riverine nutrient discharges to the coastal ocean.

Firstly, the Newport Bay watershed Nitrogen and Selenium Management Plan workgroup (NSMP) conducted special studies during the 2011-12 year to characterize pollutant loading from sources as part of the overall watershed implementation plan. A subset of the Newport Bay watershed implementation plan being developed by the NSMP includes monitoring special studies to better understand the nitrate contributions of groundwater and MS4 discharges into receiving waters. The 2011-12 monitoring year included efforts focused on;

- Assessing groundwater to surface interactions by developing a water budget / water balance model in San Diego Creek watershed
- Conducting pollutant load mass balance studies in Peters Canyon Wash and Big Canyon Wash to evaluate the feasibility of storm drain diversions

The second effort completed by the Permittees during the 2011-12 monitoring year included contributions to the final reports of the 2008 Southern California Bight Regional Monitoring Program Water Quality Study (2008 Bight Study). The goal of this study was to establish a better understanding about the contributions that riverine discharges can have on supporting harmful algae blooms in the coastal ocean. Work is currently in progress to finalize this effort and submit the manuscript to a scientific journal for final approval.

Some of the principal findings from the 2008 Bight Study were;

- On a Bight-wide scale, upwelling of nutrient rich water represents the largest source that contributes to harmful algae blooms.
- At the smaller regional scales, riverine discharges do contribute to localized nutrient increases in the coastal ocean.
- On a Bight-wide comparison basis, the magnitude of nutrient loads discharged from San Diego Creek were amongst the top five highest loads discharged to coastal waters.

C-11.4.1.2 Metals

Metals issues in receiving waters during the 2011-12 monitoring year were fairly limited in terms of the number of constituents that exceeded assessment benchmarks and the areas affected as shown in **Figure C-11.15** and listed in **Table C-11.12**. At the mass emissions monitoring sites, exceedances of the freshwater CTR criteria during dry weather were due predominantly to total recoverable selenium, and those exceedances were concentrated in channels in the Newport Bay watershed. The receiving water metals issues, in decreasing order of benchmark exceedances, were limited to selenium, copper, and zinc.

Metal concentrations in receiving waters were considerably different between dry weather and storm events. Average selenium concentrations in Newport Bay watershed receiving waters ranged from 1.0 to 26 µg/L during dry weather in contrast to concentrations ranging from 0.54 to 10 µg/L during storm events. Dry weather flows in Peter's Canyon Wash and Santa Ana-Delhi Channels continues to represent the top two areas affected by selenium.

Copper exceedances in receiving water varied significantly across the region and showed distinct differences between inland and enclosed bay conditions, as shown in **Figure C-11.16**. Comparing copper exceedance frequencies during dry weather reveals that while copper levels in inland receiving waters exceeded benchmarks in only 4% of samples, harbor and estuary sites exceeded copper levels in 17% and 11% of samples, respectively. Copper exceedance patterns in storm events showed a much different pattern than dry weather conditions. The pattern of exceedance frequencies in harbor areas is supportive of the documented findings regarding the influence of copper-based boat paints on water quality.

Copper concentrations in inland receiving waters varied significantly across the region and between sites. A summary of average copper concentrations during dry weather and storm events at all long term trend monitoring sites is provided in **Table C-11.13.** Copper concentrations in dry weather ranged from 6.4 to 24 µg/L while storm events ranged from 15 to 58 µg/L. The highest and lowest average copper concentrations were measured in East Costa Mesa Channel and San Diego Creek at Harvard Avenue, respectively. The source(s) of the elevated copper levels in East Costa Mesa Channel are not understood at the present time.

*Progress in Assessing Sources of Selenium in Newport Bay Watershed Receiving Waters*

The NSMP conducted special studies during the 2011-12 year to assess sources of selenium as part of an overall watershed implementation plan. A subset of the watershed implementation plan includes monitoring special studies to better understand the source contributions and environmental cycling of Selenium. The 2011-12 monitoring year included efforts focused on;

- Assessing groundwater to surface interactions by developing a water budget / water balance model in San Diego Creek watershed
- Conducting pollutant load mass balance studies in Peters Canyon Wash and Big Canyon Wash to evaluate the feasibility of storm drain diversions
- Preparing monitoring plans to study background sources and cycling of selenium in these watersheds.

These monitoring and assessment efforts are intended to inform the management process for implementation activities that will focus on reducing selenium levels in receiving waters.

C-11.4.1.3 Pesticides and Other Toxicants

Evaluating the linkages between monitored constituents and biological conditions helps us understand the extent and magnitude of receiving water problems. The 2011-12 toxicity testing results show nearly consistent patterns between dry weather and storm event conditions across testing organisms as shown in **Figure C-11.17**. In general, toxicity testing organisms showed little to no negative response during dry weather conditions. The notable divergence from this pattern was the increased growth of the freshwater algae specie *Selenastrum capricornutum*. The increased growth is associated with an abundance of nutrients in the environmental samples and shows the linkage between monitored constituents and biological conditions.

*Progress in identifying toxicants to aquatic species*

An important assessment for the monitoring program is to understand which pollutants have toxic effects (toxicants) or negative effects on aquatic species. Adjusting toxicity testing efforts, following the seasonal patterns shown in **Figure C-11.18,** helps to increase chances of detecting important toxicant(s). The toxicity testing organisms utilized for the monitoring program have a broad spectrum of sensitivities to toxicants at varying levels of concentration thresholds.

It has been noted in previous years that, despite having high concentrations of dissolved copper and zinc, many storm event samples do not show toxicity to urchin fertilization. In addition to having high concentrations of dissolved metals those first flush samples from 2009-10 also contained high concentrations of dissolved organic carbon. This organic carbon may have included organic ligands that complex with the dissolved metals decreasing the bioavailability of those metals.

The 2011-12 toxicity test results have several distinct patterns suggesting that potentially only a few key pollutants may be causing toxicity in receiving waters. The toxicity testing results indicate that monitored constituents such as copper create negligible toxic effect on *Strongylocentrotus purpuratus,* which is a species sensitive to metals.

The toxicity testing organisms with the greatest response differences to environmental sample exposure are *Ceriodaphnia dubia* and *Americamysis bahia,* but these have low concentration sensitivities to pesticides. Connecting pesticides concentrations with the toxicity testing responses remains a challenge. Confounding factors work to add difficulty in assessing the linkage between pesticides and impacts on biological species. To highlight this difficulty, the correlation between *Americamysis bahia* and Bifenthrin (the most frequently detected pyrethroid pesticide and second most toxic compound monitored) shows a poor relationship and correlation as shown in **Figure C-11.19**. Despite the fact that Bifenthrin concentrations were present at substantially toxic levels, the lack of a significant relationship suggests that there is not a direct association between the measured pesticide concentration and subsequent effects on the aquatic species.

Findings from a small scale feasibility study being conducted in the Salt Creek watershed, under the jurisdiction of the San Diego Regional Board, are being evaluated as part of the effort to refine toxicity monitoring approaches. The watershed investigation provides an opportunity to intensively study pollutants correlated with toxicity and assess alternate methods for evaluating the bioavailable fraction of pesticides present in samples. Efforts during the 2012-13 monitoring year will continue working towards establishing a better approach for assessing the relationship between pesticide concentrations and aquatic toxicity.

*Progress in identifying toxicants to benthic sediment species*

Sediment toxicity testing results show a distinct pattern in testing organism responses as shown in **Attachment C-11-II Table 13** and provided in terms of the SQO integrated toxicity assessment **in Table C-11.4** The *Eohaustorius estuarius* (*Eohaustorius*) results indicate that 69% of samples are classified as exhibiting a low toxicity level. In contrast, only 3.8% Mytillus gavoprovinciallus (Mytillus) samples showed a low toxicity level. The differences in these toxicity testing response patterns indicate:

- Although water column copper levels were elevated and Mytillus is sensitive to copper, the general absence of sediment-water interface toxicity to Mytillus suggests that benthic copper levels are not an important contributor to toxicity.
- The frequent occurrence of *Eohaustorius* toxicity suggests that pesticides or other similar stressors are affecting survival rates in harbor and estuary sediments.

Sediment toxicity monitoring using the *Eohaustorius* 10 day survival test in enclosed bays occurs multiple times throughout the year in Newport Bay, Talbert Marsh, Bolsa Bay, and Huntington Harbour. A summary of the 2011-12 *Eohaustorius* toxicity testing results are shown in **Table C-11.14**. Sediment toxicity results ranged from a survival rate of 48% to 100% on a regional basis and 48% of the samples collected were considered toxic.

Sediment samples for pesticide analysis were collected in concert with sediment toxicity samples to evaluate the relationship between the presence of the pyrethroid pesticides and survival rates for *Eohaustorius*. The results from the 2011-12 monitoring, shown in **Figure C-11.20**, indicate a poor relationship between pesticide presence and *Eohaustorius* survival rates.

Efforts during the 2012-13 will focus on analyzing additional data for relationship and patterns that help to better explain sediment toxicity including an effort to connect with the 2013 Bight Study coastal ecology workgroup to explore the causes of sediment toxicity in further detail.

C-11.4.2 Recreational Conditions from Bacteriological / Pathogen Monitoring

The structure of the beach water quality monitoring and assessment program is expected to change during 2012-13. As part of a coordinated effort to develop a collaborative, integrated, and efficient shoreline monitoring program, OC Public Works, on behalf of the Permittees, participated in technical workgroup meetings with representatives from the Santa Ana and San Diego Regional Water Quality Control Boards, Orange County Health Care Agency, South Orange County Wastewater Authority, and Orange County Sanitation District.

The goal of the workgroup was to establish a sustainable shoreline monitoring program that would ensure the future protection of beach water quality for residents and visitors. This workgroup formed as a result of 2008 state budget shortfalls and the moratorium on funding for the AB411 program.

Representatives from each agency initially joined together in 2008 to develop a unified program that would ensure monitoring coverage at beaches in the absence of state funding. Through support of the State Water Resources Control Board Beach Water Quality Workgroup, representatives from non-governmental organizations were provided the opportunity to review the proposed monitoring program to ensure that a broad spectrum of interests were met with the finalization of the collaborative monitoring program. Additionally, a workgroup convened in 2012 to finalize the development of the San Diego Regional Board jurisdiction shoreline program which included representative listed above and also included participation of Surfrider and Sierra Club representatives.

Beginning in early summer 2012, the Permittees entered into the new collaborative regional shoreline monitoring program. The regional shoreline monitoring program supports multiple objectives including

- a first time opportunity for the partners share knowledge about conditions and site histories while working together to monitor beach water quality
- development of a monitoring program that helps the regional boards achieve their goal of developing a sustainable beach water quality monitoring program that will ensure protection of the public
- combining monitoring programs so that sites are evaluated on an even comparison which provides a better contextual understanding of issues and ensures that priority sites receive the collective attention firsthand.
- a first time opportunity for the partners to leverage existing resources coupled with a greatly expanded set of technical capabilities that will allow the workgroup to collectively address water quality issues as needed.

Stakeholders in this regional program for the Fourth Term Municipal Stormwater Permit (R8-2009-0030, NPDES CAS618030) from the Santa Ana Regional Board, include the Permittees, the Santa Ana Regional Water Quality Control Boards, Orange County Health Care Agency, Orange County Sanitation District and representatives from Surfrider and Sierra Club.

*Progress in assessing indicator bacteria in inland receiving waters*

The NSMP conducted special studies during the 2011-12 year as part of the overall watershed implementation plan. A subset of the watershed implementation plan includes monitoring special studies to better understand the sources and pollutant loads from the MS4. The 2011-12 monitoring year included conducting mass balance studies in Peters Canyon Wash and Big Canyon Wash to evaluate the feasibility of storm drain diversions. While the primary focus of these diversions was to address Nitrogen and Selenium issues in the watershed, these efforts may also help to reduce indicator bacteria loads in the receiving waters and recreational areas such as Newport Bay.

### C-11.4.3 Urban Stream Bioassessment Monitoring

The Urban Stream Bioassessment monitoring effort has become integrated into a multi-year regional study of southern California watersheds. Each year, a new group of randomly selected creeks and channels in each county of Southern California are monitored using consistent protocols developed by the State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP). Although a comprehensive report of the results of this regional study will not be released until all of the sampling is completed, preliminary results of the monitoring conducted in Orange County are available. All eight sites monitored in Orange County this year yielded Index of Biotic Integrity scores in the "Poor" to "Very Poor" range.

During the 2011-12 year, the Permittees continued to participate in the Stormwater Monitoring Coalition's Regional Watershed Monitoring Program (SMC Program). The 2012 survey was the fourth year of the five year study to assess stream macroinvertebrate conditions across southern California. The goal of this multi-agency and multiple region study is to 1) determine the status of macroinvertebrate conditions across southern California streams, 2) identify key stressors that affect stream macroinvertebrate conditions, and 3) monitor receiving water stressors over time. Stream monitoring sites are stratified by urban, open space, and agricultural land uses to provide a better assessment across stressor gradients from chemical, biological, and physical influences.

Additionally, the Permittees participation in the SMC Program is contributing data to the State Waters Resources Control Board's development of biological objectives that will take into account conditions specific to the semi-arid coastal watersheds of southern California. Nearly one-third of all the data that the State Waters Resources Control Board will use to develop the biological objectives comes from the SMC Program and the efforts of the Permittees.

C-11.4.4 Dry Weather Reconnaissance Program

This was the fifth year of Dry Weather Reconnaissance Program and the data from some stormdrains in the monitoring network have identified persistent problems. The cities are kept up to date with immediate notification of obvious problems identified during the time of sampling and with monthly updates of the data from the entire program. An assessment of the MS4 dry weather data collected during the 2011-12 monitoring year provided an evaluation of urban sources as well as highlight lessons learned from this year.

The analysis discussed in **Section C-11.2.** shows that across monitoring sites, on a regional basis, individual constituent concentrations exceed benchmarks over wide range of frequencies from 0 to 92%. The ten constituents from the analyses, in decreasing order of prevalence, were 1) Inorganic Nitrogen, 2) Enterococcus, 3) Reactive Phosphorus, 4) Fecal Coliforms, 5) Ammonia, 6) Selenium, 7) Anionic Surfactants, 8) Copper, 9) Dissolved Oxygen, and 10) Total Suspended Solids. The analysis had some additional surprising results such as the exceedances frequencies for the organophosphorus pesticides (Chlorpyrifos, Diazinon, Dimethoate, Disulfoton, Malathion) ranging from 0% to 1.3%. In general, the analysis of the MS4 discharges mirrors that of the receiving waters.

The second approach to assessing the urban source contributions to receiving waters focuses on the magnitude of exceedance over benchmarks. Monitoring data were normalized to the benchmarks and ranked according to median values in decreasing order. This ranking of dry weather discharges indicates that Enterococcus, Orthophosphorus, Fecal Coliforms, Inorganic

Nitrogen, and Ammonia as N are the top five constituents from a magnitude assessment perspective. This ranking approach for constituents in dry weather is consistent with the receiving water issues suggesting that nutrients and indicator bacteria represent the most prevalent regulatory issues on a systemwide basis.

The magnitude ranking additionally shows that in contrast to applying only an exceedance frequency approach, the magnitude of the discharge does not always agree with the frequency of exceedance. The differences are particularly highlighted in the rankings of Inorganic Nitrogen and Enterococcus using the two different assessment approaches. These seemingly contradictory findings between frequency of exceedance and magnitude of exceedance suggest that a prioritization metric for dry weather discharges based on both frequency, magnitude and environmental significance needs to be given further consideration.

Efforts to identify and characterize urban sources that contribute to receiving water problems focuses on addressing each of the receiving water priorities listed in Section C-11.4.1.

C-11.4.4.1 Nutrients

Nutrient issues in dry weather MS4 discharges represents an area of uncertainty for the monitoring program with respect to making a connection between discharges and identification of various sources within a watershed. Lessons learned from Newport Bay have shown that agricultural, nurseries, and groundwater sources can contain high nutrients levels between 10 to 100 mg/L. The dry weather discharge monitoring shows that on average, the inorganic nitrogen concentration across the region is 2.6 mg/L ranging between 2.0 and 4.8 mg/L for the $25^{th}$ and $75^{th}$ percentiles, respectively. Seemingly, inorganic nitrogen levels in receiving waters equal and in some cases far exceed the regional MS4 average. This uncertainty has led the Permittees to initiate several efforts focused towards a better understanding of MS4 discharge characteristics including development of a sample database library to create "fingerprint" patterns of various nutrient sources in an effort to improve the Permittees' ability to track and locate sources within a MS4 drainage area.

Lessons learned from the 2011-12 monitoring year have helped to improve the understanding of nutrient issues by providing a greater level of detail about the relative proportions of the nutrient chemical forms from various sources. For example, the 2011-12 MS4 monitoring data indicates that 90.2% of the inorganic nitrogen is associated with nitrate-nitrogen. This type of basic understanding helps to direct source investigation efforts towards sources more likely to contribute nitrate in contrast the other forms of nitrogen present in the water column. This understanding will in turn provide perspective on the relationships between MS4 contributions and receiving water issues including a more informed approach towards developing appropriate control measures to address nutrient issues in receiving waters.

C-11.4.4.2 Copper in wet weather discharges

Sources of coppers in MS4 discharge during storm events can include atmospheric deposition, industrial and commercial area runoff, and the release of copper based algaecides.

Architectural copper represents a source of copper in wet weather discharges that the Permittees have not previously assessed.

In response to persistent elevated levels of total recoverable copper in stormwater runoff, a source investigation of architectural copper was conducted in a residential community MS4 drainage area. The monitoring design evaluated the wet weather runoff over multiple storm events of different sizes and at multiple locations within the drainage area. The monitoring design was intended to evaluate runoff within the upper and lower MS4 and included runoff monitoring from the adjacent highway.

Copper levels in the MS4 samples showed concentrations from 38 μg/L to 285 μg/L. In contrast, runoff samples collected from homes with architectural copper were found to have total copper concentrations ranging from 510 to 9800 μg/L. Highway runoff samples were much lower with concentrations ranging from 29 to 69 μg/L while atmospheric deposition concentrations of copper ranged from 8.9 to 120 μg/L. The results of the drainage area source investigation show that architectural copper was likely the largest source of copper in stormwater in this watershed.

C-11.4.4.3 Pesticides

Assessing the relationship between pesticides and impacts on receiving waters aquatic species is challenged by many confounding factors (see **Section C-11.4.1.3**) including the monitoring of appropriate pollutants actually correlated with toxicity. One of the primary goals of the monitoring program is to identify issues of concern and determine their extent within watersheds.

In order to manageably assess the relationship between pesticides and receiving water issues, a technical workgroup of the watershed stakeholders including the County of Orange, the cities of Dana Point and Laguna Niguel, the University of California Cooperative Extension, in coordination with staff from the Department of Pesticides Regulations, started a collaborative effort in the Salt Creek watershed to address receiving water toxicity issues. While the Salt Creek watershed is not under the jurisdiction of the Santa Ana Regional Board, the source investigation effort is relevant for understanding toxicity issues on a larger scale and findings from this feasibility study may support management efforts countywide.

The watershed investigation places a strong emphasis on evaluating pyrethroid pesticides but is also evaluating fipronil pesticides as a potential contributor to toxicity in receiving waters. Past watershed monitoring data collected by the Department of Pesticide Regulation indicates that fipronil pesticides are frequently detected in receiving waters throughout the Salt Creek Watershed in addition to the pyrethroid pesticides.

Preliminary findings from the watershed investigation suggests that both pyrethroid and fipronil pesticides are correlated with toxicity effects. The results suggests that the matrix type analyzed, for example the dissolved fraction in preference to total recoverable, is important for assessment purposes. The data analysis will continue during the 2012-13 year and the findings from this effort will summarized in a technical report.

C-11.4.5 Conditions from Land Use Correlations Monitoring

The Land Use Correlations Monitoring Program concluded sampling efforts in 2009 upon adoption of the Fourth Term Permit. No monitoring was conducted during the 2011-12 reporting period.

C-11.4.6 Newport Bay Conditions from Nutrient TMDL Monitoring

The Nutrient TMDL's reporting process is now quarterly. Electronic copies of the reports from the last four quarters can be found on the OC Watersheds website at

http://www.ocwatersheds.com/DocumentDatabaseLibrary.aspx

## C-11.5 Long Term Trends in Water Quality Conditions

Newport Bay has had a long challenging history with eutrophication, caused by over enrichment of nutrients. Beginning in the 1970's excessive growth of macro algae started to become detrimental to the beneficial uses of the Bay. Upper Newport Bay was especially impacted by the eutrophication conditions, as shown in **Figure C-11.21**. The intertidal mudflats that are an important component to the overall environmental function were increasingly carpeted by macro algae during the summer months.

By the mid 1980's, macro algae growth in the peak growing season extended throughout the entire Upper Bay and macro algae mats had even extended into the Lower Bay area as shown in **Figure C-11.22**. These algae mats contributed to periodic depletions of oxygen levels in the water column that in turn detrimentally affected the survival of aquatic species.

As a consequence, in the 1980s, a series of management actions were implemented in the watershed to reduce the discharge of nutrient rich waters. These initial actions included a focused effort on limiting treated effluent releases from storage impoundments, reducing discharges from the local horticulture nurseries, and the adoption of subsequent regulatory directives.

Water quality conditions in the San Diego Creek watershed, the primary contributing source for excess nutrient conditions, have experienced a dramatic change in nitrate levels over the period of nearly 40 years. Average nitrate concentrations in San Diego Creek at Campus Drive, **Figure C-11.23**, show that peak nitrate levels were experienced in the late 1980s and have declined significantly since.

While the early actions took aim at the largest contributing sources, progress has continued to be made in the watershed as a result of both BMPs and watershed land use changes. The implementation and subsequent expansion of diversions through the San Joaquin Marsh, adoption of water conserving strategies by Irvine Ranch Water District and implementation of the municipal stormwater program by the County and cities are all contributing factors in reduced nutrient loading to the Bay. Also significant has been the rapid development that has occurred in the watershed displacing agriculture, a significant source of nutrients and runoff, and resulting in a more manageable drainage system.

**Figure C-11.24** and **Figure C-11.25** show the long-term trends in dry weather flow rates and total nitrogen loads. The latter illustrates compliance with both the 2002 and 2007 summer season targets. Visual evidence, **Figure C-11.26**, also supports much improved conditions with significantly less macro algae on the intertidal mudflats of Upper Bay.

*Progress in the Newport Bay watershed*

The long term benefits to receiving waters conditions that the efforts of the Newport Bay watershed eutrophication problem have produced are many fold. This multiple decade effort that was accomplished by the watershed stakeholders and as a result produced;

- A ten fold decrease in the dry weather flow rates in San Diego Creek at Campus Drive**.**
- A ten fold or greater decrease in the average nitrate loads in San Diego Creek at Campus Drive**.**
- An almost complete absence of algae on the Upper Newport Bay intertidal mudflats

C-11.5.1 Indicator Bacteria

Beach water quality sites across the region continue to show moderate to low exceedance frequencies during dry weather conditions. Indicator bacteria exceedance frequencies over the period of 2007 to 2012, as shown in shown in **Figure C-11.27**, indicate that in general most beach sites have remained in fair to good condition with exceedance frequencies ranging from 1.6% to 8.9% over the five year period.

Buck Gulley Creek, which exhibited the highest overall exceedance frequency at 8.9%, has continued to improve with annual exceedances frequencies decreasing from 19.6% in 2007 down to 3.3% in 2012 (2012 data in **Table C-11.8**). These changes are attributed to the implementation of Best Management Practices by the City of Newport Beach to reduce urban runoff discharges to the beach and as a result beach water quality has shown remarkably improvement

C-11.5.2 MS4 Dry Weather Discharges

MS4 dry weather discharges have shown differing trends over the past seven years from 2006 to 2012. Regional average concentrations of fecal coliform and Enterococcus in dry weather MS4 discharges have decreased by a factor of 30 and 2, respectively, as shown in **Figure 32.** Median concentrations have decreased from 10,500 CFU/100mL in 2006 down to 340 CFU/100mL in 2012. The range of the 25$^{th}$ to 75$^{th}$ percentile fecal coliform concentrations in 2012 was 140 CFU/100mL to 3750 CFU/100mL. Likewise, Enterococcus median concentrations have decreased during this period from 4000 CFU/100mL in 2006 down to 2000 CFU/100mL in 2012 with a range in the 25$^{th}$ to 75$^{th}$ percentile concentrations from 390 CFU/100mL to 5100 CFU/100mL. Dry weather discharges are trending in right direction, but also suggest that efforts could be focused on sites with concentrations about the median values.

Dry weather MS4 nutrient levels from 2006 to 2012 are shown in **Figure 33**. Regional concentrations of reactive phosphorus have decreased 18% from 0.40 mg/L to 0.33 mg/L.

Regional concentrations of inorganic nitrogen, however, increased from 3.64 mg/L in 2006 to 3.89 mg/L in 2012. In the latter case, it is unclear whether the data indicates a source contribution not well characterized yet or whether there are other influences that might be contributing to the trend.

Average MS4 flow rates during dry weather also experienced a wide range of conditions between 2006 and 2012, see **Figure 34**. Mean discharge rate estimates over the seven year period have fluctuated five fold over from 0.27 cubic feet per second (cfs) in 2007 to 1.02 cfs in 2011. The range in the median discharge rates during this same time period was considerably smaller from 0.07 to 0.14 cfs. In 2012, the mean and median discharge rates were 0.45 and 0.08 cfs, respectively.

MS4 flow rates in dry weather appear to trend similarly with those of indicator bacteria and reactive phosphorus but not with inorganic nitrogen concentrations. This would suggest that additional effort is needed to better understand the relationship between nutrient levels and flow rates in MS4 discharges.

### C-11.6 Quality Assurance / Quality Control

The monitoring and reporting program is supported by an independent quality assurance assessment program developed and implemented by the Orange County Stormwater Program. Laboratory analyses are independently validated through quality control check samples in addition to the quality assurance requirements established by USEPA and Standard Method procedures. The quality assurance program evaluates data for accuracy, precision, and contamination using certified reference materials, laboratory control standards for common analyses, and duplicate field samples along with equipment and trip blanks.

The proportion of quality assurance samples submitted this year was 12.5% of the total samples submitted to the contractor laboratories for analyses. The Annual QA/ QC Summary which describes the quality assurance (QA) sample type and percent breakdown are presented in **Attachment C-11-IV**.

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 laboratory prepared standards to assess the quality of mobile laboratory field 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-IV**. 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.

Analyses from the Quality Assurance / Quality Control program results indicate that:

- The majority of pathogen indicator bacteria accuracies were within bounds of the control limits with total coliform accuracies having less scatter than fecal coliform bacteria. Pathogen indicator bacteria precisions were generally within bounds of the control limits with the highest range of scatter occurring for *Enterococcus*.

- The recoveries for duplicate analyses for nutrients were generally acceptable with most of the results remaining within control bounds. The majority of out of bounds results occurred for total suspended solids (TSS) and turbidity. Total kjeldahl nitrogen (TKN) precision recoveries had a few outliers for saltwater matrices.

- Accuracy results for oil and grease analyses trended low throughout the year. Recoveries from two contract labs returned similar results prompting an ongoing investigatory QA/QC study.

- Trace metal precision and accuracy results were generally within bounds with the majority of outliers occurring for antimony, beryllium and thallium in a saltwater matrix. Trace metals tended to have the best overall performance in terms of having the least amount and range of scatter associated with the analytical results.

- Organphosphorous Pesticides (OPP) returned accuracies which tended to have large and varied scatter. An investigation was established in order to determine the cause of the scatter. Findings showed the standard had expired in October 2011. Although the expired standard can account for the results after October the investigation did not yield any findings into the results prior to the expiration date.

- Trip blanks as well as equipment blanks for nutrients and trace metals were generally within bounds of the non-detect limit. The majority of outliers for trace metals occurred for saltwater matrices using a Suprapur and Nanopure synthetic solution. The majority of these detects were for zinc, iron, copper and lead. The majority of detects for nutrients occurred for total organic carbon (TOC). The contract lab tasked with the TOC analyses was switched mid-year and produced better results.

The accuracy of field chemical analyses in the Dry-Weather reconnaissance programs was generally acceptable and within control limits. Results of blind samples analyses were within acceptable error limits of ± 25% of the target value for more than 95% of the overall samples analyzed.

In 2012-13 it is expected that an intercalibration program will be initiated with the SMC to evaluate laboratory toxicity testing performance.

## C-11.7 Changes in Monitoring Program

The expected changes to the monitoring program in 2012-13 are;

- Participation in Bight 2013 to support the Marine Debris, Coastal Impact Assessment, and potentially Shoreline Microbiology studies. Pursuant to Monitoring and Reporting Program No. R8-2009-0030 Section I.2, a request may be submitted to the Executive Officer to allow further changes in the approved monitoring program for 2013/2014 in lieu of participation in Bight 2013.
- In 2012-13 the County will initiate a grant-funded project focusing on trash in receiving waters.
- Efforts during the 2012-13 monitoring year will continue working towards establishing a better approach for assessing the relationship between pesticide concentrations and aquatic toxicity
- Efforts during the 2012-13 will focus on analyzing additional data for relationship and patterns that help to better explain sediment toxicity including an effort to connect with the 2013 Bight Coastal Impact Assessment workgroup to explore the causes of harbor, estuary, and wetland sediment toxicity in further detail.
- Participation in the regional shoreline monitoring program, in collaboration with the, Orange County Health Care Agency, South Orange County Wastewater Authority, and Orange County Sanitation District.

## C-11.8 Summary

The 2012 Annual Water Quality Monitoring and Assessment Progress Report follows the question-driven monitoring approach established in 2002 by the Stormwater Monitoring Coalition. The analyses and findings presented in this progress report reflect an attempt to answer those questions through an effort that encompasses multiple assessments to evaluate conditions and trends over time in both the receiving waters and the MS4. The framework of this approach focuses on answering questions on a regional basis and highlights site specific issues that remain challenging to solve. Monitoring data collected across programs or across water bodies are integrated (to the extent possible) to a) provide an overview of the priority issues, b) identify major receiving water problems to address, c) assess contributions of MS4 discharges, d) determine if/how have management actions over time have affected the trends and e) create measurable, tangible and actionable results for managers to use as a reference point from which program effectiveness can be evaluated.

Analysis of monitoring data resulted in the following observations during the reporting year:

1) Nutrient and indicator bacteria contribute the greatest number of benchmark exceedances in receiving waters across the region. However, monitoring data suggests that nutrient and indicator bacteria levels are exhibiting significant decreasing trends over time.

2) Nutrient levels, in the Newport Bay watershed, have decreased very significantly and represent a major water quality success story. Indeed, monitoring shows:

- A ten fold decrease in the dry weather flow rates in San Diego Creek at Campus Drive**,**
- A ten fold or greater decrease in the average nitrate loads in San Diego Creek at Campus Drive**, and**
- An almost complete absence of algae on the Upper Newport Bay intertidal mudflats.

3) Beach water quality during dry weather tends to be in very good condition. Results show that monitoring sites exhibit low exceedance frequencies ranging from 2.6% to 3.1 % on an annual basis. Conditions in regional channels, on the other hand, tend to exhibit more exceedances; Enterococcus is the primary contributing factor to those exceedances.

4) Trends over time indicate that levels of indicator bacteria and reactive phosphorus in MS4 discharges, on average, are decreasing. Median Fecal Coliform levels across the MS4 during dry weather were 340 CFU/100mL while Enterococcus remains a more challenging, with a median concentration of 390 CFU/100mL. While progress to date is encouraging, Enterococcus levels at some sites are still elevated suggesting that additional source tracking efforts are needed.

5) In general, toxicity testing organisms showed little to no negative response to environmental sample exposure during dry weather conditions. The notable exception to this patter was the increased growth of *Selenastrum* capricornutum which is attributed to the presence of nutrients. During wet weather, the test organisms with the greatest response are the *Ceriodaphnia* dubia and *Americamysis* bahia which implicates pesticides as the source of the toxicity although no clear correlation between pyrethroid concentration and biological impact was established.

6) Sediment quality in the enclosed bays and estuaries are an area of concern. Sediment quality at 54% of enclosed bay and estuary sites are “Likely Impacted.” Sediment quality assessments did tend to follow noticeable patterns but were not consistent across the region. Sediment toxicity at these sites was also not equally distributed between the two toxicity testing species suggesting that future monitoring efforts will need to identify the contributing toxicant(s).

7) Biotic Integrity scores from urban streams were considered to be poor to very poor and ranged from 2.9 to 12.9 which was consistent with urban sites sampled during the prior years of the SMC Program. The evaluation of four years of SMC Program monitoring data in the Santa Ana Region shows that there is an apparent relationship between the biological community patterns and physical habitat parameters (e.g., channel alteration and instream cover). This relationship has been observed in a number of other bioassessment programs, including the County’s bioassessment monitoring in the San Diego Region and the San Gabriel River Watershed (LASGRWC 2010).